

# An Equivalent Radius of Gyration Approach to Flexural-Torsional Buckling for Singly Symmetric Sections

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## INTRODUCTION

Flexural-torsional buckling of compression members must now be considered when designing under all AISC specifications, i.e., Load and Resistance Factor Design<sup>1</sup> (LRFD) and Allowable Stress Design<sup>2</sup> (ASD). Many practicing structural engineers are probably somewhat unfamiliar with the basic flexural-torsional buckling theory and its meaning and application in the design environment. Zahn and Iwankiw<sup>3</sup> have presented an overview on this topic as a means of providing a practical understanding of this strength limit state. Furthermore, the presentation of this new dimension to novice design students not only poses a similar dilemma, but is compounded by the fact that more and more material must be crammed into an already crowded initial course of steel design.

It would seem reasonable that an attempt should be made to find a way of introducing this additional buckling mode to both students and practicing designers that would not only be comprehensive in nature, but easy to apply in the design arena. This could be accomplished by using the concept of an equivalent radius of gyration which has been utilized for many years and in a variety of design formats.<sup>4,5</sup> Thus, if an equivalent radius of gyration could be easily established for flexural-torsional buckling, that radius could be used along with the other applicable radii of gyration, i.e.,  $r_x$  and  $r_y$ , to establish the minimum tangent-modulus Euler load that would produce the governing critical buckling load. Such a concept could be easily explained and applied and, thus, provides the basis for this paper.

## TORSIONAL AND FLEXURAL-TORSIONAL BUCKLING OF COLUMNS

Although most axially loaded columns fail at either the tangent modulus Euler load or the load that produces significant local buckling, there is another mode of buckling failure which is characterized by twisting and occurs at smaller column lengths. Twist or torsional buckling is significant only

for open cross-sections with relatively thin-walled elements such as angles, structural tees, and channels.

The problem of torsional buckling in columns has been studied extensively by many investigators including Goodier,<sup>6</sup> Timoshenko and Gere,<sup>7</sup> and Hoff.<sup>8,9</sup> Such a detailed examination is beyond the scope of this paper. An attempt will be made, however, to summarize this problem in such a way as to shed light on the basic parameters that contribute to this buckling phenomenon. This paper also describes a reliable, quick approach to implementing such considerations, when applicable, into the design sequence of compression members.

Consider the thin-walled open cross-section of an arbitrary unsymmetrical shape as shown in Fig. 1. The deformation

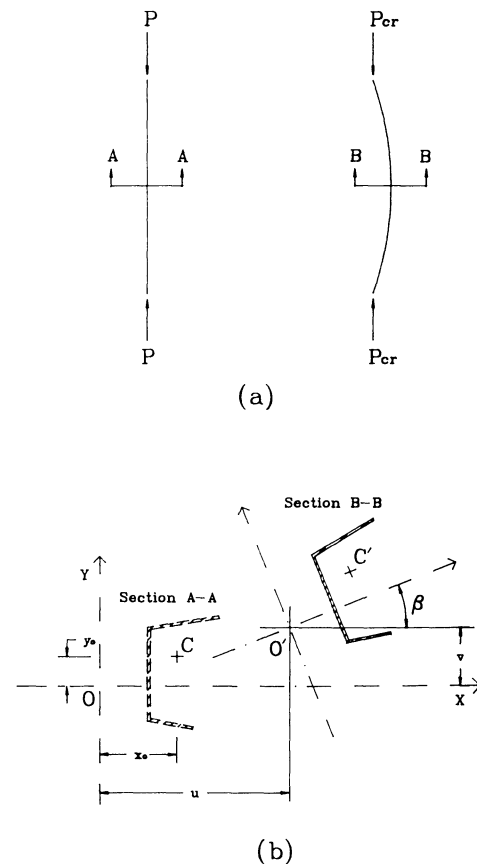


Fig. 1. Flexural-torsional buckling notations and displacements.<sup>9</sup>

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taking place during buckling is assumed to be a simultaneous combination of twisting about the shear center and bending about the two centroidal axes. It is desirable to maintain simplicity by reducing the deformation into two pure translations and a pure rotation. This can be accomplished by using the shear center (O) as the origin of the general coordinate system. The x and y directions are assumed to coincide with the principal axes of the section and the z direction is taken along the longitudinal axis through the shear center. As the result of buckling, the section undergoes translations  $u$  and  $v$  in the x and y directions, respectively, and a rotation  $\beta$  about the z axis (see Section B-B in Fig. 1).

Thus, in the general case where the shear center does not coincide with the section centroid, the buckling failure is actually a combination of torsion and flexure. For this case, the three differential equations which describe buckling by lateral bending about the x-axis, buckling by lateral bending about the y-axis and twisting about the shear center are interdependent. These three differential equations must be solved simultaneously in order to obtain the buckling loads. The development and solution of these simultaneous, interdependent equations have been treated extensively by Hoff<sup>9</sup> and Chajes,<sup>10</sup> and thus only the results will be presented here. For the unsymmetric case, the critical buckling load is the lowest of the three possible roots of the cubic equation

$$(P_y - P)(P_x - P)(P_z - P) - (P_y - P) \frac{P^2 x_O^2}{r_O^2} = 0 \quad (1)$$

where:

$$\begin{aligned} P_x &= \pi^2 EI_x / L^2 \\ P_y &= \pi^2 EI_y / L^2 \\ P_z &= \frac{1}{r_O^2} \left( GJ + E \frac{C_w \pi^2}{L^2} \right) \end{aligned} \quad (2)$$

$r_O$  = the polar radius of gyration of the cross-section with respect to the shear center.

The first two expressions are the usual Euler flexural buckling loads about the x and y axes, respectively. The third term  $P_z$  corresponds to torsional buckling in which  $C_w$  is the warping constant and  $J$  is the torsional constant. Values of  $J$  for non-circular shapes are available in textbooks on the theory of elasticity. For structural shapes such as the angle, W or I shapes, and channels made up of relatively thin, rectangular elements,  $J$  may be taken as:

$$J = \Sigma bt^3 / 3 \quad (3)$$

where  $b$  and  $t$  are the width and thickness of the rectangular elements of the cross-section respectively. Fortunately, the torsional values (including  $r_O$ ) for most shapes are tabulated in Part 1 of the AISC LRFD and ASD manuals. It can be clearly seen from the terms in this cubic equation that failure

of an unsymmetric column section will be a combination of buckling about the x and y axes and twisting about the z axis, as shown in Fig. 1.

If the cross-section has two axes of symmetry such as a wide flange member, the shear center (O) and the centroid (C) coincide, i.e.,  $x_O = 0$ ,  $y_O = 0$ , and the cubic equation reduces to

$$(P_y - P)(P_x - P)(P_z - P) = 0 \quad (4)$$

whose roots are

$$\begin{aligned} P &= P_y = \pi^2 EI_y / L^2 \\ P &= P_x = \pi^2 EI_x / L^2 \\ P &= P_z = \frac{1}{r_O^2} \left( GJ + \pi^2 \frac{EC_w}{L^2} \right) \end{aligned} \quad (5)$$

and the governing critical load will be the lowest load  $P$ . For columns in which the shear center and centroid are coincident, i.e., doubly symmetric shapes such as a wide flange, buckling will occur by the usual bending about one of the principal axes (flexural buckling) or by twisting (torsion) about the shear center (centroid). Combined flexural-torsional buckling does not occur since there are three independent solutions resulting in the fact that the twisting and flexural modes do not interfere (interact) with one another. In addition, torsional buckling will not generally control the design unless the member is relatively short, and this is not usually encountered in practice. In fact, material yielding may result before torsional buckling can occur in these sections.

When the cross-section has only one axis of symmetry, say the y axis, the shear center lies on that axis and  $x_O = 0$ . For this case the cubic equation for the critical buckling load reduces to

$$(P_x - P) \left[ (P_y - P)(P_z - P) - \frac{P^2 y_O^2}{r_O^2} \right] = 0 \quad (6)$$

whose solution yields

$$P = P_x = \pi^2 EI_x / L^2$$

or

$$(P_y - P)(P_z - P) - \frac{P^2 y_O^2}{r_O^2} = 0 \quad (7)$$

The first expression is flexural buckling about the x axis and the second is a quadratic in  $P$  whose roots correspond to buckling by a combination of bending and twisting, i.e., flexural-torsional buckling. The smaller of the roots is

$$P = P_{ft} = \frac{1}{2k} [P_z + P_y - \sqrt{(P_z + P_y)^2 - 4kP_z P_y}] \quad (8)$$

where:

$$k = 1 - (y_o / r_o)^2$$

and (12)

$$r_t = \sqrt{\frac{0.04JL^2}{I_p} + \frac{C_w}{I_p}}$$

Notice that for a singly symmetric shape such as an equal-leg angle, double angles, or tees, flexural buckling (about the symmetrical axis) and torsional buckling interact or are interdependent thereby indicating that buckling for such shapes will be by either flexural buckling about the non-symmetric axis or by the interacting flexural-torsional buckling. Which of these two modes is critical depends upon the shape of the cross-section as well as the given effective length.

In summary, for doubly symmetric sections it is customary and safe to neglect torsional buckling and base the design on the critical Euler load. For singly symmetric sections (double angles, tees, etc.) and unsymmetric sections, the flexural-torsional buckling load may be considerably less than the Euler load and thus, can govern the design.

If one takes the critical buckling load equations presented herein, and converts them to critical stresses by dividing through by the cross-section area  $A$ , these equations will reduce to those presented in Appendix E of the AISC LRFD Specification, provided that some additional modifications and substitutions are made such as

$$\begin{aligned} \bar{r}_o^2 &= x_o^2 + y_o^2 + \frac{I_x + I_y}{A} \\ H &= 1 - \left( \frac{x_o^2 + y_o^2}{\bar{r}_o^2} \right) \\ L &= KL \\ r_x &= \sqrt{I_x / A} \\ r_y &= \sqrt{I_y / A} \end{aligned} \quad (9)$$

### EQUIVALENT RADIUS OF GYRATION CONCEPT

Converting the expression for the critical torsional buckling load  $P_c$  given by Eq. 2 to a critical stress yields

$$F_c = \frac{1}{I_p} \left( GJ + \frac{\pi^2 EC_w}{L^2} \right) \quad (10)$$

Equating the critical Euler stress to this value yields

$$\begin{aligned} \frac{\pi^2 E}{(L/r)^2} &= \frac{1}{I_p} \left( GJ + \pi^2 \frac{EC_w}{L^2} \right) \\ r_t^2 &= \frac{L^2}{\pi^2 EI_p} \left( GJ + \pi^2 \frac{EC_w}{L^2} \right) \\ &= \frac{GJL^2}{\pi^2 EI_p} + \frac{C_w}{I_p} \end{aligned} \quad (11)$$

Taking  $G = 0.4E$  and  $\pi^2 = 9.87$

$$r_t^2 = \frac{0.04JL^2}{I_p} + \frac{C_w}{I_p}$$

where  $r_t$  is the equivalent radius of gyration for torsional buckling. Notice that  $r_t$  is a function of the column length  $L$ . Proceeding in a similar fashion for the flexural-torsional buckling mode,

$$\frac{\pi^2 E}{(L/r)^2} = \frac{P_{ft}}{A} \quad (13)$$

yields

$$\frac{1}{r_{ft}^2} = \frac{1}{2r_x^2} + \frac{1}{2r_y^2} + \sqrt{\left( \frac{1}{2r_x^2} - \frac{1}{2r_y^2} \right)^2 + \left( \frac{Y_o}{r_x r_y r_o} \right)^2} \quad (14)$$

where  $r_{ft}$  is the equivalent radius of gyration (in inches) for flexural-torsional buckling and  $r_o$  is the polar radius of gyration ( $\sqrt{I_p / A}$ ) where  $I_p$  is the polar moment of inertia about the shear center. It must be emphasized that since the expression for  $r_{ft}$  contains  $r_x$ , then  $r_{ft}$  is also dependent on the column length  $L$ .

This equivalent radius of gyration can be employed as with any radius of gyration. Therefore, if a singly symmetric section is considered such that  $x_o = 0$ , then  $(K_x L_x / r_x)$  and  $(K_y L_y / r_y)$  can be compared to determine which controls, since it is these two buckling modes which have to be considered for such singly symmetric shapes. The larger effective slenderness ratio value will govern the design and can be used with the applicable stress equations (either  $F_c$  in LRFD or  $F_a$  in ASD) to determine the controlling design or allowable load. In either case (LRFD or ASD), local buckling must be considered and the introduction of the form factors  $Q_s$  and  $Q_a$  can be incorporated as usual. For LRFD design, the additional consideration of  $(KL/r)_m$  for built-up members may also be incorporated when applicable using the usual procedures.

Before proceeding with specific design applications, some attention must be devoted to the physical significance of the equivalent radius of gyration  $r_{ft}$ . A plot of the various radii of gyration versus effective lengths are presented in Fig. 2 for a pair of 8x4x1 angles, long legs back-to-back (3/8-in. spacing). As was stated earlier,  $r_{ft}$  is a function of the effective length of the column while the other significant radii are constant for a given section and separation distance. For sections with  $r_x > r_y$ , flexural-torsional buckling will always control the buckling mode for any given effective length. For large effective lengths there will be essentially no difference between flexural buckling about the y-axis and flexural-torsional buckling, i.e.,  $r_y \approx r_{ft}$ . For sections where  $r_x < r_y$  a different relationship between these radii is obtained as shown in Fig. 3. In this instance, it would appear that flexural-torsional

buckling occurs for short effective column lengths only. Since the equivalent radii  $r_t$  and  $r_{ft}$  are approximately equal for very short effective lengths, torsional buckling is probably the controlling mode in these intervals. However, no accuracy is lost by assuming that  $r_{ft} \approx r_t$  in such instances.

In summary it should be noted that for sections represented by Figs. 2 and 3, only  $(KL/r)_x$  and  $(KL/r)_{ft}$  need to be compared since  $r_y$  will always be greater than  $r_{ft}$ . At short effective lengths  $r_t$  should also be considered since torsional buckling might control. However, since  $r_{ft}$  and  $r_t$  are numerically close for these lengths, no accuracy will be sacrificed by using  $r_{ft}$  for all cases.

The equivalent radius of gyration,  $r_{ft}$ , was computed and tabulated for all practical effective lengths for each double angle section (long legs and short legs back to back) as well as for each structural tee (cut from W shapes) that appears in the column load tables of the AISC manuals of steel construction. For the pairs of angles, back to back spacings of 0 in.,  $\frac{3}{8}$ -in., and  $\frac{3}{4}$ -in. have been included.

### USE OF TABLES

In order to demonstrate the use of the equivalent radius of gyration ( $r_{ft}$ ) concept for flexural-torsional buckling in a design scenario, a series of examples is presented using both the AISC LRFD and ASD Specifications. Each example is concluded by demonstrating its accuracy using a comparison with tabular values presented in the AISC manuals. It should

also be noted that an added benefit of these tabular  $r_{ft}$  values is that the designer is not limited by the grade of the steel used.

### Example 1

*Given:*

Determine the design strength using the AISC LRFD Specification for a pair of  $5 \times 3 \times \frac{3}{8}$  angles (long legs back to back,  $\frac{3}{8}$ -in. spacing) with  $KL_x = KL_y = 14$  ft. Use A36 steel and assume two intermediate connections.

*Solution:*

From the AISC LRFD Manual Part 1:

$$\begin{aligned} Q_s &= 0.982 & r_z &= 0.654 \text{ in.} & A_g &= 5.72 \text{ in.}^2 \\ r_x &= 1.61 \text{ in.} & r_y &= 1.23 \text{ in.} \end{aligned}$$

From the  $r_{ft}$  tables:  $r_{ft} = 1.19$  in. (at  $KL = 14$  ft.)

Since  $KL_x = KL_y$  and  $r_{ft} < r_y < r_x$ , flexural-torsional buckling will control.

Checking AISC LRFD Section E4:

$$a = (14)(12) / 3 = 56 \text{ in.}$$

$a / r_t = 56 / 0.654 = 85.63 > 50$ . Therefore, a modified slenderness ratio using AISC LRFD Eq. E4-2 must be computed.

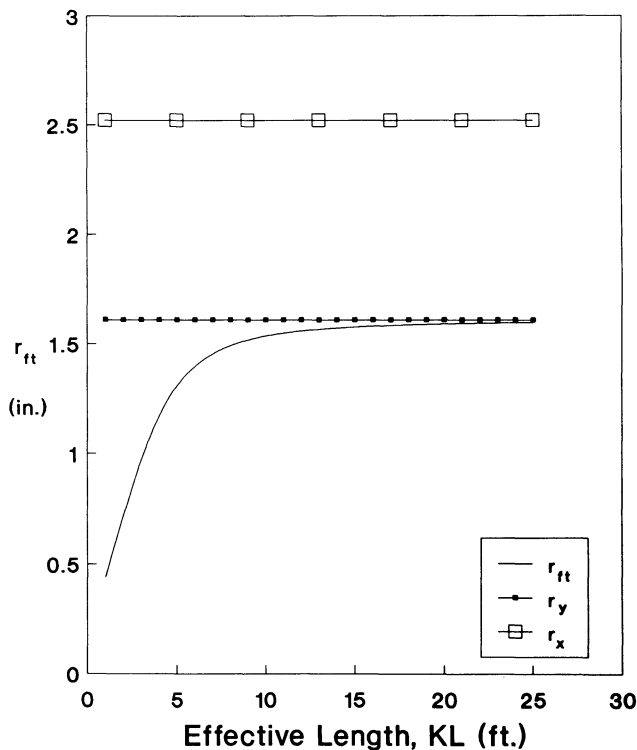


Fig. 2.  $r_{ft}$  vs.  $KL$  for double angles  $8 \times 4 \times 1$  LLBB,  $\frac{3}{8}$ -in. spacing.

