Axial Capacities of Eccentrically Loaded Equal-Leg Single Angles: Comparisons of Various Design Methods

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ABSTRACT

For most structural engineers, the design of an eccentrically loaded single angle without lateral restraint along its length was considered to be a formidable task prior to the publication of the 2005 AISC *Specification for Structural Steel Buildings*. According to Section E5 of the 2005 *Specification*, the effects of eccentricity on single-angle members are permitted to be neglected by using the effective slenderness ratio as specified, provided that members are loaded at the ends in compression through the same leg; members are attached by welding or by a minimum of two-bolt connections; there are no intermediate transverse loads; the leg length ratio is less than 1.7, if angles are connected through the shorter leg; and the modified *KL/r* is less than or equal to 200.

Table 4-12 of the 13th edition AISC *Steel Construction Manual* provided the available strengths in axial compression of eccentrically loaded single angles, with the assumption that the compressive force is applied at the geometric *y-y* axis at a distance of 0.75*t* from the back of the connected leg, where *t* is the angle thickness. Table 4-12 has been revised in the 14th edition AISC *Steel Construction Manual*. The new table corrects some numerical errors in the calculations and moves the compressive force to the midpoint of the connected leg. The values of the axial compressive design strength in Table 4-12 are developed on the basis of bending about the principal axes *w-w* and *z-z*.

Keywords: eccentrically loaded single angles, design tables.

INTRODUCTION

Single angles are commonly used as secondary bracing members for bridges and other structures, as web members for small or medium-sized truss structures, and in latticed structures, such as transmission towers. In structural analysis, single-angle members are always treated as "truss members" that can take only axial loads, either in tension or in compression. However, because single angles are connected to gusset plates through one leg using welding or bolting, the members are subjected to both axial and flexural demands resulting from the eccentric connection. Although the single angle is the most basic shape of hot-rolled steel sections, its behavior under eccentric force is complex and difficult to predict due to the fact that its geometric axes do not align with its principal axes. Therefore, the design method for predicting the axial strength of single angles evolves with the better understanding of its behavior, and it is evident in specification revisions over the years.

A design example of eccentrically loaded equal-leg single angles was presented in the 1st edition AISC *Manual of Steel Construction*, *LRFD* (AISC, 1986). However, there was not a specification specifically for single angles. The stand-alone *Specification for Allowable Stress Design of Single-Angle Members* was first introduced by the 9th edition AISC *Steel Construction Manual*, *ASD* (AISC, 1989). In 1993, AISC introduced the first stand-alone *Specification for Load and Resistance Factor Design of Single-Angle Members* (AISC, 1993), and this specification was included in the 2nd edition AISC *Manual of Steel Construction, LRFD* (AISC, 1994). The same specification was updated in 2000 and was included in the 3rd edition of the AISC *Manual of Steel Construction, LRFD* (AISC, 2001). Single-angle design was finally incorporated into the 2005 AISC *Specification for Structural Steel Buildings* (AISC, 2005a) with additional improvements. For instance, the slenderness ratio of eccentrically loaded single-angle members was modified to make use of the formulas applicable to concentrically loaded members.

Design tables for equal-leg single angles in compression based on the 1989 ASD *Specification* were developed by Walker (1991). Tables for the design strength of concentrically loaded single-angle struts based on the 1986 LRFD *Specification* were presented by Zureick (1993). Tables for the design strength of eccentrically loaded single angle struts based on the 1993 LRFD *Specification* were prepared by Sakla (2001). The 13th edition AISC *Manual* (AISC, 2005b) provided a table of available strengths for eccentrically loaded single angles in axial compression (Table 4-12), with an assumption that the compressive force is applied at

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the geometric *y-y* axis at a distance of 0.75t from the back of the connected leg. Table 4-12 has been completely updated in the 14th edition *Manual* (AISC, 2011) with the introduction point of the compressive force moved to the mid-point of the connected leg, $b/2$.