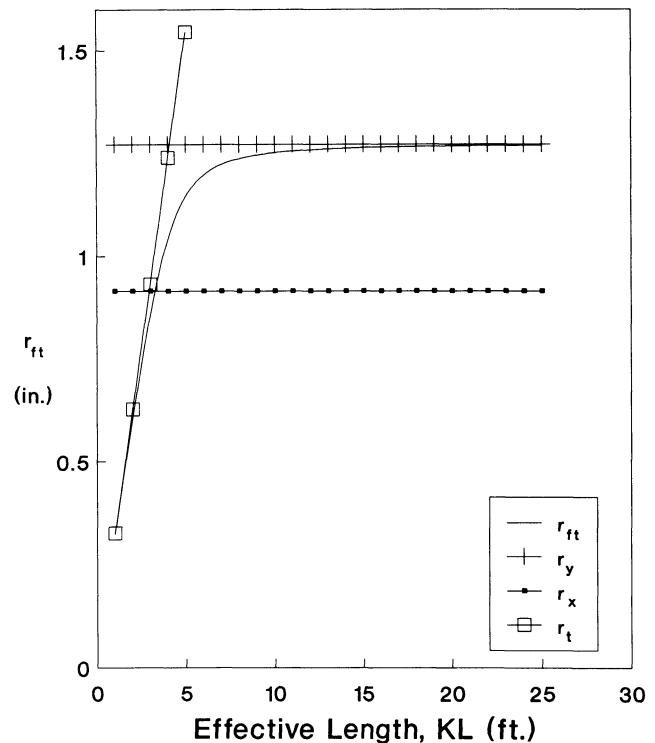


Fig. 3.  $r_{ft}$  vs.  $KL$  for double angles  $3 \times 3 \times \frac{3}{8}$ , equal legs, 0-in. spacing.

$$\left(\frac{KL}{r}\right)_m = \sqrt{\left[\frac{12(14)}{1.19}\right]^2 + (85.63 - 50)^2} = 145.60$$

$$\lambda_c = \frac{145.60}{\pi} \sqrt{\frac{36}{29,000}} = 1.633 \quad (\text{AISC LRFD Eq. E2-4})$$

since  $\lambda_c \sqrt{Q} = 1.633 \sqrt{0.982} = 1.62 > 1.5$ , use AISC LRFD Eq. E2-3.

$$F_{cr} = \left[\frac{0.877}{(1.633)^2}\right](36) = 11.84 \text{ ksi}$$

$$P_u = A_g F_{cr} = (5.72)(11.84) = 67.72 \text{ kip}$$

$$P_u = \phi P_n = 0.85(67.72) = 57.56 \text{ kip, say 58 kip}$$

Using the AISC LRFD column load tables (p. 2-62) as verification

$$P_u = 57 \text{ kip}$$

### Example 2

Given:

Determine the design strength using the AISC LRFD Specifications for a pair of  $5 \times 3 \times \frac{1}{2}$  angles (long legs back to back, 0-in. spacing) with  $KL_x = 20$  ft. and  $KL_y = 15$  ft. Use A36 steel and assume 2 intermediate connections.

Solution:

From the AISC LRFD Manual Part 1:

$$Q_s = 1.0 \quad r_z = 0.648 \text{ in.} \quad A_g = 7.5 \text{ in.}^2$$

$$r_y = 1.12 \text{ in.} \quad r_x = 1.59 \text{ in.}$$

From the  $r_{ft}$  tables:  $r_{ft} = 1.11$  in. (at  $KL = 15$  ft.)

$$KL_x / r_x = (12)(20) / 1.59 = 150.9$$

$$KL_y / r_y = (12)(15) / 1.12 = 160.7$$

$$KL_y / r_{ft} = (12)(15) / 1.11 = 162.2$$

Since  $KL_y / r_{ft}$  is the maximum effective slenderness ratio, flexural-torsional buckling will control.

Checking AISC LRFD Section E4:

$$a = (15)(12) / 3 = 60 \text{ in.}$$

$a / r_i = 60 / 0.648 = 92.6 > 50$ . Therefore, a modified slenderness ratio using AISC LRFD Eq. E4-2 must be computed.

$$\left(\frac{KL}{r}\right)_m = \sqrt{\left[\frac{12(15)}{1.11}\right]^2 + (92.6 - 50)^2} = 167.66$$

$$\lambda_c = \frac{167.66}{\pi} \sqrt{\frac{36}{29,000}} = 1.88 \quad (\text{AISC LRFD Eq. E2-4})$$

since  $\lambda_c > 1.5$ , use AISC LRFD Eq. E2-3.

$$F_{cr} = \left[\frac{0.877}{(1.88)^2}\right](36) = 9.93 \text{ ksi}$$

$$P_n = A_g F_{cr} = (7.5)(9.93) = 66.98 \text{ kip}$$

$$P_u = \phi P_n = 0.85(66.98) = 56.93 \text{ kip, say 57 kip}$$

Using AISC LRFD Table 3-36 (p. 6-124):

$$\text{For } KL / r = 167.66, \phi F_{cr} = 7.59 \text{ ksi}$$

$$P_n = \phi F_{cr} A_g = (7.59)(7.5) = 56.92 \text{ kip, say 57 kip}$$

Again, using the AISC LRFD column load tables (p. 2-62) as verification. Note  $r_y$  ( $\frac{3}{8}$ -in. spacing) = 1.25 in. and  $r_y$  (0-in. spacing) = 1.12 in.

$$r_y / r'_y = 1.25 / 1.12 = 1.116$$

An equivalent  $KL$  for  $\frac{3}{8}$ -in. spacing =  $1.116(15) = 16.74$  ft. and by interpolation from the table  $P_u = 56.67$  kip, say 57 kip

### Example 3

Given:

Determine the design strength using the AISC LRFD Specification for a WT10.5 $\times$ 25 with  $KL_x = KL_y = 14$  ft. Use A36 steel.

Solution:

From the AISC LRFD Manual Part 1:

$$Q_s = 0.733 \quad A_g = 7.36 \text{ in.}^2$$

$$r_y = 1.30 \text{ in.} \quad r_x = 3.30 \text{ in.}$$

From the  $r_{ft}$  tables:  $r_{ft} = 1.20$  in. (at  $KL = 14$  ft.)

Since  $KL_x = KL_y$  and  $r_{ft} < r_y < r_x$ , flexural-torsional buckling will control.

$$\lambda_c = \frac{14(12)}{1.20\pi} \sqrt{\frac{36}{29,000}} = 1.570 \quad (\text{AISC LRFD Eq. E2-4})$$

since  $\lambda_c \sqrt{Q} = 1.570 \sqrt{0.733} = 1.34 < 1.5$ , use AISC LRFD Eq. E2-2.

$$F_{cr} = 0.733(0.658^{(1.34)^2})36 = 12.44 \text{ ksi}$$

$$P_n = A_g F_{cr} = (7.36)(12.44) = 91.56$$

$$P_u = \phi P_n = 0.85(91.56) = 77.82 \text{ kip, say 78 kip}$$

Using the AISC LRFD column load tables (p. 2-87) again for verification,

$$P_u = 77 \text{ kip}$$

### Example 4

Given:

Determine the allowable load using the AISC ASD Specification for a pair of  $7 \times 4 \times \frac{3}{4}$  angles (long legs back to back,  $\frac{3}{8}$ -in. spacing) with  $KL_x = KL_y = 12$  ft. Use A36 steel.

*Solution:*

From the AISC ASD Manual Part 1:

$$\begin{aligned} Q_s &= 1.0 & A_g &= 15.4 \text{ in.}^2 \\ r_y &= 1.62 \text{ in.} & r_x &= 2.22 \text{ in.} \end{aligned}$$

From the  $r_{ft}$  tables:  $r_{ft} = 1.56 \text{ in.}$  (at  $KL = 12 \text{ ft.}$ )

Since  $KL_x = KL_y$ , and  $r_{ft} < r_y < r_x$ , flexural-torsional buckling will control.

$$KL / r_{ft} = (12)(12) / 1.56 = 92.31$$

$$C_c = \sqrt{2\pi^2 E / F_y} = \sqrt{2\pi^2(29,000) / 36} = 126.1$$

Since  $KL / r < C_c$ , use AISC ASD Eq. E2-1.

$$F_a = \frac{\left[1 - \frac{(92.31)^2}{2(126.1)^2}\right] 36}{\frac{5}{3} + \frac{3(92.31)}{8(126.1)} - \frac{(92.31)^3}{8(126.1)^3}} = 13.93 \text{ ksi}$$

Or using AISC ASD Table C-36 (p. 3-16):

$$\text{For } KL / r = 92.31, F_a = 13.93 \text{ ksi}$$

$$P = F_a A_g = (13.93)(15.4) = 214.5 \text{ kip, say } \mathbf{214 \text{ kip}}$$

Using the AISC ASD column load tables (p. 3-68) for verification

$$P = 214 \text{ kip}$$

### Example 5

*Given:*

Determine the allowable load using the AISC ASD Specification for a WT15x66 with  $KL_x = 40 \text{ ft.}$  and  $KL_y = 20 \text{ ft.}$  Use GR50 steel.

*Solution:*

From the AISC ASD Manual Part 1:

$$\begin{aligned} Q_s &= 0.664 & A_g &= 19.4 \text{ in.}^2 \\ r_y &= 2.25 \text{ in.} & r_x &= 4.66 \text{ in.} \end{aligned}$$

From the  $r_{ft}$  tables:  $r_{ft} = 2.12 \text{ in.}$  (at  $KL = 20 \text{ ft.}$ )

$$KL_x / r_x = (12)(40) / 4.66 = 103.0$$

$$KL_y / r_y = (12)(20) / 2.25 = 106.7$$

$$KL_y / r_{ft} = (12)(20) / 2.12 = 113.21 \leftarrow$$

Since  $KL_y / r_{ft}$  is the maximum effective slenderness ratio, flexural-torsional buckling will control.

$$C_c' = \sqrt{\frac{2\pi^2 E}{Q F_y}} = \sqrt{\frac{2\pi^2(29,000)}{(0.664)(50)}} = 131.31$$

where  $Q_s = Q$

Since  $KL / r < C_c'$ , use AISC ASD Eq. A-B5-11.

$$F_a = \frac{(0.664) \left[1 - \frac{(113.21)^2}{2(131.31)^2}\right] (50)}{\frac{5}{3} + \frac{3(113.21)}{8(131.31)} - \frac{(113.21)^3}{8(131.31)^3}} = 10.92 \text{ ksi}$$

$$P = F_a A_g = (10.92)(19.4) = 211.85 \text{ kip, say } \mathbf{212 \text{ kip}}$$

Using the AISC ASD column load tables (p. 3-88) for verification

$$P = 211 \text{ kip}$$

### CONCLUSIONS

Flexural-torsional buckling is a concept unfamiliar to most designers, and yet it can be the predominant factor in the design of singly symmetric compression members. A detailed explanation of this buckling mode cannot be found in most elementary steel design texts, and thus the seasoned designer, as well as the steel design student, are left to using a series of complicated design equations as a means of evaluating this phenomenon. While the column load tables in the AISC manuals deal effectively with this buckling mode, a student or novice designer would have some difficulty duplicating these tabular values. For grades of steel other than A36 or GR50, these designers would be left to their own means to consider the flexural-torsional contribution to the design process.

The introduction of the equivalent radius of gyration for flexural-torsional buckling (and torsional buckling to some degree) is an effective way of introducing the concept of this buckling mode to the steel design student or the novice designer. The tables associated with this equivalent radius of gyration provide an excellent supplement to the AISC manuals and an easy way to introduce this buckling mode into the usual design procedure for compression members. With some brief initial explanation of this buckling phenomena and how it interacts with the usual flexural buckling considerations (as presented herein), the introduction of the equivalent radius of gyration for flexural-torsional buckling blends right into usual design considerations and computations.

### NOMENCLATURE

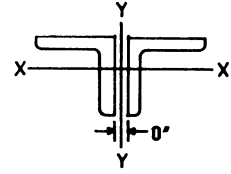
The symbols used in this paper follow the usage of the AISC ASD Manual, 9th Edition and the AISC LRFD Manual, 1st Edition.

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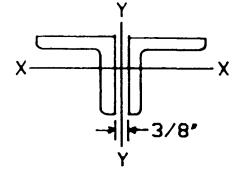
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**COLUMNS  
DOUBLE ANGLES**  
Flexural-Torsional Equivalent Radius of Gyration  
Equal legs 0 in. back to back of angles



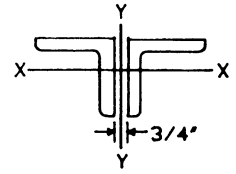
KL (ft):	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
SECTION	Flexural-Torsional Radius of Gyration (in)																								
8x8x1 1/8	0.46	0.75	1.06	1.38	1.69	1.99	2.27	2.52	2.73	2.89	3.01	3.10	3.17	3.21	3.25	3.28	3.30	3.31	3.33	3.34	3.35	3.35	3.36	3.37	3.37
8x8x1	0.41	0.67	0.95	1.23	1.52	1.79	2.06	2.30	2.52	2.70	2.85	2.97	3.05	3.12	3.17	3.20	3.23	3.26	3.27	3.29	3.30	3.31	3.32	3.33	3.33
8x8x7/8	0.36	0.59	0.83	1.09	1.34	1.59	1.83	2.06	2.27	2.46	2.63	2.77	2.89	2.98	3.05	3.10	3.15	3.18	3.21	3.23	3.25	3.26	3.27	3.28	3.29
8x8x3/4	0.31	0.50	0.72	0.94	1.16	1.37	1.59	1.79	1.99	2.18	2.35	2.51	2.65	2.77	2.86	2.94	3.01	3.06	3.10	3.13	3.16	3.19	3.20	3.22	3.23
8x8x5/8	0.26	0.42	0.60	0.79	0.97	1.16	1.34	1.52	1.69	1.86	2.03	2.18	2.33	2.46	2.58	2.69	2.78	2.86	2.92	2.98	3.02	3.06	3.09	3.12	3.14
8x8x1/2	0.21	0.34	0.49	0.63	0.78	0.93	1.08	1.23	1.38	1.52	1.66	1.80	1.93	2.06	2.19	2.30	2.41	2.51	2.60	2.68	2.76	2.82	2.88	2.93	2.97
6x6x1	0.48	0.84	1.22	1.57	1.88	2.12	2.28	2.38	2.44	2.48	2.50	2.52	2.53	2.54	2.55	2.55	2.56	2.56	2.56	2.57	2.57	2.57	2.57	2.57	2.58
6x6x7/8	0.43	0.74	1.07	1.39	1.69	1.94	2.14	2.27	2.35	2.41	2.45	2.47	2.49	2.50	2.51	2.52	2.53	2.53	2.54	2.54	2.54	2.55	2.55	2.55	2.55
6x6x3/4	0.37	0.64	0.92	1.21	1.48	1.72	1.93	2.10	2.22	2.31	2.36	2.40	2.43	2.45	2.47	2.48	2.49	2.50	2.50	2.51	2.51	2.52	2.52	2.52	2.52
6x6x5/8	0.31	0.54	0.78	1.02	1.26	1.48	1.69	1.87	2.02	2.14	2.23	2.30	2.34	2.38	2.40	2.42	2.44	2.45	2.46	2.47	2.47	2.48	2.48	2.49	2.49
6x6x1/2	0.25	0.43	0.63	0.83	1.02	1.21	1.40	1.57	1.73	1.87	1.99	2.09	2.17	2.24	2.28	2.32	2.35	2.37	2.39	2.40	2.42	2.43	2.44	2.44	2.45
6x6x3/8	0.19	0.33	0.48	0.63	0.78	0.93	1.08	1.22	1.36	1.49	1.62	1.73	1.84	1.94	2.02	2.09	2.15	2.20	2.24	2.27	2.30	2.32	2.34	2.36	2.37
5x5x7/8	0.48	0.87	1.25	1.58	1.82	1.96	2.03	2.07	2.09	2.11	2.12	2.13	2.13	2.14	2.14	2.14	2.14	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15
5x5x3/4	0.42	0.76	1.09	1.40	1.66	1.84	1.95	2.01	2.04	2.07	2.08	2.09	2.10	2.11	2.11	2.11	2.12	2.12	2.12	2.12	2.13	2.13	2.13	2.13	2.13
5x5x1/2	0.28	0.51	0.75	0.98	1.20	1.40	1.58	1.72	1.82	1.89	1.94	1.97	2.00	2.02	2.03	2.04	2.05	2.06	2.06	2.07	2.07	2.07	2.08	2.08	2.08
5x5x3/8	0.22	0.39	0.57	0.75	0.93	1.10	1.26	1.41	1.54	1.66	1.75	1.82	1.87	1.91	1.94	1.97	1.98	2.00	2.01	2.02	2.03	2.04	2.04	2.05	2.05
5x5x5/16	0.18	0.33	0.48	0.63	0.78	0.93	1.08	1.21	1.34	1.46	1.57	1.66	1.73	1.79	1.84	1.88	1.91	1.94	1.96	1.97	1.98	1.99	2.00	2.01	2.02
4x4x3/4	0.49	0.90	1.27	1.51	1.62	1.67	1.69	1.70	1.71	1.72	1.72	1.73	1.73	1.73	1.73	1.73	1.73	1.73	1.73	1.73	1.74	1.74	1.74	1.74	1.74
4x4x5/8	0.41	0.77	1.10	1.36	1.52	1.60	1.64	1.66	1.68	1.69	1.69	1.69	1.70	1.70	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.72
4x4x1/2	0.33	0.62	0.90	1.16	1.36	1.49	1.56	1.60	1.63	1.65	1.66	1.67	1.67	1.68	1.68	1.68	1.68	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.69
4x4x3/8	0.25	0.47	0.69	0.91	1.10	1.26	1.39	1.48	1.53	1.57	1.59	1.61	1.62	1.63	1.64	1.65	1.65	1.65	1.66	1.66	1.66	1.66	1.67	1.67	1.67
4x4x5/16	0.21	0.40	0.58	0.77	0.94	1.10	1.24	1.35	1.44	1.49	1.53	1.56	1.58	1.60	1.61	1.62	1.63	1.63	1.64	1.64	1.64	1.65	1.65	1.65	1.65
4x4x1/4	0.17	0.32	0.47	0.62	0.77	0.91	1.05	1.17	1.27	1.35	1.42	1.47	1.51	1.54	1.56	1.57	1.59	1.60	1.60	1.61	1.62	1.62	1.63	1.63	1.63
3.5x3.5x3/8	0.29	0.54	0.78	1.00	1.18	1.29	1.36	1.40	1.42	1.43	1.44	1.45	1.45	1.46	1.46	1.46	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47
3.5x3.5x5/16	0.24	0.45	0.66	0.86	1.04	1.18	1.27	1.33	1.37	1.40	1.41	1.42	1.43	1.44	1.44	1.45	1.45	1.45	1.45	1.46	1.46	1.46	1.46	1.46	1.46
3.5x3.5x1/4	0.19	0.37	0.54	0.71	0.86	1.01	1.13	1.22	1.28	1.33	1.36	1.38	1.39	1.41	1.41	1.42	1.43	1.43	1.44	1.44	1.44	1.44	1.44	1.44	1.45
3x3x1/2	0.42	0.79	1.06	1.19	1.24	1.26	1.27	1.27	1.28	1.28	1.28	1.28	1.28	1.28	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29
3x3x3/8	0.32	0.61	0.87	1.06	1.15	1.20	1.22	1.24	1.24	1.25	1.25	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.27	1.27	1.27	1.27	1.27
3x3x5/16	0.27	0.52	0.75	0.94	1.08	1.15	1.19	1.21	1.22	1.23	1.24	1.24	1.24	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.26	1.26	1.26
3x3x1/4	0.22	0.42	0.61	0.79	0.95	1.06	1.13	1.17	1.19	1.21	1.22	1.23	1.23	1.24	1.24	1.24	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
3x3x3/16	0.17	0.32	0.47	0.62	0.76	0.88	0.98	1.06	1.11	1.15	1.17	1.19	1.20	1.21	1.21	1.22	1.22	1.23	1.23	1.23	1.23	1.23	1.24	1.24	1.24
2.5x2.5x3/8	0.37	0.70	0.91	1.00	1.03	1.05	1.05	1.06	1.06	1.06	1.06	1.06	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07
2.5x2.5x5/16	0.31	0.59	0.82	0.95	1.00	1.02	1.03	1.04	1.05	1.05	1.05	1.05	1.05	1.05	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06
2.5x2.5x1/4	0.25	0.48	0.69	0.85	0.94	0.98	1.01	1.02	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05
2.5x2.5x3/16	0.19	0.37	0.54	0.70	0.82	0.90	0.95	0.98	0.99	1.00	1.01	1.02	1.02	1.02	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.04
2x2x3/8	0.45	0.75	0.83	0.85	0.86	0.86	0.86	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
2x2x5/16	0.38	0.68	0.80	0.83	0.84	0.85	0.85	0.85	0.85	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
2x2x1/4	0.31	0.58	0.74	0.80	0.82	0.83	0.84	0.84	0.84	0.84	0.84	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
2x2x3/16	0.24	0.45	0.63	0.74	0.79	0.81	0.82	0.82	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
2x2x1/8	0.16	0.31	0.46	0.58	0.68	0.74	0.77	0.79	0.80	0.81	0.81	0.81	0.81	0.82	0.82	0.82	0.82	0.82	0.82	0.83	0.83	0.83	0.83	0.83	0.83

**COLUMNS  
DOUBLE ANGLES**  
Flexural-Torsional Equivalent Radius of Gyration  
Equal legs  $\frac{3}{8}$ -in. back to back of angles



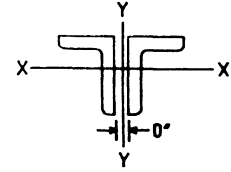
KL (ft):	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
SECTION	Flexural-Torsional Radius of Gyration (in)																								
8x8x1 1/8	0.45	0.73	1.04	1.35	1.66	1.96	2.25	2.51	2.73	2.92	3.06	3.17	3.25	3.31	3.35	3.38	3.41	3.43	3.44	3.45	3.46	3.47	3.48	3.49	3.49
8x8x1	0.40	0.65	0.93	1.21	1.49	1.76	2.03	2.28	2.50	2.70	2.87	3.01	3.11	3.19	3.25	3.30	3.33	3.36	3.38	3.40	3.42	3.43	3.44	3.45	3.46
8x8x7/8	0.35	0.57	0.82	1.07	1.31	1.56	1.80	2.03	2.25	2.45	2.63	2.79	2.92	3.03	3.11	3.18	3.23	3.27	3.31	3.33	3.35	3.37	3.39	3.40	3.41
8x8x3/4	0.30	0.49	0.70	0.92	1.13	1.35	1.56	1.76	1.96	2.15	2.33	2.50	2.65	2.78	2.90	2.99	3.07	3.13	3.18	3.22	3.26	3.28	3.31	3.33	3.34
8x8x5/8	0.25	0.41	0.59	0.77	0.95	1.13	1.31	1.49	1.67	1.84	2.00	2.16	2.31	2.45	2.58	2.70	2.80	2.89	2.97	3.04	3.09	3.14	3.18	3.21	3.24
8x8x1/2	0.20	0.33	0.47	0.62	0.77	0.92	1.06	1.21	1.35	1.49	1.64	1.77	1.91	2.04	2.16	2.28	2.40	2.51	2.61	2.70	2.78	2.85	2.92	2.98	3.03
6x6x1	0.47	0.82	1.18	1.54	1.86	2.13	2.33	2.46	2.54	2.59	2.62	2.64	2.66	2.67	2.68	2.69	2.69	2.70	2.70	2.70	2.70	2.71	2.71	2.71	2.71
6x6x7/8	0.41	0.72	1.04	1.36	1.66	1.93	2.15	2.31	2.43	2.50	2.55	2.58	2.60	2.62	2.63	2.64	2.65	2.65	2.66	2.66	2.67	2.67	2.67	2.68	2.68
6x6x3/4	0.36	0.62	0.90	1.18	1.45	1.70	1.93	2.12	2.26	2.37	2.44	2.50	2.53	2.56	2.58	2.59	2.61	2.62	2.62	2.63	2.63	2.64	2.64	2.65	2.65
6x6x5/8	0.30	0.52	0.76	1.00	1.23	1.45	1.66	1.86	2.03	2.17	2.28	2.36	2.42	2.47	2.50	2.53	2.55	2.56	2.57	2.58	2.59	2.60	2.61	2.62	2.62
6x6x1/2	0.24	0.42	0.61	0.81	1.00	1.18	1.37	1.54	1.71	1.86	2.00	2.12	2.21	2.29	2.35	2.40	2.44	2.47	2.49	2.51	2.53	2.54	2.55	2.56	2.57
6x6x3/8	0.18	0.32	0.46	0.61	0.76	0.91	1.05	1.19	1.33	1.46	1.59	1.72	1.83	1.94	2.03	2.12	2.19	2.25	2.30	2.34	2.38	2.41	2.43	2.45	2.47
5x5x7/8	0.47	0.84	1.22	1.56	1.84	2.02	2.12	2.18	2.21	2.23	2.25	2.26	2.26	2.27	2.27	2.28	2.28	2.28	2.28	2.29	2.29	2.29	2.29	2.29	2.29
5x5x3/4	0.40	0.73	1.06	1.37	1.65	1.87	2.01	2.10	2.15	2.18	2.20	2.22	2.23	2.24	2.24	2.25	2.25	2.26	2.26	2.26	2.26	2.26	2.27	2.27	2.27
5x5x1/2	0.27	0.50	0.73	0.95	1.17	1.38	1.57	1.73	1.86	1.96	2.02	2.07	2.11	2.13	2.15	2.16	2.17	2.18	2.19	2.19	2.20	2.20	2.21	2.21	2.21
5x5x3/8	0.21	0.38	0.55	0.73	0.90	1.07	1.24	1.39	1.53	1.66	1.77	1.86	1.93	1.99	2.03	2.06	2.08	2.10	2.12	2.13	2.14	2.15	2.16	2.16	2.17
5x5x5/16	0.17	0.32	0.46	0.61	0.76	0.90	1.05	1.19	1.32	1.44	1.56	1.66	1.75	1.83	1.89	1.95	1.99	2.02	2.05	2.07	2.09	2.10	2.11	2.12	2.13
4x4x3/4	0.47	0.87	1.25	1.54	1.70	1.78	1.81	1.83	1.84	1.85	1.86	1.86	1.86	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.88	1.88	1.88
4x4x5/8	0.40	0.74	1.07	1.36	1.57	1.69	1.75	1.78	1.80	1.82	1.83	1.83	1.84	1.84	1.84	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85
4x4x1/2	0.32	0.60	0.87	1.13	1.36	1.53	1.63	1.70	1.73	1.76	1.77	1.78	1.79	1.80	1.80	1.81	1.81	1.81	1.81	1.82	1.82	1.82	1.82	1.82	1.82
4x4x3/8	0.24	0.45	0.67	0.88	1.07	1.25	1.40	1.52	1.60	1.66	1.69	1.72	1.73	1.75	1.76	1.77	1.77	1.78	1.78	1.78	1.79	1.79	1.79	1.79	1.79
4x4x5/16	0.20	0.38	0.56	0.74	0.91	1.08	1.23	1.36	1.47	1.55	1.61	1.65	1.68	1.70	1.72	1.73	1.74	1.75	1.75	1.76	1.76	1.77	1.77	1.77	1.78
4x4x1/4	0.17	0.31	0.46	0.60	0.74	0.88	1.02	1.15	1.26	1.36	1.45	1.52	1.57	1.61	1.65	1.67	1.69	1.70	1.71	1.72	1.73	1.74	1.74	1.75	1.75
3.5x3.5x3/8	0.27	0.51	0.75	0.98	1.18	1.33	1.43	1.49	1.52	1.54	1.56	1.57	1.57	1.58	1.58	1.59	1.59	1.59	1.60	1.60	1.60	1.60	1.60	1.60	1.60
3.5x3.5x5/16	0.23	0.43	0.64	0.83	1.02	1.18	1.31	1.40	1.45	1.49	1.52	1.53	1.55	1.56	1.56	1.57	1.57	1.58	1.58	1.58	1.58	1.58	1.59	1.59	1.59
3.5x3.5x1/4	0.19	0.35	0.52	0.68	0.84	0.99	1.12	1.24	1.33	1.39	1.44	1.47	1.50	1.51	1.53	1.54	1.54	1.55	1.55	1.56	1.56	1.56	1.57	1.57	1.57
3x3x1/2	0.40	0.76	1.07	1.26	1.34	1.38	1.39	1.40	1.41	1.41	1.42	1.42	1.42	1.42	1.42	1.42	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43
3x3x3/8	0.31	0.58	0.84	1.07	1.22	1.30	1.34	1.36	1.37	1.38	1.39	1.39	1.39	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.41	1.41	1.41
3x3x5/16	0.26	0.49	0.72	0.93	1.10	1.22	1.28	1.32	1.34	1.36	1.36	1.37	1.38	1.38	1.38	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39
3x3x1/4	0.21	0.40	0.59	0.77	0.93	1.07	1.17	1.24	1.28	1.31	1.33	1.34	1.35	1.36	1.36	1.37	1.37	1.37	1.37	1.38	1.38	1.38	1.38	1.38	1.38
3x3x3/16	0.16	0.30	0.45	0.59	0.73	0.86	0.98	1.08	1.16	1.21	1.25	1.28	1.30	1.31	1.33	1.33	1.34	1.35	1.35	1.35	1.36	1.36	1.36	1.36	1.36
2.5x2.5x3/8	0.35	0.66	0.93	1.08	1.14	1.17	1.18	1.19	1.19	1.20	1.20	1.20	1.20	1.20	1.20	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21
2.5x2.5x5/16	0.29	0.56	0.81	0.99	1.09	1.14	1.16	1.17	1.18	1.18	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20
2.5x2.5x1/4	0.24	0.46	0.67	0.85	0.99	1.07	1.11	1.14	1.15	1.16	1.17	1.17	1.17	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.19	1.19	1.19
2.5x2.5x3/16	0.18	0.35	0.51	0.67	0.81	0.93	1.01	1.07	1.10	1.12	1.13	1.14	1.15	1.15	1.16	1.16	1.16	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17
2x2x3/8	0.42	0.77	0.94	0.98	0.99	1.00	1.00	1.00	1.00	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
2x2x5/16	0.35	0.66	0.87	0.95	0.97	0.98	0.99	0.99	0.99	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2x2x1/4	0.29	0.55	0.77	0.89	0.94	0.96	0.97	0.97	0.98	0.98	0.98	0.98	0.98	0.98	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
2x2x3/16	0.22	0.42	0.61	0.77	0.86	0.91	0.93	0.95	0.95	0.96	0.96	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
2x2x1/8	0.15	0.29	0.43	0.56	0.68	0.77	0.84	0.88	0.90	0.92	0.93	0.94	0.94	0.95	0.95	0.95	0.95	0.95	0.95	0.96	0.96	0.96	0.96	0.96	0.96

**COLUMNS  
DOUBLE ANGLES**  
Flexural-Torsional Equivalent Radius of Gyration  
Equal legs 3/4-in. back to back of angles



KL (ft):	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
SECTION																										
8x8x1 1/8	0.44	0.71	1.02	1.33	1.63	1.93	2.22	2.48	2.72	2.93	3.10	3.23	3.32	3.40	3.45	3.49	3.52	3.54	3.56	3.58	3.59	3.60	3.61	3.62	3.62	3.62
8x8x1	0.39	0.64	0.91	1.18	1.46	1.73	1.99	2.25	2.48	2.70	2.88	3.04	3.16	3.26	3.34	3.39	3.44	3.47	3.50	3.52	3.54	3.55	3.56	3.58	3.58	3.58
8x8x7/8	0.34	0.56	0.80	1.04	1.29	1.53	1.77	2.00	2.22	2.43	2.62	2.79	2.94	3.07	3.17	3.25	3.31	3.36	3.40	3.43	3.46	3.48	3.50	3.51	3.52	3.52
8x8x3/4	0.30	0.48	0.69	0.90	1.11	1.32	1.53	1.74	1.93	2.13	2.31	2.48	2.64	2.79	2.92	3.02	3.12	3.19	3.25	3.30	3.34	3.38	3.41	3.43	3.45	3.45
8x8x5/8	0.25	0.41	0.58	0.76	0.93	1.11	1.29	1.46	1.64	1.81	1.97	2.13	2.29	2.43	2.57	2.70	2.81	2.91	3.00	3.08	3.15	3.20	3.25	3.29	3.32	3.32
8x8x1/2	0.20	0.33	0.47	0.61	0.75	0.90	1.04	1.19	1.33	1.47	1.61	1.75	1.88	2.01	2.14	2.27	2.38	2.50	2.60	2.70	2.79	2.88	2.95	3.02	3.08	3.08
6x6x1	0.45	0.80	1.15	1.50	1.83	2.12	2.36	2.52	2.62	2.69	2.73	2.76	2.78	2.80	2.81	2.82	2.82	2.83	2.83	2.84	2.84	2.84	2.85	2.85	2.85	2.85
6x6x7/8	0.40	0.70	1.01	1.33	1.63	1.91	2.15	2.35	2.49	2.59	2.65	2.70	2.73	2.75	2.76	2.78	2.79	2.80	2.80	2.81	2.81	2.82	2.82	2.82	2.82	2.82
6x6x3/4	0.35	0.60	0.88	1.15	1.41	1.67	1.90	2.11	2.29	2.42	2.52	2.59	2.63	2.67	2.69	2.71	2.73	2.74	2.75	2.76	2.77	2.77	2.78	2.78	2.78	2.78
6x6x5/8	0.29	0.51	0.74	0.97	1.20	1.42	1.64	1.84	2.02	2.18	2.31	2.42	2.50	2.56	2.60	2.63	2.66	2.68	2.69	2.71	2.72	2.73	2.73	2.74	2.75	2.75
6x6x1/2	0.23	0.41	0.60	0.78	0.97	1.16	1.34	1.51	1.68	1.84	1.99	2.12	2.24	2.33	2.41	2.47	2.52	2.56	2.59	2.62	2.64	2.66	2.67	2.68	2.69	2.69
6x6x3/8	0.18	0.31	0.45	0.60	0.74	0.88	1.02	1.16	1.30	1.44	1.57	1.69	1.81	1.92	2.03	2.12	2.21	2.28	2.35	2.40	2.45	2.48	2.52	2.54	2.57	2.57
5x5x7/8	0.45	0.81	1.18	1.53	1.84	2.06	2.21	2.29	2.33	2.36	2.38	2.40	2.41	2.41	2.42	2.42	2.43	2.43	2.43	2.43	2.43	2.44	2.44	2.44	2.44	2.44
5x5x3/4	0.39	0.70	1.03	1.34	1.63	1.87	2.06	2.18	2.25	2.29	2.32	2.34	2.36	2.37	2.38	2.38	2.39	2.39	2.39	2.40	2.40	2.40	2.40	2.40	2.40	2.41
5x5x1/2	0.26	0.48	0.70	0.92	1.14	1.35	1.55	1.72	1.87	2.00	2.09	2.15	2.20	2.24	2.26	2.28	2.29	2.31	2.32	2.32	2.33	2.33	2.34	2.34	2.35	2.35
5x5x3/8	0.20	0.36	0.53	0.71	0.87	1.04	1.20	1.36	1.51	1.65	1.77	1.88	1.97	2.04	2.09	2.14	2.17	2.20	2.22	2.24	2.25	2.26	2.27	2.28	2.29	2.29
5x5x5/16	0.17	0.31	0.45	0.59	0.74	0.88	1.02	1.16	1.29	1.42	1.54	1.65	1.75	1.85	1.92	1.99	2.05	2.09	2.13	2.16	2.18	2.20	2.22	2.23	2.24	2.24
4x4x3/4	0.45	0.84	1.23	1.61	1.96	2.25	2.46	2.58	2.66	2.70	2.73	2.75	2.77	2.78	2.79	2.79	2.80	2.80	2.80	2.81	2.81	2.81	2.81	2.81	2.81	2.82
4x4x5/8	0.38	0.71	1.03	1.33	1.58	1.75	1.84	1.89	1.92	1.94	1.95	1.96	1.97	1.97	1.98	1.98	1.98	1.99	1.99	1.99	1.99	1.99	1.99	1.99	1.99	1.99
4x4x1/2	0.31	0.57	0.84	1.10	1.34	1.54	1.69	1.78	1.84	1.88	1.90	1.92	1.93	1.94	1.94	1.95	1.95	1.96	1.96	1.96	1.96	1.96	1.97	1.97	1.97	1.97
4x4x3/8	0.23	0.44	0.64	0.84	1.04	1.23	1.39	1.54	1.65	1.73	1.78	1.82	1.85	1.87	1.88	1.89	1.90	1.91	1.91	1.92	1.92	1.92	1.92	1.93	1.93	1.93
4x4x5/16	0.20	0.37	0.54	0.71	0.88	1.04	1.20	1.34	1.47	1.58	1.66	1.72	1.77	1.80	1.83	1.84	1.86	1.87	1.88	1.89	1.89	1.90	1.90	1.91	1.91	1.91
4x4x1/4	0.16	0.30	0.44	0.58	0.72	0.86	0.99	1.12	1.24	1.35	1.46	1.54	1.62	1.68	1.72	1.76	1.79	1.81	1.83	1.84	1.85	1.86	1.87	1.87	1.88	1.88
3.5x3.5x3/8	0.26	0.49	0.72	0.94	1.15	1.33	1.47	1.56	1.62	1.65	1.67	1.69	1.70	1.71	1.72	1.72	1.72	1.73	1.73	1.73	1.74	1.74	1.74	1.74	1.74	1.74
3.5x3.5x5/16	0.22	0.41	0.61	0.80	0.99	1.16	1.31	1.43	1.52	1.58	1.62	1.64	1.66	1.68	1.69	1.70	1.70	1.71	1.71	1.71	1.72	1.72	1.72	1.72	1.72	1.72
3.5x3.5x1/4	0.18	0.33	0.49	0.65	0.81	0.96	1.10	1.23	1.34	1.43	1.50	1.55	1.59	1.62	1.64	1.65	1.66	1.67	1.68	1.69	1.69	1.70	1.70	1.70	1.70	1.70
3x3x1/2	0.38	0.72	1.04	1.29	1.44	1.51	1.54	1.55	1.56	1.57	1.57	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.59	1.59	1.59	1.59	1.59	1.59	1.59
3x3x3/8	0.29	0.55	0.81	1.04	1.24	1.37	1.44	1.48	1.50	1.52	1.53	1.53	1.54	1.54	1.54	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55
3x3x5/16	0.24	0.46	0.69	0.90	1.09	1.24	1.35	1.42	1.46	1.48	1.50	1.51	1.52	1.52	1.53	1.53	1.53	1.53	1.54	1.54	1.54	1.54	1.54	1.54	1.54	1.54
3x3x1/4	0.20	0.38	0.56	0.73	0.90	1.05	1.19	1.29	1.36	1.41	1.44	1.46	1.47	1.48	1.49	1.50	1.50	1.50	1.51	1.51	1.51	1.51	1.52	1.52	1.52	1.52
3x3x3/16	0.15	0.29	0.43	0.56	0.70	0.83	0.95	1.07	1.17	1.25	1.31	1.36	1.39	1.42	1.44	1.45	1.46	1.47	1.48	1.48	1.49	1.49	1.49	1.49	1.49	1.50
2.5x2.5x3/8	0.32	0.62	0.90	1.12	1.24	1.29	1.32	1.33	1.34	1.34	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36
2.5x2.5x5/16	0.27	0.52	0.77	0.99	1.15	1.23	1.28	1.30	1.31	1.32	1.33	1.33	1.34	1.34	1.34	1.34	1.34	1.34	1.34	1.34	1.34	1.35	1.35	1.35	1.35	1.35
2.5x2.5x1/4	0.22	0.43	0.63	0.82	0.99	1.12	1.20	1.25	1.28	1.29	1.30	1.31	1.32	1.32	1.32	1.32	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33
2.5x2.5x3/16	0.17	0.32	0.48	0.63	0.78	0.91	1.03	1.12	1.18	1.22	1.24	1.26	1.27	1.28	1.29	1.29	1.30	1.30	1.30	1.30	1.31	1.31	1.31	1.31	1.31	1.31
2x2x3/8	0.38	0.73	1.00	1.10	1.14	1.15	1.16	1.16	1.16	1.16	1.16	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17
2x2x5/16	0.32	0.62	0.89	1.04	1.10	1.13	1.14	1.14	1.15	1.15	1.15	1.15	1.15	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16
2x2x1/4	0.26	0.50	0.74	0.92	1.03	1.08	1.10	1.11	1.12	1.12	1.13	1.13	1.13	1.13	1.13	1.13	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14
2x2x3/16	0.20	0.39	0.57	0.74	0.89	0.99	1.04	1.07	1.09	1.10	1.11	1.11	1.11	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.13	1.13	1.13	1.13
2x2x1/8	0.14	0.27	0.39	0.52	0.64	0.76	0.85	0.93	0.99	1.02	1.04	1.06	1.07	1.08	1.08	1.09	1.09	1.09	1.09	1.10	1.10	1.10	1.10	1.10	1.10	1.10