DESIGN CONSIDERATIONS OF SINGLE ANGLES IN COMPRESSION

Slenderness Ratio Requirement

The slenderness ratio KL/r requirement differs among the design codes. For members designed on the basis of compression, the user note in Section E2 of the 2010 AISC *Specification* indicates that the slenderness ratio preferably should satisfy $KL/r \leq 200$. However, the KL/r ratio requirement is more stringent for steel bridges: the slenderness ratio should satisfy $KL/r \leq 120$ for main members and $KL/r \leq 140$ for bracing members according to Section 6.9.3 of AASHTO (2004). It should be noted that bracing for curved girder bridges are considered main members.

Effective Length Factor

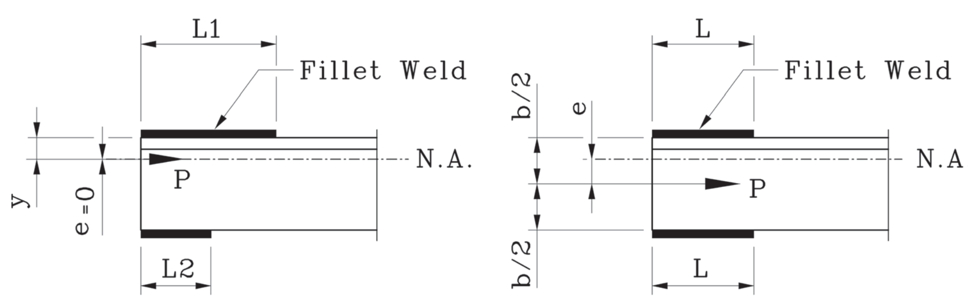
The effective length factor $K = 1.0$ should be used to determine the unbraced length of single angles in compression based on Chapter C of the 2010 AISC *Specification*. The effective length factor $K = 0.75$ for bolted or welded end connections at both ends has been used by AASHTO (2004). However, a change was made in AASHTO (2007) to use $K = 1.0$ for single angles, regardless of end connection types.

Minimum Size of Single Angles

The minimum size of angles is not stipulated AISC specifications. Although AASHTO does not specifically limit the minimum angle size, it does limit the minimum thickness of most structural steels to $\frac{5}{16}$ in., including angles. However, the designer should check with owners about the requirements for the minimum sizes of single angles that they may have. For example, MassDOT requires a minimum size of L3×3×$\frac{3}{8}$, PennDOT and NJDOT require L3$\frac{1}{2}$×3$\frac{1}{2}$×$\frac{3}{8}$ as a minimum, and VDOT requires L5×3×$\frac{3}{8}$ as a minimum.

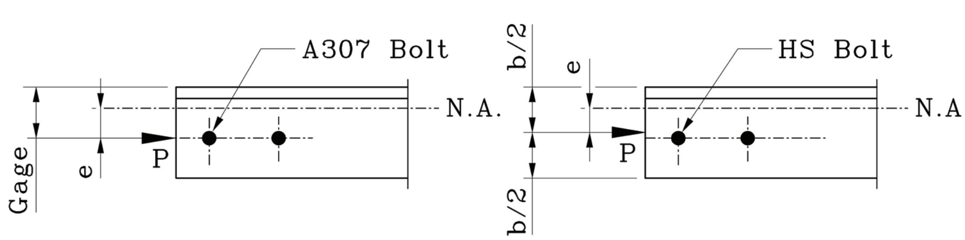
Connection to Gusset Plate

Single-angle members are attached to the gusset plate by either welding or bolting. Connection type and details affect how the axial load is transferred through the connection from the gusset plate to the angle members. For welded connections where fillet welds are placed on two sides of the connected leg, conventional wisdom says to place the welds in such a way that the center of gravity of weld resistance coincides with the centroid of the member (Figure 1a vs. Figure 1b) in order to minimize the torsion induced in the



(a) (b)

Fig. 1. Welded connection.