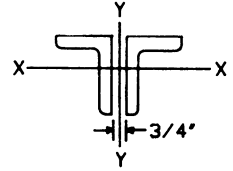
**COLUMNS  
DOUBLE ANGLES**  
Flexural-Torsional Equivalent Radius of Gyration  
Long legs 0 in. back to back of angles



KL (ft):	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
SECTION	Flexural-Torsional Radius of Gyration (in)																								
8x6x1	0.44	0.73	1.03	1.31	1.57	1.78	1.94	2.05	2.13	2.19	2.23	2.26	2.28	2.30	2.31	2.32	2.33	2.34	2.34	2.35	2.35	2.35	2.36	2.36	2.36
8x6x3/4	0.33	0.55	0.79	1.02	1.24	1.44	1.62	1.77	1.89	1.98	2.05	2.10	2.15	2.18	2.20	2.22	2.24	2.25	2.26	2.27	2.28	2.29	2.29	2.30	2.30
8x6x1/2	0.22	0.37	0.53	0.69	0.85	1.01	1.16	1.30	1.43	1.55	1.66	1.75	1.83	1.90	1.96	2.01	2.05	2.08	2.11	2.13	2.15	2.17	2.18	2.20	2.21
8x4x1	0.45	0.72	0.96	1.14	1.25	1.31	1.36	1.38	1.40	1.41	1.42	1.43	1.44	1.44	1.45	1.45	1.45	1.45	1.46	1.46	1.46	1.46	1.46	1.46	1.46
8x4x3/4	0.34	0.56	0.77	0.95	1.08	1.17	1.23	1.28	1.31	1.33	1.35	1.36	1.37	1.37	1.38	1.39	1.39	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.41
8x4x1/2	0.23	0.38	0.54	0.69	0.82	0.93	1.02	1.10	1.15	1.19	1.22	1.25	1.27	1.28	1.30	1.31	1.32	1.32	1.33	1.33	1.34	1.34	1.35	1.35	1.35
7x4x3/4	0.37	0.62	0.86	1.05	1.19	1.27	1.33	1.37	1.39	1.41	1.42	1.43	1.44	1.44	1.45	1.45	1.46	1.46	1.46	1.46	1.46	1.47	1.47	1.47	1.47
7x4x1/2	0.25	0.43	0.61	0.77	0.92	1.04	1.13	1.20	1.25	1.29	1.31	1.34	1.35	1.36	1.37	1.38	1.39	1.40	1.40	1.40	1.41	1.41	1.41	1.42	1.42
7x4x3/8	0.19	0.33	0.47	0.60	0.73	0.85	0.95	1.04	1.11	1.17	1.21	1.25	1.27	1.30	1.31	1.33	1.34	1.35	1.36	1.37	1.37	1.38	1.38	1.39	1.39
6x4x3/4	0.40	0.70	0.98	1.18	1.31	1.39	1.44	1.46	1.48	1.50	1.51	1.51	1.52	1.52	1.53	1.53	1.53	1.53	1.54	1.54	1.54	1.54	1.54	1.54	1.54
6x4x5/8	0.34	0.60	0.85	1.05	1.20	1.30	1.37	1.41	1.44	1.46	1.47	1.48	1.49	1.49	1.50	1.50	1.51	1.51	1.51	1.51	1.51	1.52	1.52	1.52	1.52
6x4x1/2	0.27	0.49	0.69	0.88	1.04	1.17	1.26	1.32	1.36	1.39	1.41	1.43	1.44	1.45	1.46	1.47	1.47	1.48	1.48	1.48	1.49	1.49	1.49	1.49	1.49
6x4x3/8	0.21	0.37	0.54	0.69	0.84	0.97	1.08	1.17	1.24	1.29	1.33	1.36	1.38	1.40	1.41	1.42	1.43	1.44	1.45	1.45	1.46	1.46	1.46	1.47	1.47
6x3.5x3/8	0.21	0.37	0.53	0.68	0.81	0.92	1.00	1.06	1.10	1.13	1.15	1.17	1.19	1.20	1.20	1.21	1.22	1.22	1.23	1.23	1.23	1.24	1.24	1.24	1.24
6x3.5x5/16	0.18	0.31	0.45	0.59	0.71	0.82	0.90	0.98	1.03	1.07	1.11	1.13	1.15	1.17	1.18	1.19	1.20	1.21	1.21	1.22	1.22	1.23	1.23	1.23	1.23
5x3.5x3/4	0.46	0.81	1.07	1.22	1.29	1.33	1.35	1.36	1.37	1.38	1.38	1.38	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.40	1.40	1.40	1.40
5x3.5x1/2	0.31	0.56	0.79	0.98	1.11	1.18	1.23	1.26	1.28	1.30	1.31	1.31	1.32	1.32	1.33	1.33	1.33	1.33	1.34	1.34	1.34	1.34	1.34	1.34	1.34
5x3.5x3/8	0.24	0.43	0.62	0.79	0.94	1.05	1.13	1.18	1.22	1.24	1.26	1.27	1.29	1.29	1.30	1.30	1.31	1.31	1.32	1.32	1.32	1.32	1.32	1.32	1.33
5x3.5x5/16	0.20	0.36	0.53	0.68	0.82	0.94	1.03	1.10	1.15	1.19	1.21	1.23	1.25	1.26	1.27	1.28	1.29	1.29	1.29	1.30	1.30	1.31	1.31	1.31	1.31
5x3x1/2	0.31	0.56	0.76	0.90	0.98	1.02	1.05	1.07	1.08	1.09	1.09	1.10	1.10	1.10	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11
5x3x3/8	0.24	0.43	0.61	0.76	0.86	0.93	0.98	1.01	1.03	1.04	1.05	1.06	1.07	1.07	1.08	1.08	1.08	1.08	1.08	1.08	1.09	1.09	1.09	1.09	1.09
5x3x5/16	0.20	0.36	0.52	0.66	0.77	0.86	0.92	0.96	0.99	1.01	1.02	1.03	1.04	1.05	1.06	1.06	1.06	1.07	1.07	1.07	1.07	1.08	1.08	1.08	1.08
5x3x1/4	0.16	0.29	0.43	0.55	0.66	0.75	0.82	0.88	0.92	0.95	0.98	0.99	1.01	1.02	1.03	1.03	1.04	1.04	1.04	1.05	1.05	1.05	1.06	1.06	1.06
4x3.5x1/2	0.35	0.65	0.92	1.13	1.26	1.33	1.36	1.38	1.40	1.41	1.41	1.42	1.42	1.42	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.44
4x3.5x3/8	0.27	0.50	0.72	0.92	1.09	1.20	1.27	1.31	1.34	1.36	1.37	1.38	1.38	1.39	1.39	1.40	1.40	1.40	1.40	1.40	1.41	1.41	1.41	1.41	1.41
4x3.5x5/16	0.23	0.42	0.62	0.80	0.96	1.09	1.18	1.25	1.29	1.32	1.34	1.36	1.37	1.38	1.38	1.39	1.39	1.39	1.39	1.40	1.40	1.40	1.41	1.41	1.41
4x3.5x1/4	0.18	0.34	0.50	0.65	0.80	0.93	1.04	1.13	1.20	1.24	1.28	1.31	1.32	1.34	1.35	1.36	1.36	1.36	1.37	1.37	1.38	1.38	1.38	1.39	1.39
4x3x1/2	0.37	0.67	0.90	1.03	1.10	1.13	1.15	1.17	1.17	1.18	1.18	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.20	1.20	1.20	1.20	1.20
4x3x3/8	0.28	0.52	0.73	0.89	1.00	1.06	1.10	1.12	1.13	1.14	1.15	1.15	1.16	1.16	1.16	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17
4x3x5/16	0.23	0.44	0.63	0.79	0.91	0.99	1.05	1.08	1.10	1.11	1.13	1.13	1.14	1.14	1.15	1.15	1.15	1.15	1.16	1.16	1.16	1.16	1.16	1.16	1.16
4x3x1/4	0.19	0.35	0.51	0.66	0.79	0.89	0.96	1.01	1.05	1.07	1.09	1.10	1.11	1.12	1.12	1.13	1.13	1.14	1.14	1.14	1.14	1.14	1.15	1.15	1.15
3.5x3x3/8	0.30	0.57	0.80	0.97	1.07	1.13	1.16	1.17	1.18	1.19	1.20	1.20	1.20	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.22	1.22	1.22	1.22
3.5x3x5/16	0.25	0.48	0.69	0.87	0.99	1.07	1.11	1.14	1.16	1.17	1.18	1.18	1.19	1.19	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20
3.5x3x1/4	0.21	0.39	0.57	0.73	0.87	0.97	1.04	1.08	1.11	1.13	1.15	1.16	1.16	1.17	1.17	1.18	1.18	1.18	1.18	1.18	1.19	1.19	1.19	1.19	1.19
3.5x2.5x3/8	0.31	0.57	0.75	0.85	0.90	0.93	0.94	0.95	0.96	0.96	0.96	0.96	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
3.5x2.5x5/16	0.26	0.49	0.67	0.79	0.86	0.89	0.92	0.93	0.94	0.94	0.95	0.95	0.95	0.95	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
3.5x2.5x1/4	0.21	0.40	0.57	0.70	0.79	0.84	0.88	0.90	0.91	0.92	0.93	0.93	0.94	0.94	0.94	0.94	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
3x2.5x3/8	0.35	0.64	0.83	0.93	0.97	0.98	0.99	1.00	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02
3x2.5x1/4	0.24	0.45	0.63	0.78	0.86	0.91	0.94	0.96	0.97	0.97	0.98	0.98	0.98	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.00	1.00	1.00	1.00
3x2.5x3/16	0.18	0.34	0.50	0.64	0.75	0.83	0.88	0.91	0.93	0.94	0.95	0.96	0.97	0.97	0.97	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.99	0.99	0.99
3x2x3/8	0.36	0.60	0.70	0.74	0.75	0.76	0.76	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.78	0.78	0.78	0.78	0.78	0.78	0.78
3x2x5/16	0.30	0.53	0.65	0.71	0.73	0.74	0.75	0.75	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.77	0.77	0.77	0.77
3x2x1/4	0.25	0.45	0.59	0.66	0.70	0.72	0.73	0.74	0.74	0.74	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
3x2x3/16	0.19	0.36	0.50	0.59	0.65	0.68	0.70	0.71	0.72	0.73	0.73	0.73	0.73	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.75	0.75
2.5x2x3/8	0.40	0.67	0.76	0.79	0.80	0.81	0.81	0.81	0.81	0.81	0.81	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82
2.5x2x5/16	0.34	0.59	0.72	0.76	0.78	0.79	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81
2.5x2x1/4	0.27	0.50	0.66	0.73	0.76	0.77	0.78	0.78	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
2.5x2x3/16	0.21	0.39	0.55	0.65	0.71	0.74	0.75	0.76	0.77	0.77	0.77	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.79	0.79	0.79	0.79	0.79	0.79	0.79

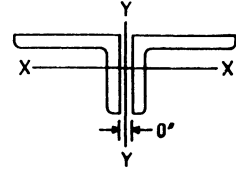


**COLUMNS  
DOUBLE ANGLES**  
Flexural-Torsional Equivalent Radius of Gyration  
Long legs  $\frac{3}{4}$ -in. back to back of angles



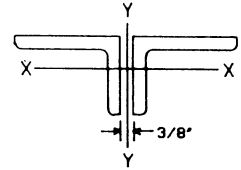
KL (ft):	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
SECTION	Flexural-Torsional Radius of Gyration (in)																								
8x6x1	0.42	0.70	1.00	1.29	1.56	1.80	2.00	2.16	2.27	2.36	2.42	2.46	2.50	2.52	2.54	2.56	2.57	2.58	2.59	2.60	2.60	2.61	2.61	2.62	2.62
8x6x3/4	0.32	0.53	0.76	0.99	1.21	1.42	1.62	1.79	1.94	2.07	2.17	2.25	2.31	2.36	2.40	2.43	2.46	2.48	2.49	2.51	2.52	2.53	2.54	2.55	2.55
8x6x1/2	0.21	0.36	0.51	0.67	0.83	0.98	1.13	1.28	1.42	1.55	1.67	1.78	1.88	1.97	2.05	2.12	2.17	2.22	2.26	2.30	2.33	2.35	2.37	2.39	2.41
8x4x1	0.44	0.72	0.99	1.21	1.37	1.48	1.55	1.60	1.63	1.65	1.67	1.68	1.69	1.70	1.71	1.71	1.72	1.72	1.72	1.73	1.73	1.73	1.73	1.73	1.74
8x4x3/4	0.33	0.55	0.77	0.97	1.14	1.27	1.37	1.44	1.50	1.53	1.56	1.58	1.60	1.61	1.62	1.63	1.64	1.64	1.65	1.65	1.66	1.66	1.66	1.66	1.67
8x4x1/2	0.22	0.37	0.53	0.69	0.83	0.96	1.08	1.18	1.26	1.32	1.37	1.42	1.45	1.48	1.50	1.52	1.53	1.54	1.55	1.56	1.57	1.58	1.58	1.59	1.59
7x4x3/4	0.36	0.61	0.86	1.08	1.27	1.40	1.49	1.56	1.60	1.64	1.66	1.68	1.69	1.70	1.71	1.71	1.72	1.72	1.73	1.73	1.73	1.74	1.74	1.74	1.74
7x4x1/2	0.24	0.42	0.60	0.77	0.93	1.08	1.20	1.30	1.38	1.44	1.49	1.53	1.56	1.58	1.60	1.61	1.62	1.63	1.64	1.65	1.65	1.66	1.66	1.67	1.67
6x4x3/8	0.18	0.32	0.46	0.60	0.73	0.86	0.97	1.08	1.17	1.25	1.32	1.37	1.42	1.45	1.48	1.51	1.53	1.55	1.56	1.57	1.58	1.59	1.60	1.61	1.61
6x4x3/4	0.39	0.68	0.97	1.22	1.41	1.54	1.62	1.68	1.71	1.74	1.76	1.77	1.78	1.79	1.79	1.80	1.80	1.80	1.81	1.81	1.81	1.81	1.81	1.81	1.82
6x4x5/8	0.33	0.58	0.83	1.06	1.26	1.41	1.52	1.59	1.64	1.68	1.70	1.72	1.74	1.75	1.76	1.76	1.77	1.77	1.78	1.78	1.78	1.78	1.79	1.79	1.79
6x4x1/2	0.26	0.47	0.68	0.87	1.06	1.21	1.34	1.44	1.52	1.57	1.61	1.64	1.66	1.68	1.70	1.71	1.72	1.72	1.73	1.73	1.74	1.74	1.75	1.75	1.75
6x4x3/8	0.20	0.36	0.52	0.68	0.83	0.97	1.10	1.22	1.31	1.39	1.46	1.51	1.55	1.58	1.61	1.63	1.65	1.66	1.67	1.68	1.69	1.70	1.70	1.71	1.71
6x3.5x3/8	0.20	0.36	0.52	0.68	0.82	0.95	1.06	1.16	1.23	1.29	1.33	1.36	1.39	1.41	1.43	1.44	1.45	1.46	1.47	1.47	1.48	1.48	1.49	1.49	1.50
6x3.5x5/16	0.17	0.30	0.44	0.58	0.71	0.83	0.93	1.03	1.11	1.18	1.23	1.28	1.31	1.34	1.37	1.38	1.40	1.41	1.42	1.43	1.44	1.45	1.45	1.46	1.46
5x3.5x3/4	0.43	0.78	1.09	1.32	1.46	1.54	1.58	1.61	1.62	1.64	1.64	1.65	1.65	1.66	1.66	1.66	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67
5x3.5x1/2	0.29	0.54	0.78	0.99	1.17	1.30	1.40	1.46	1.50	1.53	1.55	1.56	1.57	1.58	1.59	1.59	1.60	1.60	1.60	1.61	1.61	1.61	1.61	1.61	1.62
5x3.5x3/8	0.22	0.41	0.60	0.78	0.94	1.09	1.21	1.30	1.37	1.42	1.45	1.48	1.50	1.52	1.53	1.54	1.55	1.55	1.56	1.56	1.57	1.57	1.57	1.57	1.58
5x3.5x5/16	0.19	0.34	0.50	0.66	0.81	0.94	1.06	1.17	1.25	1.32	1.37	1.41	1.44	1.46	1.48	1.50	1.51	1.52	1.53	1.53	1.54	1.54	1.55	1.55	1.56
5x3x1/2	0.30	0.54	0.77	0.96	1.10	1.19	1.25	1.29	1.31	1.33	1.34	1.35	1.36	1.37	1.37	1.37	1.38	1.38	1.38	1.38	1.38	1.39	1.39	1.39	1.39
5x3x3/8	0.23	0.42	0.60	0.77	0.91	1.03	1.11	1.18	1.22	1.25	1.27	1.29	1.30	1.31	1.32	1.33	1.33	1.34	1.34	1.34	1.35	1.35	1.35	1.35	1.35
5x3x5/16	0.19	0.35	0.51	0.66	0.80	0.91	1.01	1.09	1.14	1.19	1.22	1.24	1.26	1.28	1.29	1.30	1.31	1.31	1.32	1.32	1.33	1.33	1.33	1.33	1.34
5x3x1/4	0.15	0.28	0.41	0.54	0.66	0.77	0.87	0.95	1.02	1.08	1.13	1.16	1.19	1.21	1.23	1.24	1.26	1.27	1.28	1.29	1.29	1.30	1.30	1.30	1.30
4x3.5x1/2	0.32	0.61	0.88	1.13	1.34	1.47	1.56	1.61	1.64	1.66	1.67	1.68	1.69	1.69	1.69	1.70	1.70	1.70	1.71	1.71	1.71	1.71	1.71	1.71	1.71
4x3.5x3/8	0.25	0.46	0.68	0.89	1.08	1.24	1.37	1.47	1.53	1.57	1.60	1.62	1.63	1.64	1.65	1.66	1.66	1.67	1.67	1.68	1.68	1.68	1.68	1.68	1.68
4x3.5x5/16	0.21	0.39	0.57	0.75	0.92	1.08	1.22	1.34	1.42	1.49	1.53	1.57	1.59	1.61	1.62	1.63	1.64	1.65	1.65	1.66	1.66	1.66	1.66	1.67	1.67
4x3.5x1/4	0.17	0.31	0.46	0.61	0.76	0.89	1.02	1.14	1.25	1.33	1.40	1.46	1.50	1.53	1.55	1.57	1.58	1.60	1.60	1.61	1.62	1.62	1.63	1.63	1.64
4x3x1/2	0.34	0.63	0.90	1.12	1.26	1.34	1.38	1.41	1.43	1.44	1.45	1.45	1.46	1.46	1.46	1.46	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47
4x3x3/8	0.26	0.49	0.71	0.90	1.07	1.19	1.27	1.32	1.35	1.37	1.39	1.40	1.41	1.41	1.42	1.42	1.43	1.43	1.43	1.43	1.44	1.44	1.44	1.44	1.44
4x3x5/16	0.22	0.41	0.60	0.77	0.93	1.07	1.17	1.24	1.29	1.32	1.35	1.36	1.38	1.39	1.39	1.40	1.41	1.41	1.42	1.42	1.42	1.42	1.42	1.42	1.42
4x3x1/4	0.18	0.33	0.49	0.64	0.78	0.91	1.02	1.11	1.18	1.24	1.28	1.31	1.33	1.34	1.36	1.37	1.37	1.38	1.39	1.39	1.40	1.40	1.40	1.40	1.41
3.5x3x3/8	0.28	0.52	0.76	0.98	1.15	1.28	1.35	1.40	1.42	1.44	1.45	1.46	1.47	1.47	1.48	1.48	1.48	1.48	1.49	1.49	1.49	1.49	1.49	1.49	1.49
3.5x3x5/16	0.23	0.44	0.65	0.84	1.01	1.16	1.26	1.33	1.37	1.40	1.42	1.43	1.44	1.45	1.46	1.46	1.47	1.47	1.47	1.47	1.47	1.48	1.48	1.48	1.48
3.5x3x1/4	0.19	0.36	0.53	0.69	0.85	0.99	1.11	1.20	1.27	1.32	1.36	1.38	1.40	1.41	1.42	1.43	1.44	1.44	1.45	1.45	1.45	1.46	1.46	1.46	1.46
3.5x2.5x3/8	0.29	0.54	0.77	0.95	1.07	1.14	1.17	1.20	1.21	1.22	1.23	1.24	1.24	1.24	1.24	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
3.5x2.5x5/16	0.24	0.46	0.66	0.84	0.97	1.06	1.12	1.16	1.18	1.19	1.21	1.21	1.22	1.22	1.23	1.23	1.23	1.23	1.24	1.24	1.24	1.24	1.24	1.24	1.24
3.5x2.5x1/4	0.20	0.37	0.54	0.70	0.84	0.95	1.03	1.08	1.12	1.14	1.16	1.17	1.18	1.19	1.20	1.20	1.20	1.21	1.21	1.21	1.21	1.21	1.21	1.22	1.22
3x2.5x3/8	0.31	0.59	0.85	1.04	1.16	1.22	1.25	1.27	1.28	1.28	1.29	1.29	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.31	1.31	1.31	1.31	1.31
3x2.5x1/4	0.21	0.40	0.59	0.77	0.92	1.04	1.12	1.16	1.20	1.21	1.23	1.24	1.25	1.25	1.26	1.26	1.26	1.26	1.27	1.27	1.27	1.27	1.27	1.27	1.27
3x2.5x3/16	0.16	0.31	0.46	0.61	0.74	0.86	0.97	1.04	1.10	1.14	1.17	1.19	1.21	1.22	1.22	1.23	1.24	1.24	1.25	1.25	1.25	1.25	1.25	1.25	1.26
3x2x3/8	0.33	0.61	0.82	0.94	0.99	1.02	1.03	1.04	1.05	1.05	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07
3x2x5/16	0.28	0.52	0.73	0.87	0.94	0.98	1.01	1.02	1.03	1.04	1.04	1.04	1.04	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.06	1.06	1.06	1.06
3x2x1/4	0.23	0.43	0.61	0.76	0.86	0.92	0.96	0.98	0.99	1.00	1.01	1.02	1.02	1.02	1.02	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
3x2x3/16	0.17	0.33	0.48	0.62	0.74	0.82	0.88	0.92	0.95	0.96	0.98	0.99	1.00	1.00	1.00	1.01	1.01	1.01	1.01	1.02	1.02	1.02	1.02	1.02	1.02
2.5x2x3/8	0.35	0.67	0.90	1.02	1.06	1.08	1.09	1.10	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12
2.5x2x5/16	0.30	0.57	0.80	0.94	1.01	1.05	1.06	1.07	1.08	1.08	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.10	1.10	1.10	1.10	1.10	1.10	1.10
2.5x2x1/4	0.24	0.46	0.67	0.83	0.94	1.00	1.03	1.04	1.06	1.06	1.07	1.07	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.09	1.09	1.09
2.5x2x3/16	0.18	0.35	0.52	0.67	0.80	0.89	0.95	0.98	1.01	1.02	1.03	1.04	1.04	1.05	1.05	1.05	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06

**COLUMNS  
DOUBLE ANGLES**  
Flexural-Torsional Equivalent Radius of Gyration  
Short legs 0 in. back to back of angles



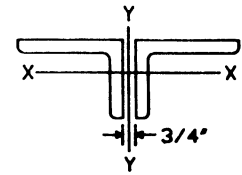
KL (ft):	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
SECTION	Flexural-Torsional Radius of Gyration (in)																								
8x6x1	0.43	0.71	1.03	1.34	1.66	1.98	2.28	2.57	2.83	3.06	3.23	3.35	3.43	3.48	3.51	3.54	3.55	3.57	3.58	3.58	3.59	3.60	3.60	3.61	3.61
8x6x3/4	0.32	0.54	0.78	1.02	1.27	1.51	1.75	1.99	2.22	2.44	2.65	2.84	3.01	3.14	3.25	3.32	3.38	3.42	3.45	3.47	3.49	3.51	3.52	3.53	3.53
8x6x1/2	0.22	0.37	0.53	0.69	0.86	1.02	1.19	1.35	1.52	1.68	1.84	2.00	2.15	2.30	2.45	2.59	2.72	2.84	2.95	3.05	3.13	3.20	3.25	3.30	3.33
8x4x1	0.43	0.72	1.04	1.37	1.70	2.03	2.36	2.69	3.01	3.31	3.57	3.75	3.84	3.88	3.90	3.91	3.92	3.92	3.93	3.93	3.93	3.94	3.94	3.94	3.94
8x4x3/4	0.33	0.55	0.80	1.05	1.30	1.55	1.80	2.06	2.31	2.56	2.80	3.04	3.27	3.47	3.63	3.73	3.79	3.82	3.84	3.85	3.86	3.87	3.87	3.87	3.88
8x4x1/2	0.22	0.38	0.54	0.71	0.88	1.06	1.23	1.40	1.58	1.75	1.92	2.09	2.26	2.43	2.60	2.77	2.93	3.09	3.24	3.38	3.50	3.59	3.66	3.71	3.75
7x4x3/4	0.35	0.62	0.90	1.19	1.47	1.76	2.04	2.32	2.58	2.83	3.02	3.15	3.22	3.26	3.29	3.30	3.31	3.32	3.32	3.33	3.33	3.33	3.33	3.33	3.34
7x4x1/2	0.24	0.42	0.61	0.81	1.01	1.20	1.40	1.60	1.79	1.98	2.17	2.36	2.54	2.71	2.86	2.98	3.07	3.13	3.17	3.20	3.22	3.23	3.24	3.25	3.26
7x4x3/8	0.18	0.32	0.47	0.62	0.77	0.92	1.07	1.22	1.37	1.51	1.66	1.81	1.96	2.10	2.24	2.38	2.52	2.65	2.76	2.87	2.96	3.03	3.08	3.12	3.15
6x4x3/4	0.39	0.70	1.03	1.36	1.68	1.99	2.27	2.49	2.62	2.69	2.72	2.74	2.75	2.76	2.77	2.77	2.78	2.78	2.78	2.79	2.79	2.79	2.79	2.79	2.79
6x4x5/8	0.33	0.60	0.87	1.15	1.43	1.70	1.96	2.20	2.40	2.54	2.62	2.67	2.70	2.72	2.73	2.74	2.75	2.75	2.75	2.76	2.76	2.76	2.76	2.77	2.77
6x4x1/2	0.27	0.48	0.70	0.93	1.16	1.38	1.60	1.81	2.02	2.20	2.36	2.49	2.57	2.62	2.65	2.68	2.69	2.70	2.71	2.72	2.72	2.73	2.73	2.73	2.74
6x4x3/8	0.20	0.37	0.54	0.71	0.88	1.06	1.23	1.40	1.56	1.73	1.89	2.04	2.18	2.30	2.41	2.49	2.55	2.59	2.62	2.64	2.66	2.67	2.68	2.69	2.69
6x3.5x3/8	0.21	0.37	0.54	0.72	0.89	1.07	1.24	1.41	1.59	1.76	1.92	2.08	2.24	2.37	2.49	2.58	2.65	2.69	2.72	2.73	2.75	2.76	2.77	2.77	2.78
6x3.5x5/16	0.17	0.31	0.46	0.61	0.75	0.90	1.05	1.20	1.35	1.49	1.64	1.78	1.92	2.06	2.19	2.31	2.42	2.51	2.58	2.63	2.67	2.69	2.71	2.73	2.74
5x3.5x3/4	0.45	0.82	1.21	1.58	1.91	2.13	2.23	2.27	2.29	2.30	2.31	2.31	2.31	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.33	2.33	2.33	2.33
5x3.5x1/2	0.30	0.56	0.83	1.09	1.35	1.60	1.82	2.00	2.11	2.17	2.21	2.23	2.24	2.25	2.26	2.26	2.27	2.27	2.27	2.27	2.28	2.28	2.28	2.28	2.28
5x3.5x3/8	0.23	0.43	0.63	0.84	1.04	1.24	1.43	1.62	1.78	1.93	2.03	2.10	2.15	2.18	2.20	2.21	2.22	2.23	2.23	2.24	2.24	2.25	2.25	2.25	2.25
5x3.5x5/16	0.20	0.36	0.53	0.70	0.87	1.04	1.21	1.37	1.53	1.68	1.81	1.93	2.02	2.10	2.18	2.22	2.12	2.15	2.17	2.19	2.20	2.21	2.22	2.23	2.23
5x3x1/2	0.31	0.57	0.84	1.11	1.37	1.63	1.87	2.08	2.21	2.27	2.30	2.32	2.33	2.33	2.34	2.34	2.35	2.35	2.35	2.35	2.35	2.35	2.35	2.35	2.35
5x3x3/8	0.23	0.43	0.64	0.84	1.05	1.25	1.45	1.65	1.83	1.99	2.12	2.20	2.24	2.27	2.29	2.30	2.31	2.31	2.32	2.32	2.32	2.32	2.32	2.33	2.33
5x3x5/16	0.20	0.36	0.53	0.71	0.88	1.05	1.22	1.39	1.56	1.72	1.87	2.00	2.10	2.17	2.22	2.25	2.27	2.28	2.29	2.29	2.30	2.30	2.31	2.31	2.31
5x3x1/4	0.16	0.29	0.43	0.57	0.71	0.86	1.00	1.13	1.27	1.41	1.54	1.67	1.80	1.91	2.01	2.09	2.15	2.19	2.22	2.24	2.26	2.27	2.27	2.28	2.29
4x3.5x1/2	0.35	0.66	0.96	1.23	1.45	1.59	1.65	1.69	1.71	1.72	1.73	1.73	1.74	1.74	1.74	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
4x3.5x3/8	0.27	0.50	0.74	0.96	1.17	1.35	1.49	1.57	1.63	1.66	1.68	1.69	1.70	1.71	1.71	1.72	1.72	1.72	1.72	1.72	1.73	1.73	1.73	1.73	1.73
4x3.5x5/16	0.22	0.42	0.62	0.82	1.00	1.18	1.33	1.45	1.53	1.59	1.62	1.65	1.66	1.68	1.69	1.70	1.70	1.70	1.70	1.71	1.71	1.71	1.71	1.71	1.72
4x3.5x1/4	0.18	0.34	0.50	0.66	0.82	0.97	1.12	1.25	1.36	1.45	1.52	1.57	1.60	1.62	1.64	1.65	1.66	1.67	1.68	1.68	1.69	1.69	1.69	1.70	1.70
4x3x1/2	0.36	0.68	1.00	1.30	1.54	1.68	1.74	1.77	1.78	1.79	1.80	1.80	1.81	1.81	1.81	1.81	1.81	1.81	1.81	1.81	1.82	1.82	1.82	1.82	1.82
4x3x3/8	0.28	0.52	0.77	1.01	1.24	1.44	1.58	1.67	1.72	1.74	1.76	1.77	1.77	1.78	1.78	1.78	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79
4x3x5/16	0.23	0.44	0.65	0.85	1.05	1.24	1.41	1.54	1.63	1.68	1.71	1.73	1.74	1.75	1.76	1.76	1.77	1.77	1.77	1.77	1.78	1.78	1.78	1.78	1.78
4x3x1/4	0.19	0.35	0.52	0.69	0.86	1.02	1.18	1.32	1.45	1.55	1.62	1.66	1.69	1.71	1.72	1.73	1.74	1.75	1.75	1.76	1.76	1.76	1.76	1.77	1.77
3.5x3x3/8	0.30	0.57	0.83	1.08	1.27	1.38	1.44	1.47	1.49	1.50	1.50	1.51	1.51	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.53	1.53
3.5x3x5/16	0.25	0.48	0.71	0.92	1.12	1.27	1.36	1.42	1.45	1.47	1.48	1.49	1.49	1.50	1.50	1.50	1.51	1.51	1.51	1.51	1.51	1.51	1.51	1.51	1.51
3.5x3x1/4	0.20	0.39	0.58	0.76	0.93	1.09	1.22	1.32	1.38	1.42	1.45	1.46	1.47	1.48	1.49	1.49	1.50	1.50	1.50	1.50	1.51	1.51	1.51	1.51	1.51
3.5x2.5x3/8	0.31	0.59	0.87	1.13	1.35	1.48	1.53	1.56	1.57	1.58	1.58	1.59	1.59	1.59	1.59	1.59	1.59	1.59	1.60	1.60	1.60	1.60	1.60	1.60	1.60
3.5x2.5x5/16	0.26	0.50	0.74	0.97	1.18	1.36	1.46	1.51	1.54	1.55	1.56	1.57	1.57	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.59	1.59	1.59
3.5x2.5x1/4	0.21	0.40	0.60	0.79	0.97	1.15	1.30	1.41	1.47	1.51	1.53	1.54	1.55	1.55	1.56	1.56	1.56	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57
3x2.5x3/8	0.34	0.66	0.95	1.15	1.25	1.28	1.30	1.31	1.31	1.32	1.32	1.32	1.32	1.32	1.32	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33
3x2.5x1/4	0.23	0.45	0.66	0.86	1.03	1.15	1.21	1.25	1.27	1.28	1.28	1.29	1.29	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.31	1.31	1.31
3x2.5x3/16	0.18	0.34	0.51	0.67	0.83	0.96	1.07	1.15	1.20	1.23	1.25	1.26	1.27	1.27	1.28	1.28	1.28	1.28	1.29	1.29	1.29	1.29	1.29	1.29	1.29
3x2x3/8	0.36	0.69	1.01	1.25	1.35	1.37	1.38	1.39	1.39	1.39	1.39	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40
3x2x5/16	0.30	0.58	0.86	1.11	1.27	1.34	1.36	1.37	1.38	1.38	1.38	1.38	1.38	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39
3x2x1/4	0.24	0.47	0.70	0.92	1.12	1.25	1.32	1.34	1.35	1.36	1.36	1.37	1.37	1.37	1.37	1.37	1.37	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38
3x2x3/16	0.19	0.36	0.54	0.71	0.88	1.04	1.17	1.26	1.30	1.32	1.34	1.34	1.35	1.35	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.37	1.37	1.37
2.5x2x3/8	0.40	0.76	1.01	1.09	1.11	1.12	1.12	1.12	1.12	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13
2.5x2x5/16	0.34	0.65	0.91	1.04	1.08	1.10	1.10	1.11	1.11	1.11	1.11	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12
2.5x2x1/4	0.27	0.52	0.76	0.94	1.03	1.07	1.08	1.09	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11
2.5x2x3/16	0.21	0.40	0.59	0.77	0.91	1.00	1.04	1.06	1.07	1.08	1.08	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.10	1.10	1.10	1.10	1.10	1.10	1.10