(a) (b)

Fig. 2. Bolted connection.

connection. It is suggested that this is even more desirable when the member is subjected to repeated or reversed stress.

For bolted connections, a minimum of two bolts are required per connection per AISC and AASHTO. Bolt holes often follow the gage line of the angle. If ASTM A307 bolts are used (Figure 2), the axial force is applied to the angle members through the bolt line. The axial force can be considered applied through the mid-point of the bolted leg if high-strength bolted connections are designed as slip critical joints and the friction between the connected leg and gusset plate is uniformly distributed.

Placement of welds and bolts is stipulated in Chapter J of the 2010 AISC *Specification* and has evolved over the years. The provision of arranging the center of gravity of the welds or bolts group to coincide with the center of gravity of the member is not applicable to statically loaded single angles according to the 1989 AISC ASD *Specification*, the 1986, 1998 and 2001 AISC LRFD *Specifications*, and the 2005 AISC *Specification*. The wording "statically loaded" is eliminated from Section J1.7 of the 2010 AISC *Specification*. However, the requirement for balancing the welds about the neutral axis of the angle is still warranted when the members are subjected to cyclic loading. Therefore, one can assume that the static axial load is applied at the mid-point of the connected leg, as it generates larger axial compressive design strength (Example 3), and the cyclic axial load is applied at neutral axis because it generates smaller and conservative axial compressive design strength (Example 4).

Eccentricity

As previously discussed, an end connection through one leg creates the eccentricity for the applied axial load that induces the end moment and, therefore, affects the load carrying capacity of either the connection or the member, or both. The effect of connection eccentricity is a function of connection and member stiffness, the proper eccentricity should be assumed when computing the axial capacity of single angles. Blodgett (1966) concluded that if the gusset plate is very flexible and offers no restraining action at the end of the member, the moment due to connection eccentricity must be resisted by the member, not by the connection. On the other hand, if the gusset plate is rigid enough so that there is no end rotation of the member, the moment due to connection eccentricity must be resisted by the connection, not by the member. The same concept is now presented in Figure C-D3.3 of the 2010 AISC *Specification* Commentary.

The actual eccentricity in the angle is less than the distance from the gusset centerline if there is any restraint from the gusset (Lutz, 2006). Woolcock and Kitipornchai (1986) recommended reduction of the eccentricity to $y - t/2$, where t is the angle thickness. Because the eccentricity will affect the capacity of the single angle, if a larger capacity is required, the connection should be evaluated to see if the eccentricity can be minimized. Three scenarios of end connections are summarized as follows:

- ***Figure 3a.*** When the end connection is flexible relative to the single-angle member, the eccentricity in the angle can be assumed as $e = y$ or $e = y + t_1/2$, with the latter being more conservative, and used to generate Table 4-12 in the 13th and 14th editions of the AISC *Manual*.

- ***Figure 3b.*** When the end connection is rigid relative to the single-angle member, the eccentricity in the angle can be assumed as $e = y$ or $e = y - t/2$, with the former being more conservative.

- ***Figure 3c.*** When the end connection is similar to that shown, eccentricity in the angle can be assumed as $e = y - t_1/2$, which is measured from the mid-thickness of gusset plate to the neutral axis of the angle.

DESIGN EXAMPLES

Four methods are presented here to illustrate the design procedures involved with the eccentrically loaded single angle. Equation and section references in these examples refer to the 2010 AISC *Specification*.

- **Method 1.** Axial capacities of equal-leg angle (L4×4×⅜) based on Section E5, the effects of eccentricity and end restraint are incorporated by using the effective slenderness ratio.