**COLUMNS  
DOUBLE ANGLES**  
Flexural-Torsional Equivalent Radius of Gyration  
Short legs  $\frac{3}{8}$ -in. back to back of angles



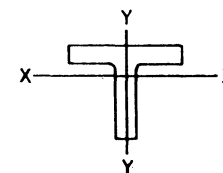
KL (ft):	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
SECTION	Flexural-Torsional Radius of Gyration (in)																								
8x6x1	0.41	0.69	1.00	1.31	1.62	1.93	2.23	2.52	2.79	3.04	3.24	3.40	3.50	3.57	3.62	3.65	3.67	3.69	3.70	3.71	3.72	3.73	3.74	3.74	3.74
8x6x3/4	0.32	0.53	0.76	1.00	1.23	1.47	1.71	1.94	2.17	2.39	2.60	2.81	2.99	3.15	3.28	3.38	3.46	3.51	3.55	3.58	3.61	3.63	3.64	3.65	3.66
8x6x1/2	0.21	0.36	0.51	0.67	0.83	1.00	1.16	1.32	1.48	1.64	1.80	1.95	2.11	2.26	2.41	2.55	2.69	2.82	2.94	3.05	3.14	3.23	3.30	3.36	3.41
8x4x1	0.41	0.70	1.01	1.33	1.65	1.97	2.29	2.60	2.92	3.23	3.51	3.76	3.92	3.99	4.03	4.05	4.06	4.07	4.07	4.08	4.08	4.08	4.09	4.09	4.09
8x4x3/4	0.32	0.53	0.77	1.01	1.26	1.50	1.74	1.99	2.23	2.48	2.72	2.95	3.19	3.40	3.60	3.76	3.87	3.93	3.96	3.98	4.00	4.01	4.01	4.02	4.02
8x4x1/2	0.22	0.36	0.52	0.69	0.86	1.02	1.19	1.36	1.52	1.69	1.86	2.03	2.19	2.36	2.52	2.69	2.85	3.01	3.16	3.31	3.45	3.58	3.68	3.76	3.82
7x4x3/4	0.34	0.60	0.87	1.15	1.42	1.70	1.97	2.25	2.51	2.77	3.00	3.18	3.30	3.36	3.40	3.42	3.44	3.45	3.45	3.46	3.46	3.47	3.47	3.47	3.47
7x4x1/2	0.23	0.41	0.59	0.78	0.97	1.16	1.35	1.54	1.73	1.92	2.10	2.29	2.47	2.64	2.81	2.95	3.08	3.18	3.25	3.30	3.33	3.35	3.37	3.38	3.39
7x4x3/8	0.18	0.31	0.45	0.59	0.74	0.88	1.03	1.17	1.32	1.46	1.61	1.75	1.89	2.03	2.17	2.31	2.45	2.58	2.71	2.83	2.94	3.04	3.12	3.18	3.23
6x4x3/4	0.38	0.68	0.99	1.31	1.62	1.93	2.22	2.47	2.66	2.77	2.83	2.86	2.88	2.89	2.90	2.91	2.91	2.92	2.92	2.92	2.92	2.93	2.93	2.93	2.93
6x4x5/8	0.32	0.57	0.84	1.11	1.38	1.64	1.90	2.14	2.37	2.56	2.69	2.76	2.81	2.84	2.86	2.87	2.88	2.88	2.89	2.89	2.90	2.90	2.90	2.90	2.90
6x4x1/2	0.26	0.46	0.68	0.90	1.11	1.33	1.54	1.76	1.96	2.16	2.34	2.49	2.61	2.69	2.75	2.79	2.81	2.83	2.84	2.85	2.86	2.86	2.87	2.87	2.87
6x4x3/8	0.20	0.35	0.52	0.68	0.85	1.02	1.18	1.35	1.51	1.67	1.83	1.99	2.13	2.27	2.39	2.50	2.59	2.65	2.70	2.73	2.76	2.78	2.79	2.80	2.81
6x3.5x3/8	0.20	0.36	0.52	0.69	0.86	1.03	1.20	1.36	1.53	1.70	1.86	2.02	2.18	2.33	2.46	2.59	2.68	2.76	2.81	2.84	2.86	2.88	2.89	2.90	2.91
6x3.5x5/16	0.17	0.30	0.44	0.58	0.72	0.87	1.01	1.15	1.29	1.43	1.57	1.71	1.85	1.99	2.12	2.25	2.37	2.48	2.58	2.66	2.73	2.78	2.81	2.83	2.85
5x3.5x3/4	0.43	0.79	1.16	1.52	1.86	2.15	2.32	2.39	2.42	2.44	2.45	2.46	2.46	2.46	2.47	2.47	2.47	2.47	2.47	2.47	2.47	2.47	2.47	2.48	2.48
5x3.5x1/2	0.29	0.54	0.79	1.05	1.30	1.54	1.77	1.98	2.14	2.25	2.31	2.34	2.37	2.38	2.39	2.40	2.40	2.41	2.41	2.41	2.41	2.41	2.41	2.42	2.42
5x3.5x3/8	0.22	0.41	0.60	0.80	0.99	1.19	1.38	1.56	1.74	1.90	2.04	2.15	2.22	2.27	2.31	2.33	2.34	2.36	2.36	2.37	2.38	2.38	2.38	2.39	2.39
5x3.5x5/16	0.19	0.34	0.51	0.67	0.84	1.00	1.16	1.32	1.48	1.63	1.77	1.90	2.02	2.11	2.18	2.23	2.27	2.29	2.31	2.32	2.33	2.34	2.35	2.35	2.36
5x3x1/2	0.29	0.54	0.79	1.05	1.31	1.56	1.80	2.03	2.22	2.34	2.41	2.44	2.44	2.45	2.46	2.47	2.48	2.48	2.48	2.49	2.49	2.49	2.49	2.49	2.49
5x3x3/8	0.22	0.41	0.61	0.80	1.00	1.19	1.39	1.58	1.77	1.94	2.10	2.23	2.32	2.37	2.40	2.42	2.43	2.44	2.45	2.45	2.45	2.46	2.46	2.46	2.47
5x3x5/16	0.19	0.34	0.51	0.67	0.84	1.00	1.17	1.33	1.49	1.65	1.80	1.95	2.08	2.19	2.28	2.33	2.37	2.39	2.41	2.42	2.43	2.43	2.44	2.44	2.45
5x3x1/4	0.15	0.28	0.41	0.55	0.68	0.81	0.95	1.08	1.21	1.35	1.48	1.60	1.73	1.85	1.97	2.07	2.16	2.24	2.29	2.33	2.36	2.38	2.39	2.40	2.41
4x3.5x1/2	0.33	0.62	0.92	1.19	1.44	1.62	1.73	1.79	1.82	1.84	1.85	1.86	1.86	1.87	1.87	1.87	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88
4x3.5x3/8	0.25	0.48	0.70	0.92	1.14	1.33	1.50	1.62	1.70	1.75	1.78	1.80	1.81	1.82	1.83	1.84	1.84	1.85	1.85	1.85	1.85	1.85	1.86	1.86	1.86
4x3.5x5/16	0.21	0.40	0.59	0.78	0.97	1.14	1.31	1.45	1.56	1.65	1.70	1.74	1.77	1.79	1.80	1.81	1.82	1.82	1.83	1.83	1.83	1.84	1.84	1.84	1.84
4x3.5x1/4	0.17	0.32	0.48	0.63	0.79	0.94	1.08	1.22	1.34	1.45	1.55	1.62	1.67	1.71	1.74	1.76	1.77	1.78	1.79	1.80	1.81	1.81	1.82	1.82	1.82
4x3x1/2	0.34	0.65	0.95	1.25	1.52	1.72	1.83	1.88	1.91	1.92	1.93	1.94	1.94	1.94	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.96	1.96
4x3x3/8	0.26	0.49	0.73	0.96	1.19	1.40	1.58	1.72	1.80	1.85	1.87	1.89	1.90	1.91	1.91	1.92	1.92	1.92	1.92	1.93	1.93	1.93	1.93	1.93	1.93
4x3x5/16	0.22	0.41	0.61	0.81	1.00	1.19	1.37	1.53	1.66	1.75	1.81	1.84	1.86	1.88	1.89	1.89	1.90	1.90	1.91	1.91	1.91	1.91	1.92	1.92	1.92
4x3x1/4	0.18	0.34	0.50	0.66	0.82	0.98	1.13	1.28	1.42	1.54	1.65	1.72	1.78	1.81	1.84	1.85	1.86	1.87	1.88	1.89	1.89	1.89	1.90	1.90	1.90
3.5x3x3/8	0.28	0.54	0.80	1.04	1.26	1.42	1.52	1.58	1.61	1.62	1.63	1.64	1.65	1.65	1.65	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66
3.5x3x5/16	0.24	0.46	0.67	0.89	1.09	1.26	1.40	1.49	1.55	1.58	1.60	1.61	1.62	1.63	1.63	1.64	1.64	1.64	1.64	1.65	1.65	1.65	1.65	1.65	1.65
3.5x3x1/4	0.19	0.37	0.55	0.72	0.89	1.05	1.20	1.33	1.43	1.49	1.54	1.56	1.58	1.60	1.61	1.62	1.62	1.63	1.63	1.63	1.63	1.63	1.63	1.64	1.64
3.5x2.5x3/8	0.29	0.55	0.82	1.08	1.32	1.51	1.62	1.67	1.70	1.71	1.72	1.72	1.72	1.73	1.73	1.73	1.73	1.73	1.73	1.73	1.73	1.74	1.74	1.74	1.74
3.5x2.5x5/16	0.24	0.46	0.69	0.91	1.13	1.32	1.49	1.59	1.65	1.67	1.69	1.70	1.70	1.71	1.71	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72
3.5x2.5x1/4	0.20	0.38	0.56	0.74	0.92	1.09	1.26	1.40	1.51	1.59	1.63	1.66	1.67	1.68	1.69	1.69	1.70	1.70	1.71	1.71	1.71	1.71	1.71	1.71	1.71
3x2.5x3/8	0.32	0.62	0.90	1.15	1.32	1.39	1.42	1.44	1.45	1.46	1.46	1.46	1.46	1.46	1.46	1.46	1.46	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47
3x2.5x1/4	0.22	0.42	0.62	0.82	1.00	1.16	1.27	1.34	1.38	1.40	1.41	1.42	1.42	1.43	1.43	1.43	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44
3x2.5x3/16	0.17	0.32	0.48	0.63	0.79	0.93	1.06	1.17	1.26	1.31	1.35	1.37	1.39	1.40	1.40	1.41	1.41	1.42	1.42	1.42	1.42	1.43	1.43	1.43	1.43
3x2x3/8	0.33	0.64	0.94	1.23	1.43	1.50	1.52	1.53	1.54	1.54	1.54	1.54	1.54	1.54	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55
3x2x5/16	0.28	0.54	0.80	1.05	1.27	1.42	1.47	1.50	1.51	1.51	1.52	1.52	1.52	1.52	1.52	1.52	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53
3x2x1/4	0.23	0.44	0.65	0.86	1.06	1.24	1.37	1.44	1.47	1.49	1.50	1.50	1.51	1.51	1.51	1.51	1.51	1.51	1.51	1.51	1.51	1.52	1.52	1.52	1.52
3x2x3/16	0.17	0.34	0.50	0.67	0.83	0.98	1.13	1.26	1.36	1.42	1.45	1.47	1.48	1.48	1.49	1.49	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
2.5x2x3/8	0.37	0.71	1.02	1.19	1.24	1.26	1.26	1.27	1.27	1.27	1.27	1.27	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28
2.5x2x5/16	0.31	0.60	0.87	1.09	1.19	1.22	1.24	1.24	1.25	1.25	1.25	1.25	1.25	1.25	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26
2.5x2x1/4	0.25	0.48	0.71	0.92	1.08	1.17	1.20	1.22	1.23	1.23	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
2.5x2x3/16	0.19	0.37	0.55	0.72	0.88	1.02	1.11	1.16	1.19	1.20	1.21	1.22	1.22	1.22	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.24	1.24	1.24

**COLUMNS  
DOUBLE ANGLES**  
Flexural-Torsional Equivalent Radius of Gyration  
Short legs  $\frac{3}{4}$ -in. back to back of angles



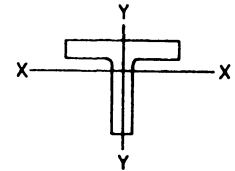
KL (ft):	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
SECTION	Flexural-Torsional Radius of Gyration (in)																								
8x6x1	0.40	0.67	0.97	1.27	1.57	1.87	2.17	2.46	2.74	3.00	3.23	3.42	3.56	3.65	3.72	3.76	3.79	3.81	3.83	3.84	3.85	3.86	3.87	3.87	3.88
8x6x3/4	0.31	0.51	0.74	0.97	1.20	1.43	1.66	1.89	2.12	2.34	2.55	2.76	2.95	3.13	3.28	3.41	3.51	3.59	3.64	3.69	3.72	3.74	3.76	3.78	3.79
8x6x1/2	0.21	0.35	0.50	0.65	0.81	0.97	1.13	1.28	1.44	1.60	1.75	1.91	2.06	2.21	2.36	2.50	2.64	2.78	2.90	3.02	3.14	3.24	3.32	3.40	3.46
8x4x1	0.40	0.68	0.98	1.28	1.59	1.90	2.21	2.52	2.83	3.13	3.42	3.70	3.93	4.07	4.14	4.18	4.20	4.21	4.22	4.22	4.23	4.23	4.23	4.23	4.24
8x4x3/4	0.31	0.52	0.75	0.98	1.22	1.45	1.69	1.93	2.16	2.40	2.63	2.87	3.10	3.32	3.53	3.73	3.89	3.99	4.06	4.10	4.12	4.13	4.14	4.15	4.16
8x4x1/2	0.21	0.35	0.51	0.67	0.83	0.99	1.15	1.31	1.48	1.64	1.80	1.96	2.12	2.28	2.44	2.60	2.76	2.92	3.07	3.23	3.37	3.51	3.64	3.76	3.85
7x4x3/4	0.33	0.58	0.84	1.10	1.37	1.64	1.91	2.17	2.43	2.69	2.93	3.15	3.33	3.44	3.51	3.55	3.57	3.58	3.59	3.60	3.61	3.61	3.62	3.62	3.62
7x4x1/2	0.23	0.39	0.57	0.75	0.94	1.12	1.30	1.49	1.67	1.85	2.03	2.21	2.39	2.56	2.73	2.89	3.04	3.18	3.28	3.36	3.42	3.46	3.49	3.50	3.52
7x4x3/8	0.17	0.30	0.44	0.57	0.71	0.85	0.99	1.13	1.27	1.41	1.55	1.69	1.83	1.97	2.11	2.24	2.38	2.51	2.64	2.76	2.89	3.00	3.10	3.19	3.27
6x4x3/4	0.36	0.65	0.95	1.26	1.56	1.86	2.15	2.42	2.66	2.83	2.93	2.98	3.01	3.03	3.04	3.05	3.06	3.06	3.06	3.07	3.07	3.07	3.07	3.07	3.08
6x4x5/8	0.31	0.55	0.81	1.07	1.32	1.58	1.83	2.08	2.31	2.53	2.70	2.82	2.90	2.95	2.97	2.99	3.00	3.01	3.02	3.03	3.03	3.03	3.04	3.04	3.04
6x4x1/2	0.25	0.44	0.65	0.86	1.07	1.28	1.48	1.69	1.89	2.09	2.28	2.45	2.60	2.72	2.81	2.87	2.91	2.94	2.96	2.97	2.98	2.99	3.00	3.00	3.01
6x4x3/8	0.19	0.34	0.50	0.66	0.82	0.98	1.14	1.30	1.46	1.61	1.77	1.92	2.07	2.22	2.35	2.48	2.59	2.68	2.76	2.81	2.86	2.89	2.91	2.93	2.94
6x3.5x3/8	0.19	0.34	0.50	0.66	0.82	0.98	1.15	1.31	1.47	1.63	1.79	1.94	2.10	2.25	2.40	2.53	2.66	2.77	2.85	2.91	2.96	2.98	3.00	3.02	3.03
6x3.5x5/16	0.16	0.29	0.42	0.56	0.70	0.83	0.97	1.11	1.24	1.38	1.51	1.65	1.78	1.92	2.05	2.18	2.30	2.42	2.54	2.64	2.73	2.81	2.87	2.92	2.95
5x3.5x3/4	0.41	0.75	1.11	1.46	1.80	2.11	2.35	2.49	2.54	2.57	2.59	2.60	2.60	2.61	2.61	2.62	2.62	2.62	2.62	2.62	2.62	2.62	2.62	2.62	2.62
5x3.5x1/2	0.28	0.51	0.76	1.00	1.24	1.48	1.71	1.93	2.13	2.28	2.38	2.44	2.48	2.50	2.52	2.53	2.53	2.54	2.54	2.55	2.55	2.55	2.55	2.55	2.56
5x3.5x3/8	0.21	0.39	0.58	0.76	0.95	1.14	1.32	1.50	1.68	1.85	2.00	2.14	2.25	2.34	2.39	2.43	2.46	2.47	2.49	2.50	2.50	2.51	2.52	2.52	2.52
5x3.5x5/16	0.18	0.33	0.49	0.64	0.80	0.96	1.12	1.27	1.42	1.57	1.72	1.86	1.99	2.11	2.21	2.29	2.35	2.39	2.42	2.44	2.46	2.47	2.48	2.49	2.49
5x3x1/2	0.28	0.51	0.76	1.00	1.25	1.49	1.73	1.96	2.18	2.36	2.48	2.55	2.58	2.60	2.61	2.62	2.62	2.63	2.63	2.63	2.64	2.64	2.64	2.64	2.64
5x3x3/8	0.21	0.39	0.58	0.77	0.95	1.14	1.33	1.51	1.70	1.87	2.04	2.20	2.33	2.43	2.50	2.53	2.56	2.57	2.58	2.59	2.60	2.60	2.61	2.61	2.61
5x3x5/16	0.18	0.33	0.48	0.64	0.80	0.96	1.12	1.27	1.43	1.58	1.73	1.88	2.02	2.16	2.27	2.37	2.44	2.48	2.51	2.54	2.55	2.56	2.57	2.57	2.58
5x3x1/4	0.14	0.27	0.39	0.52	0.65	0.78	0.90	1.03	1.16	1.29	1.41	1.54	1.66	1.78	1.90	2.01	2.12	2.22	2.31	2.38	2.43	2.47	2.49	2.51	2.53
4x3.5x1/2	0.32	0.59	0.88	1.15	1.41	1.63	1.78	1.88	1.93	1.96	1.98	1.99	2.00	2.01	2.02	2.02	2.02	2.02	2.02	2.03	2.03	2.03	2.03	2.03	2.03
4x3.5x3/8	0.24	0.45	0.67	0.88	1.09	1.29	1.47	1.63	1.75	1.83	1.88	1.91	1.93	1.95	1.96	1.97	1.97	1.98	1.98	1.98	1.99	1.99	1.99	1.99	1.99
4x3.5x5/16	0.20	0.38	0.56	0.74	0.92	1.10	1.27	1.42	1.56	1.67	1.76	1.82	1.86	1.89	1.91	1.93	1.94	1.95	1.96	1.96	1.97	1.97	1.97	1.98	1.98
4x3.5x1/4	0.16	0.31	0.46	0.61	0.75	0.90	1.04	1.18	1.31	1.43	1.54	1.64	1.72	1.78	1.82	1.85	1.88	1.90	1.91	1.92	1.93	1.94	1.94	1.95	1.95
4x3x1/2	0.32	0.61	0.90	1.19	1.47	1.71	1.89	1.99	2.03	2.06	2.07	2.08	2.09	2.09	2.09	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10
4x3x3/8	0.25	0.46	0.69	0.91	1.13	1.34	1.54	1.71	1.85	1.93	1.98	2.01	2.02	2.04	2.04	2.05	2.05	2.06	2.06	2.06	2.06	2.07	2.07	2.07	2.07
4x3x5/16	0.21	0.39	0.58	0.77	0.96	1.14	1.32	1.49	1.64	1.77	1.87	1.93	1.97	1.99	2.01	2.02	2.03	2.03	2.04	2.04	2.05	2.05	2.05	2.05	2.05
4x3x1/4	0.17	0.32	0.47	0.62	0.78	0.93	1.08	1.22	1.37	1.50	1.62	1.73	1.82	1.88	1.92	1.96	1.98	1.99	2.00	2.01	2.02	2.02	2.03	2.03	2.03
3.5x3x3/8	0.27	0.51	0.75	0.99	1.22	1.41	1.57	1.66	1.72	1.75	1.77	1.78	1.79	1.79	1.80	1.80	1.80	1.80	1.81	1.81	1.81	1.81	1.81	1.81	1.81
3.5x3x5/16	0.23	0.43	0.64	0.84	1.04	1.23	1.39	1.53	1.62	1.67	1.71	1.73	1.75	1.76	1.76	1.77	1.77	1.78	1.78	1.78	1.79	1.79	1.79	1.79	1.79
3.5x3x1/4	0.18	0.35	0.52	0.68	0.85	1.01	1.16	1.31	1.43	1.53	1.60	1.65	1.69	1.71	1.72	1.74	1.74	1.75	1.76	1.76	1.77	1.77	1.77	1.77	1.77
3.5x2.5x3/8	0.27	0.52	0.77	1.01	1.25	1.47	1.65	1.76	1.81	1.84	1.85	1.86	1.87	1.87	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.89
3.5x2.5x5/16	0.23	0.44	0.65	0.86	1.06	1.26	1.45	1.61	1.72	1.78	1.81	1.83	1.84	1.85	1.86	1.86	1.86	1.86	1.86	1.87	1.87	1.87	1.87	1.87	1.87
3.5x2.5x1/4	0.18	0.35	0.52	0.70	0.87	1.03	1.20	1.35	1.49	1.61	1.70	1.75	1.78	1.80	1.81	1.82	1.83	1.83	1.84	1.84	1.84	1.84	1.85	1.85	1.85
3x2.5x3/8	0.30	0.58	0.85	1.11	1.33	1.47	1.54	1.57	1.58	1.59	1.60	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.62	1.62	1.62	1.62	1.62
3x2.5x1/4	0.20	0.39	0.59	0.78	0.96	1.13	1.28	1.39	1.47	1.51	1.53	1.55	1.56	1.57	1.57	1.58	1.58	1.58	1.59	1.59	1.59	1.59	1.59	1.59	1.59
3x2.5x3/16	0.16	0.30	0.45	0.60	0.74	0.88	1.02	1.14	1.26	1.35	1.42	1.46	1.49	1.51	1.52	1.53	1.54	1.55	1.55	1.56	1.56	1.56	1.56	1.56	1.57
3x2x3/8	0.30	0.59	0.88	1.16	1.41	1.58	1.65	1.67	1.68	1.68	1.69	1.69	1.69	1.69	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70
3x2x5/16	0.26	0.50	0.74	0.98	1.21	1.41	1.55	1.62	1.64	1.65	1.66	1.66	1.67	1.67	1.67	1.67	1.67	1.67	1.68	1.68	1.68	1.68	1.68	1.68	1.68
3x2x1/4	0.21	0.41	0.60	0.80	0.99	1.18	1.35	1.49	1.57	1.61	1.63	1.64	1.65	1.65	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.67	1.67
3x2x3/16	0.16	0.31	0.46	0.62	0.77	0.92	1.06	1.20	1.33	1.44	1.52	1.57	1.60	1.62	1.63	1.63	1.64	1.64	1.64	1.65	1.65	1.65	1.65	1.65	1.65
2.5x2x3/8	0.34	0.66	0.96	1.22	1.35	1.39	1.40	1.41	1.42	1.42	1.42	1.42	1.42	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43
2.5x2x5/16	0.28	0.55	0.82	1.06	1.25	1.34	1.37	1.39	1.40	1.40	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42
2.5x2x1/4	0.23	0.45	0.66	0.87	1.06	1.21	1.30	1.34	1.36	1.37	1.38	1.38	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.40	1.40	1.40	1.40	1.40
2.5x2x3/16	0.17	0.34	0.51	0.67	0.83	0.98	1.11	1.22	1.28	1.32	1.34	1.35	1.36	1.37	1.37	1.37	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38

**COLUMNS  
STRUCTURAL TEES**  
Flexural-Torsional Equivalent Radius of Gyration



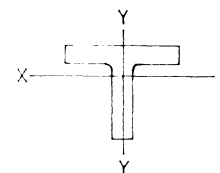
KL (ft):	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
SECTION	Flexural-Torsional Radius of Gyration (in)																								
7x66	0.42	0.70	1.00	1.31	1.62	1.93	2.24	2.54	2.83	3.11	3.33	3.50	3.59	3.64	3.67	3.69	3.71	3.72	3.72	3.73	3.73	3.74	3.74	3.74	3.74
7x60	0.39	0.64	0.92	1.20	1.49	1.78	2.06	2.35	2.62	2.89	3.13	3.34	3.48	3.57	3.62	3.65	3.67	3.68	3.69	3.70	3.71	3.71	3.71	3.72	3.72
7x54.5	0.36	0.59	0.85	1.11	1.38	1.64	1.91	2.17	2.43	2.68	2.93	3.15	3.34	3.47	3.56	3.61	3.64	3.66	3.67	3.68	3.69	3.69	3.70	3.70	3.71
7x49.5	0.33	0.54	0.77	1.01	1.26	1.50	1.74	1.99	2.22	2.46	2.69	2.91	3.12	3.29	3.42	3.51	3.57	3.60	3.63	3.64	3.65	3.66	3.67	3.67	3.68
7x45	0.30	0.50	0.71	0.93	1.16	1.38	1.60	1.83	2.05	2.27	2.49	2.70	2.90	3.09	3.26	3.39	3.48	3.54	3.58	3.61	3.62	3.64	3.65	3.65	3.66
7x41	0.27	0.46	0.66	0.88	1.10	1.32	1.54	1.76	1.98	2.20	2.42	2.64	2.86	3.08	3.30	3.52	3.74	3.96	4.18	4.40	4.62	4.84	5.06	5.28	5.50
7x37	0.24	0.42	0.60	0.78	0.96	1.14	1.32	1.50	1.68	1.86	2.04	2.22	2.40	2.58	2.76	2.94	3.12	3.30	3.48	3.66	3.84	4.02	4.20	4.38	4.56
7x34	0.21	0.38	0.55	0.72	0.89	1.06	1.23	1.40	1.57	1.74	1.91	2.08	2.25	2.42	2.59	2.76	2.93	3.10	3.27	3.44	3.61	3.78	3.95	4.12	4.29
7x30.5	0.18	0.34	0.50	0.66	0.82	0.98	1.14	1.30	1.46	1.62	1.78	1.94	2.10	2.26	2.42	2.58	2.74	2.90	3.06	3.22	3.38	3.54	3.70	3.86	4.02
7x26.5	0.15	0.29	0.43	0.57	0.71	0.85	0.99	1.13	1.27	1.41	1.55	1.69	1.83	1.97	2.11	2.25	2.39	2.53	2.67	2.81	2.95	3.09	3.23	3.37	3.51
7x24	0.14	0.27	0.40	0.53	0.66	0.79	0.92	1.05	1.18	1.31	1.44	1.57	1.70	1.83	1.96	2.09	2.22	2.35	2.48	2.61	2.74	2.87	3.00	3.13	3.26
7x21.5	0.13	0.25	0.37	0.49	0.61	0.73	0.85	0.97	1.09	1.21	1.33	1.45	1.57	1.69	1.81	1.93	2.05	2.17	2.29	2.41	2.53	2.65	2.77	2.89	3.01
7x19	0.12	0.23	0.34	0.45	0.56	0.67	0.78	0.89	1.00	1.11	1.22	1.33	1.44	1.55	1.66	1.77	1.88	1.99	2.10	2.21	2.32	2.43	2.54	2.65	2.76
7x17	0.11	0.21	0.31	0.41	0.51	0.61	0.71	0.81	0.91	1.01	1.11	1.21	1.31	1.41	1.51	1.61	1.71	1.81	1.91	2.01	2.11	2.21	2.31	2.41	2.51
7x15	0.10	0.20	0.29	0.38	0.47	0.56	0.65	0.74	0.83	0.92	1.01	1.10	1.19	1.28	1.37	1.46	1.55	1.64	1.73	1.82	1.91	2.00	2.09	2.18	2.27
7x13	0.09	0.18	0.27	0.35	0.43	0.51	0.59	0.67	0.75	0.83	0.91	0.99	1.07	1.15	1.23	1.31	1.39	1.47	1.55	1.63	1.71	1.79	1.87	1.95	2.03
7x11	0.08	0.16	0.24	0.32	0.40	0.48	0.56	0.64	0.72	0.80	0.88	0.96	1.04	1.12	1.20	1.28	1.36	1.44	1.52	1.60	1.68	1.76	1.84	1.92	2.00
6x29	0.07	0.14	0.21	0.28	0.35	0.42	0.49	0.56	0.63	0.70	0.77	0.84	0.91	0.98	1.05	1.12	1.19	1.26	1.33	1.40	1.47	1.54	1.61	1.68	1.75
6x26.5	0.06	0.12	0.18	0.25	0.32	0.39	0.46	0.53	0.60	0.67	0.74	0.81	0.88	0.95	1.02	1.09	1.16	1.23	1.30	1.37	1.44	1.51	1.58	1.65	1.72
6x25	0.05	0.11	0.16	0.22	0.28	0.34	0.40	0.46	0.52	0.58	0.64	0.70	0.76	0.82	0.88	0.94	1.00	1.06	1.12	1.18	1.24	1.30	1.36	1.42	1.48
6x22.5	0.04	0.10	0.15	0.20	0.26	0.31	0.37	0.42	0.48	0.53	0.59	0.64	0.70	0.75	0.81	0.86	0.92	0.97	1.03	1.08	1.14	1.20	1.25	1.31	1.36
6x20	0.03	0.09	0.13	0.18	0.23	0.28	0.33	0.38	0.43	0.48	0.53	0.58	0.63	0.68	0.73	0.78	0.83	0.88	0.93	0.98	1.03	1.08	1.13	1.18	1.23
6x17.5	0.02	0.08	0.11	0.15	0.20	0.24	0.29	0.33	0.38	0.42	0.47	0.51	0.56	0.60	0.65	0.70	0.74	0.79	0.83	0.88	0.92	0.97	1.01	1.06	1.10
6x15	0.01	0.07	0.10	0.14	0.18	0.22	0.26	0.30	0.34	0.38	0.42	0.46	0.50	0.54	0.58	0.62	0.66	0.70	0.74	0.78	0.82	0.86	0.90	0.94	0.98
6x13	0.01	0.06	0.09	0.12	0.16	0.20	0.24	0.28	0.32	0.36	0.40	0.44	0.48	0.52	0.56	0.60	0.64	0.68	0.72	0.76	0.80	0.84	0.88	0.92	0.96
6x11	0.01	0.05	0.07	0.10	0.13	0.16	0.19	0.22	0.25	0.28	0.31	0.34	0.37	0.40	0.43	0.46	0.49	0.52	0.55	0.58	0.61	0.64	0.67	0.70	0.73
6x9.5	0.01	0.04	0.06	0.08	0.11	0.14	0.17	0.20	0.23	0.26	0.29	0.32	0.35	0.38	0.41	0.44	0.47	0.50	0.53	0.56	0.59	0.62	0.65	0.68	0.71
6x8	0.01	0.03	0.05	0.07	0.09	0.12	0.14	0.17	0.20	0.22	0.25	0.27	0.30	0.32	0.35	0.37	0.40	0.42	0.45	0.47	0.50	0.52	0.55	0.57	0.60
6x7	0.01	0.03	0.04	0.06	0.08	0.10	0.12	0.14	0.16	0.18	0.20	0.22	0.24	0.26	0.28	0.30	0.32	0.34	0.36	0.38	0.40	0.42	0.44	0.46	0.48
5x22.5	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.25
5x19.5	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.25
5x16.5	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.25
5x15	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.25
5x13	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.25
5x11	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.25
5x9.5	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.25
5x8.5	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.25
5x7.5	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.25
5x6	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.25
4x14	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.25
4x12	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.25
4x10.5	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.25
4x9	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.25
4x7.5	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.25
4x6.5	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.25
4x5	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.25