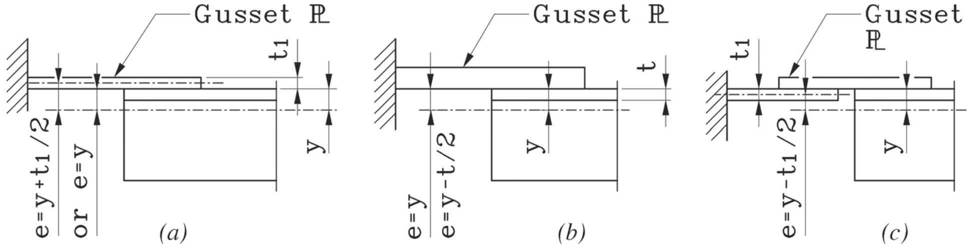


Fig. 3. Eccentricity.

- **Method 2.** Axial capacities of equal-leg angle (L4×4×⅜) based on Sections E7, F10 and H2, assuming that bending is about the one of the geometric axes, and the eccentricity is $e = y + t_1/2$, where $t_1 = 1.5t$ and t is the angle thickness.

- **Method 3.** Axial capacities of equal-leg angle (L4×4×⅜) based on Sections E7, F10 and H2, assuming that bending is about the principal axes and axial load is applied at mid-point of the connected leg, and the eccentricity is $e = y + t_1/2$, where $t_1 = 1.5t$ and t is the angle thickness.

- **Method 4.** Axial capacities of equal-leg angle (L4×4×⅜) based on Sections E7, F10 and H2, assuming that bending is about the principal axes and axial load is applied at one of the geometric axis of the angle, and the eccentricity is $e = y + t_1/2$, where $t_1 = 1.5t$ and t is the angle thickness.

Method 1

L4×4×⅜, connected one leg. See Figure 4.

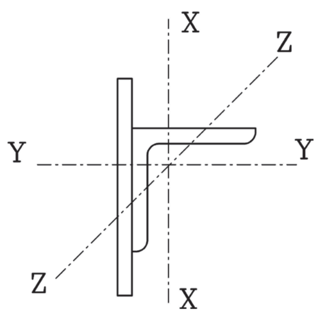


Fig. 4. Method 1.

L = 72 in.
K = 1.0
F_y = 36 ksi
E = 29,000 ksi
A_g = 2.86 in.^{2}
b = 4.0 in.
t = 0.375 in.
r_x = 1.230 in.
r_z = 0.779 in.
KL/r ≤ 200
ϕ_c = 0.90
Ω_c = 1.67

Solution

Check the required radius of gyration, r_{min}:

$r_{min} = KL/200 = 1.0(72)/200$
$= 0.360$ in

0.360 in. < r_z = 0.779 in. **OK**

Determine the effective slenderness ratio, KL/r. For equal-leg angles or unequal-leg angles connected through the longer leg that are individual members:

$$\frac{L}{r_x} = \frac{72}{1.23} = 58.5 \le 80$$

Therefore, from Equation E5-1:

$$\frac{KL}{r} = 72 + 0.75\frac{L}{r_x} = 72 + 0.75(58.5) = 116$$

Determine if reduction factor Q, for unstiffened elements is applicable [Section E7.1(c)]:

$$b/t = 4.0/0.375 = 10.7$$

From *Specification* Table B4.1a:

$$\lambda_r = 0.45\sqrt{\frac{E}{F_y}} = 0.45\sqrt{\frac{29{,}000}{36}} = 12.8$$

Because $b/t < \lambda_r$, the member is classified as a non-slender section and $Q_s = 1.0$ (Equation E7-10).

Therefore, $Q = Q_s = 1.0$.

From Equation E3-4, the elastic buckling stress, F_e, is:

$$F_e = \frac{\pi^2 E}{\left(\frac{KL}{r}\right)^2} = \frac{\pi^2(29{,}000)}{116^2} = 21.2 \text{ ksi}$$

For calculating the critical stress, F_{cr}, Equation E3-2 is essentially a special case of Equation E7-2, when the member is classified as a non-slender section.

$$KL/r \le 4\ 71\sqrt{\frac{E}{QF_y}} = 4.71\sqrt{\frac{29{,}000}{1.0(36)}} = 134$$