**COLUMNS  
STRUCTURAL TEES**  
Flexural-Torsional Equivalent Radius of Gyration



KL (ft):	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
SECTION	Flexural-Torsional Radius of Gyration (in)																								
10.5x73.5	0.41	0.67	0.95	1.24	1.52	1.79	2.04	2.25	2.43	2.56	2.65	2.72	2.77	2.80	2.83	2.84	2.86	2.87	2.88	2.89	2.90	2.90	2.91	2.91	2.91
10.5x66	0.37	0.61	0.87	1.13	1.39	1.64	1.88	2.09	2.28	2.43	2.55	2.63	2.69	2.74	2.77	2.80	2.82	2.83	2.84	2.85	2.86	2.87	2.88	2.88	2.88
10.5x61	0.34	0.57	0.81	1.06	1.30	1.54	1.77	1.98	2.17	2.33	2.46	2.56	2.63	2.69	2.73	2.76	2.79	2.80	2.82	2.83	2.84	2.85	2.86	2.86	2.87
10.5x55.5	0.31	0.52	0.74	0.97	1.20	1.42	1.64	1.84	2.03	2.20	2.34	2.45	2.54	2.61	2.66	2.70	2.73	2.76	2.78	2.79	2.81	2.82	2.82	2.83	2.84
10.5x50.5	0.29	0.48	0.68	0.89	1.10	1.31	1.51	1.71	1.89	2.06	2.21	2.34	2.44	2.53	2.59	2.64	2.68	2.71	2.74	2.76	2.77	2.79	2.80	2.81	2.82
10.5x46.5	0.32	0.54	0.77	0.99	1.19	1.35	1.48	1.57	1.64	1.68	1.71	1.74	1.75	1.77	1.78	1.79	1.79	1.80	1.80	1.81	1.81	1.81	1.81	1.82	1.82
10.5x41.5	0.29	0.49	0.70	0.91	1.10	1.26	1.40	1.50	1.58	1.63	1.67	1.70	1.72	1.74	1.75	1.76	1.77	1.78	1.78	1.79	1.79	1.80	1.80	1.80	1.80
10.5x36.5	0.26	0.44	0.63	0.82	1.00	1.16	1.30	1.41	1.50	1.57	1.61	1.65	1.68	1.70	1.72	1.73	1.74	1.75	1.75	1.76	1.77	1.77	1.77	1.78	1.78
10.5x34	0.24	0.41	0.59	0.77	0.94	1.09	1.23	1.35	1.44	1.51	1.57	1.61	1.64	1.67	1.69	1.70	1.72	1.73	1.73	1.74	1.75	1.75	1.76	1.76	1.76
10.5x31	0.18	0.29	0.41	0.54	0.66	0.78	0.89	1.00	1.10	1.19	1.28	1.35	1.41	1.46	1.51	1.54	1.57	1.60	1.62	1.63	1.65	1.66	1.67	1.68	1.69
10.5x28.5	0.21	0.36	0.51	0.66	0.79	0.91	1.01	1.09	1.15	1.19	1.22	1.24	1.26	1.27	1.29	1.29	1.30	1.31	1.31	1.32	1.32	1.32	1.32	1.33	1.33
10.5x25	0.19	0.32	0.45	0.59	0.71	0.82	0.91	0.99	1.05	1.10	1.13	1.16	1.18	1.20	1.21	1.23	1.23	1.24	1.25	1.25	1.26	1.26	1.27	1.27	1.27
10.5x22	0.17	0.28	0.40	0.51	0.62	0.72	0.81	0.89	0.96	1.01	1.05	1.08	1.11	1.13	1.15	1.16	1.18	1.19	1.19	1.20	1.21	1.21	1.22	1.22	1.22
9x59.5	0.41	0.70	1.00	1.31	1.60	1.87	2.09	2.27	2.39	2.47	2.53	2.56	2.59	2.61	2.62	2.63	2.64	2.64	2.65	2.65	2.66	2.66	2.66	2.67	2.67
9x53	0.37	0.62	0.90	1.17	1.44	1.69	1.92	2.12	2.26	2.37	2.44	2.49	2.53	2.55	2.57	2.58	2.59	2.60	2.61	2.61	2.62	2.62	2.63	2.63	2.63
9x48.5	0.34	0.58	0.84	1.10	1.35	1.59	1.82	2.01	2.18	2.30	2.39	2.45	2.49	2.52	2.54	2.56	2.57	2.58	2.59	2.60	2.60	2.61	2.61	2.62	2.62
9x43	0.30	0.52	0.75	0.98	1.21	1.43	1.64	1.84	2.01	2.15	2.27	2.35	2.41	2.45	2.49	2.51	2.53	2.54	2.55	2.56	2.57	2.58	2.58	2.59	2.59
9x38	0.27	0.46	0.67	0.88	1.08	1.28	1.48	1.67	1.84	1.99	2.12	2.23	2.31	2.37	2.41	2.45	2.47	2.49	2.51	2.52	2.53	2.54	2.55	2.55	2.56
9x35.5	0.31	0.55	0.78	1.00	1.19	1.34	1.45	1.51	1.56	1.59	1.61	1.63	1.64	1.65	1.66	1.66	1.67	1.67	1.67	1.68	1.68	1.68	1.68	1.68	1.69
9x32.5	0.29	0.51	0.73	0.94	1.13	1.28	1.40	1.48	1.53	1.56	1.59	1.61	1.62	1.63	1.64	1.65	1.65	1.66	1.66	1.66	1.67	1.67	1.67	1.67	1.67
9x30	0.27	0.47	0.68	0.89	1.07	1.22	1.35	1.44	1.50	1.54	1.57	1.59	1.61	1.62	1.63	1.64	1.65	1.65	1.66	1.66	1.66	1.67	1.67	1.67	1.67
9x27.5	0.24	0.43	0.63	0.81	0.99	1.14	1.27	1.36	1.44	1.49	1.53	1.55	1.57	1.59	1.60	1.61	1.62	1.62	1.63	1.63	1.64	1.64	1.64	1.65	1.65
9x25	0.22	0.39	0.57	0.74	0.91	1.06	1.18	1.29	1.37	1.43	1.48	1.51	1.53	1.55	1.57	1.58	1.59	1.60	1.60	1.61	1.61	1.61	1.62	1.62	1.62
9x23	0.23	0.40	0.58	0.74	0.88	0.99	1.07	1.12	1.16	1.19	1.21	1.22	1.23	1.24	1.25	1.25	1.26	1.26	1.27	1.27	1.27	1.27	1.27	1.27	1.28
9x20	0.20	0.35	0.51	0.66	0.79	0.90	0.99	1.06	1.11	1.14	1.17	1.18	1.20	1.21	1.22	1.22	1.23	1.23	1.24	1.24	1.24	1.25	1.25	1.25	1.25
9x17.5	0.17	0.30	0.43	0.55	0.67	0.77	0.86	0.94	0.99	1.04	1.07	1.10	1.12	1.13	1.14	1.15	1.16	1.17	1.17	1.18	1.18	1.19	1.19	1.19	1.19
8x50	0.41	0.71	1.03	1.34	1.64	1.90	2.10	2.24	2.32	2.38	2.41	2.43	2.44	2.46	2.46	2.47	2.48	2.48	2.48	2.49	2.49	2.49	2.49	2.49	2.50
8x44.5	0.37	0.64	0.93	1.21	1.48	1.74	1.95	2.12	2.23	2.31	2.35	2.38	2.40	2.42	2.43	2.44	2.45	2.45	2.46	2.46	2.46	2.47	2.47	2.47	2.47
8x38.5	0.32	0.56	0.82	1.07	1.32	1.55	1.77	1.96	2.10	2.20	2.27	2.32	2.35	2.37	2.39	2.40	2.41	2.42	2.43	2.43	2.44	2.44	2.44	2.44	2.45
8x33.5	0.28	0.50	0.72	0.95	1.17	1.39	1.59	1.78	1.95	2.08	2.18	2.24	2.29	2.33	2.35	2.37	2.38	2.39	2.40	2.41	2.42	2.42	2.42	2.43	2.43
8x28.5	0.30	0.54	0.78	0.99	1.18	1.31	1.40	1.46	1.49	1.52	1.53	1.55	1.55	1.56	1.57	1.57	1.57	1.58	1.58	1.58	1.58	1.59	1.59	1.59	1.59
8x25	0.27	0.48	0.70	0.90	1.08	1.22	1.33	1.40	1.45	1.48	1.50	1.52	1.53	1.54	1.55	1.55	1.56	1.56	1.56	1.57	1.57	1.57	1.57	1.57	1.58
8x22.5	0.26	0.47	0.68	0.88	1.06	1.20	1.31	1.38	1.43	1.46	1.48	1.50	1.51	1.52	1.53	1.53	1.54	1.54	1.54	1.55	1.55	1.55	1.55	1.55	1.56
8x20	0.22	0.39	0.58	0.75	0.91	1.06	1.18	1.28	1.35	1.40	1.43	1.46	1.48	1.49	1.51	1.51	1.52	1.53	1.53	1.54	1.54	1.54	1.55	1.55	1.55
8x18	0.19	0.34	0.50	0.65	0.79	0.93	1.04	1.14	1.22	1.29	1.33	1.37	1.40	1.42	1.43	1.44	1.45	1.46	1.47	1.47	1.48	1.48	1.49	1.49	1.49
8x15.5	0.19	0.34	0.49	0.63	0.75	0.86	0.93	0.99	1.03	1.06	1.08	1.10	1.11	1.12	1.13	1.13	1.14	1.14	1.14	1.15	1.15	1.15	1.15	1.15	1.16
8x13	0.15	0.27	0.40	0.51	0.62	0.72	0.80	0.87	0.92	0.96	0.99	1.01	1.03	1.04	1.05	1.06	1.07	1.08	1.08	1.08	1.09	1.09	1.09	1.10	1.10

**COLUMNS  
STRUCTURAL TEES**  
Flexural-Torsional Equivalent Radius of Gyration



KL (ft):	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
SECTION	Flexural-Torsional Radius of Gyration (in)																								
18x150	0.44	0.66	0.90	1.16	1.42	1.68	1.93	2.17	2.39	2.60	2.79	2.96	3.10	3.22	3.32	3.40	3.46	3.51	3.55	3.59	3.61	3.64	3.66	3.67	3.69
18x140	0.42	0.62	0.85	1.09	1.34	1.58	1.82	2.05	2.27	2.47	2.66	2.84	2.99	3.11	3.22	3.31	3.38	3.44	3.49	3.53	3.56	3.59	3.61	3.63	3.65
18x130	0.38	0.57	0.78	1.01	1.23	1.46	1.68	1.90	2.11	2.31	2.49	2.66	2.82	2.96	3.08	3.18	3.26	3.33	3.39	3.44	3.48	3.51	3.54	3.56	3.58
18x122.5	0.36	0.54	0.74	0.95	1.16	1.38	1.59	1.79	1.99	2.19	2.37	2.54	2.69	2.84	2.96	3.07	3.16	3.24	3.30	3.36	3.40	3.44	3.48	3.50	3.53
18x115	0.34	0.50	0.69	0.89	1.09	1.30	1.50	1.69	1.88	2.07	2.24	2.41	2.57	2.71	2.84	2.95	3.05	3.14	3.21	3.27	3.33	3.37	3.41	3.44	3.47
18x105	0.34	0.50	0.69	0.88	1.07	1.26	1.43	1.59	1.74	1.87	1.98	2.07	2.15	2.21	2.26	2.31	2.34	2.37	2.39	2.41	2.43	2.44	2.46	2.47	2.48
18x97	0.31	0.47	0.64	0.82	1.01	1.18	1.35	1.51	1.65	1.78	1.89	1.99	2.08	2.14	2.20	2.25	2.29	2.32	2.35	2.37	2.39	2.41	2.42	2.43	2.44
18x91	0.30	0.44	0.60	0.78	0.95	1.11	1.27	1.43	1.57	1.70	1.81	1.92	2.00	2.08	2.14	2.20	2.24	2.28	2.31	2.33	2.36	2.38	2.39	2.41	2.42
18x85	0.28	0.41	0.57	0.73	0.89	1.05	1.20	1.35	1.49	1.61	1.73	1.84	1.93	2.01	2.07	2.13	2.18	2.22	2.26	2.29	2.31	2.33	2.35	2.37	2.38
18x80	0.26	0.39	0.53	0.68	0.83	0.98	1.13	1.27	1.40	1.52	1.64	1.74	1.84	1.92	1.99	2.05	2.10	2.15	2.19	2.22	2.25	2.28	2.30	2.31	2.33
18x75	0.25	0.36	0.49	0.63	0.77	0.91	1.05	1.18	1.31	1.43	1.54	1.64	1.74	1.82	1.90	1.96	2.02	2.07	2.11	2.15	2.18	2.21	2.23	2.25	2.27
18x67.5	0.22	0.32	0.43	0.55	0.67	0.79	0.91	1.02	1.14	1.24	1.35	1.44	1.53	1.62	1.69	1.76	1.82	1.88	1.93	1.97	2.01	2.04	2.07	2.10	2.12
16.5x120.5	0.38	0.57	0.79	1.02	1.25	1.48	1.70	1.92	2.13	2.32	2.51	2.67	2.81	2.94	3.04	3.13	3.20	3.26	3.31	3.35	3.38	3.41	3.43	3.45	3.47
16.5x110.5	0.35	0.53	0.73	0.94	1.15	1.36	1.57	1.77	1.96	2.15	2.33	2.49	2.64	2.77	2.89	2.98	3.07	3.14	3.20	3.25	3.29	3.32	3.35	3.37	3.39
16.5x100.5	0.32	0.48	0.66	0.85	1.04	1.24	1.43	1.61	1.79	1.97	2.14	2.30	2.45	2.58	2.71	2.82	2.91	2.99	3.06	3.12	3.18	3.22	3.25	3.29	3.31
16.5x76	0.27	0.42	0.58	0.75	0.92	1.09	1.25	1.40	1.53	1.66	1.78	1.87	1.96	2.03	2.09	2.14	2.18	2.22	2.25	2.27	2.29	2.31	2.33	2.34	2.35
16.5x70.5	0.25	0.39	0.54	0.69	0.85	1.00	1.15	1.29	1.42	1.55	1.66	1.76	1.85	1.92	1.99	2.05	2.09	2.13	2.17	2.20	2.22	2.24	2.26	2.27	2.29
16.5x65	0.23	0.35	0.48	0.62	0.76	0.90	1.04	1.17	1.29	1.41	1.52	1.62	1.71	1.79	1.86	1.92	1.98	2.02	2.06	2.10	2.13	2.15	2.18	2.20	2.21
16.5x59	0.21	0.31	0.43	0.55	0.68	0.80	0.92	1.04	1.15	1.26	1.36	1.46	1.55	1.63	1.70	1.77	1.83	1.88	1.92	1.96	2.00	2.03	2.05	2.08	2.10
15x105.5	0.38	0.58	0.81	1.05	1.29	1.53	1.76	1.98	2.19	2.39	2.56	2.72	2.85	2.95	3.04	3.11	3.17	3.21	3.25	3.28	3.30	3.33	3.34	3.36	3.37
15x95.5	0.34	0.53	0.74	0.96	1.18	1.39	1.60	1.81	2.01	2.20	2.37	2.53	2.67	2.79	2.90	2.98	3.05	3.11	3.16	3.19	3.23	3.25	3.27	3.29	3.31
15x86.5	0.31	0.48	0.67	0.87	1.06	1.26	1.46	1.65	1.83	2.01	2.18	2.34	2.48	2.61	2.73	2.83	2.91	2.98	3.04	3.09	3.13	3.17	3.19	3.22	3.24
15x66	0.27	0.43	0.61	0.78	0.96	1.12	1.28	1.43	1.55	1.67	1.76	1.84	1.90	1.96	2.00	2.03	2.06	2.08	2.10	2.12	2.13	2.14	2.15	2.16	2.17
15x62	0.26	0.40	0.57	0.73	0.90	1.06	1.21	1.35	1.47	1.59	1.69	1.77	1.84	1.90	1.94	1.98	2.01	2.04	2.06	2.08	2.09	2.11	2.12	2.13	2.14
15x58	0.24	0.37	0.52	0.68	0.83	0.98	1.12	1.25	1.37	1.49	1.59	1.67	1.74	1.81	1.86	1.90	1.94	1.97	1.99	2.01	2.03	2.05	2.06	2.07	2.08
15x54	0.22	0.34	0.48	0.62	0.75	0.89	1.02	1.14	1.26	1.37	1.47	1.55	1.63	1.70	1.76	1.80	1.85	1.88	1.91	1.94	1.96	1.98	1.99	2.01	2.02
15x49.5	0.21	0.31	0.43	0.56	0.68	0.80	0.92	1.04	1.15	1.25	1.34	1.43	1.51	1.58	1.64	1.69	1.74	1.78	1.81	1.84	1.87	1.89	1.91	1.93	1.94
13.5x89	0.37	0.58	0.81	1.05	1.29	1.53	1.75	1.97	2.17	2.36	2.52	2.65	2.76	2.85	2.92	2.97	3.02	3.05	3.08	3.10	3.12	3.13	3.15	3.16	3.17
13.5x80.5	0.33	0.53	0.74	0.96	1.18	1.40	1.61	1.82	2.01	2.20	2.36	2.50	2.63	2.73	2.82	2.88	2.94	2.98	3.01	3.04	3.07	3.09	3.10	3.12	3.13
13.5x73	0.30	0.48	0.67	0.87	1.08	1.28	1.47	1.67	1.85	2.02	2.19	2.34	2.47	2.58	2.68	2.76	2.83	2.88	2.93	2.96	2.99	3.02	3.04	3.05	3.07
13.5x57	0.27	0.44	0.63	0.81	0.99	1.16	1.32	1.46	1.59	1.69	1.78	1.85	1.90	1.95	1.98	2.01	2.03	2.05	2.06	2.08	2.09	2.10	2.10	2.11	2.12
13.5x51	0.25	0.40	0.57	0.73	0.90	1.06	1.21	1.35	1.47	1.58	1.68	1.75	1.82	1.87	1.91	1.94	1.97	1.99	2.01	2.03	2.04	2.05	2.06	2.07	2.07
13.5x47	0.23	0.36	0.51	0.66	0.82	0.96	1.10	1.23	1.36	1.46	1.56	1.64	1.71	1.77	1.82	1.86	1.90	1.92	1.95	1.96	1.98	1.99	2.01	2.02	2.03
13.5x42	0.20	0.32	0.45	0.58	0.71	0.84	0.97	1.09	1.20	1.31	1.40	1.49	1.57	1.63	1.69	1.74	1.78	1.81	1.84	1.87	1.89	1.90	1.92	1.93	1.95
12x81	0.40	0.64	0.91	1.18	1.45	1.71	1.96	2.18	2.37	2.52	2.64	2.73	2.79	2.84	2.87	2.90	2.92	2.94	2.95	2.97	2.97	2.98	2.99	2.99	3.00
12x73	0.36	0.58	0.82	1.07	1.31	1.55	1.78	1.99	2.18	2.35	2.49	2.59	2.67	2.74	2.78	2.82	2.85	2.87	2.89	2.90	2.91	2.93	2.93	2.94	2.95
12x65.5	0.32	0.51	0.73	0.95	1.17	1.38	1.59	1.79	1.98	2.14	2.29	2.42	2.52	2.60	2.66	2.71	2.75	2.78	2.81	2.83	2.84	2.86	2.87	2.88	2.89
12x58.5	0.28	0.46	0.65	0.85	1.05	1.24	1.43	1.62	1.79	1.95	2.10	2.24	2.35	2.45	2.53	2.59	2.65	2.69	2.72	2.75	2.77	2.79	2.81	2.82	2.83
12x52	0.25	0.41	0.58	0.76	0.93	1.11	1.28	1.45	1.61	1.77	1.91	2.05	2.17	2.28	2.37	2.45	2.52	2.57	2.62	2.66	2.69	2.71	2.73	2.75	2.77
12x47	0.27	0.46	0.65	0.85	1.03	1.20	1.35	1.48	1.58	1.67	1.73	1.77	1.81	1.84	1.86	1.87	1.89	1.90	1.91	1.92	1.92	1.93	1.93	1.94	1.94
12x42	0.24	0.41	0.58	0.75	0.92	1.08	1.23	1.35	1.46	1.55	1.63	1.68	1.73	1.76	1.79	1.81	1.83	1.85	1.86	1.87	1.88	1.88	1.89	1.89	1.90
12x38	0.22	0.36	0.52	0.67	0.83	0.97	1.11	1.23	1.34	1.44	1.52	1.59	1.64	1.68	1.72	1.75	1.77	1.79	1.80	1.82	1.83	1.84	1.84	1.85	1.86
12x34	0.19	0.32	0.45	0.59	0.73	0.86	0.98	1.10	1.20	1.30	1.38	1.46	1.52	1.57	1.61	1.64	1.67	1.70	1.72	1.73	1.75	1.76	1.77	1.78	1.79
12x31	0.19	0.31	0.44	0.56	0.68	0.80	0.89	0.98	1.05	1.11	1.15	1.19	1.22	1.24	1.26	1.28	1.29	1.30	1.31	1.31	1.32	1.33	1.33	1.34	1.34
12x27.5	0.17	0.27	0.39	0.50	0.61	0.71	0.80	0.88	0.95	1.01	1.07	1.11	1.14	1.17	1.19	1.21	1.23	1.24	1.25	1.26	1.27	1.27	1.28	1.28	1.29