Therefore, using Equation E3-2 or E7-2:

$$F_{cr} = Q\left[0.658^{\frac{QF_y}{F_e}}\right]F_y$$

$$= 1.0\left[0.658^{1.0(36)/21.31}\right](36) = 17.8 \text{ ksi}$$

The nominal compressive strength may be calculated from Equations E3-1 or E7-1:

$$P_n = F_{cr}A_g = 17.8(2.86) = 50.8 \text{ kips}$$

Calculate the design compressive strength, $\phi_c P_n$, and the allowable compressive strength, P_n/Ω_c, using Section E1:

$$\phi_c P_n = 0.90(50.8) = 45.7 \text{ kips (LRFD)}$$

$$P_n/\Omega_c = 50.8/1.67 = 30.4 \text{ kips (ASD)}$$

Method 2

L4×4×⅜, connected to one leg, axial load is applied at the middle thickness of the gusset plate. The angle is designed on the basis of geometric axis (*x-x*) bending. See Figure 5.

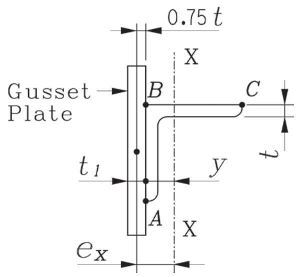


Fig. 5. Method 2.

t_1 = 1.5t = 9⁄16 in.
I_x = 4.32 in.^{4}
S_x = 1.50 in.^{3}
y = 1.13 in.
$S_{x(A,B)}$ = I_x/y = 3.82 in.^{3}
e_x = 0.75t + y = 1.41 in.
ϕ_b = 0.90

See Method 1 for additional information.

Solution

1. Calculate the design axial stress, F_{ca}.

Determine the maximum slenderness ratio, KL/r:

$$\frac{KL}{r} = \frac{KL}{r_z} = \frac{72}{0.779} = 92.4 \le 200, \textbf{ OK}$$

Determine the reduction factor Q, for unstiffened element from Section E7.1(c):

Same as Method 1, $Q = Q_s = 1.0$

Determine the elastic buckling stress, F_e from Equation E3-4:

$$F_e = \frac{\pi^2 E}{\left(\frac{KL}{r}\right)^2} = \frac{\pi^2(29{,}000)}{92.4^2} = 33.5 \text{ ksi}$$

Determine the critical stress, F_{cr}:

$$KL/r \le 4.71\sqrt{\frac{E}{QF_y}} = 4.71\sqrt{\frac{29{,}000}{1.0(36)}} = 134$$

Therefore, using Equation E3-2 or E7-2:

$$F_{cr} = Q\left[0.658^{\frac{QF_y}{F_e}}\right]F_y$$

$$= 1.0\left[0.658^{1.0(36)/33.5}\right](36) = 23.0 \text{ ksi}$$

Determine the design axial stress, F_{ca}, using Section H2:

$$F_{ca} = \phi_c F_{cr} = 0.90(22.7) = 20.7 \text{ ksi}$$

Determine the required axial stress, f_{ra}:

$$f_{ra} = P_r/A_g = P_r/2.86 \text{ ksi}$$

2. Calculate the design flexural stress, F_{cbx} (Section F10).

Check angle leg compactness for flexure (Table B4.1b):

$$\lambda_p = 0.54\sqrt{E/F_y} = 0.54\sqrt{29{,}000/36} = 15.3$$

$$\lambda_r = 0.91\sqrt{E/F_y} = 0.91\sqrt{29{,}000/36} = 25.8$$

Because $b/t < \lambda_p$, member is classified as a compact section.

Determine flexural strength based on leg local buckling (Section F10.3):

Because the member is a compact section, the limit state of local buckling does not apply.

Determine flexural strength based on yielding (Section F10-1):

$$M_y = F_y S_x = 36(1.50) = 54.0 \text{ kip-in.}$$

$$M_n = 1.5M_y = 1.5(54.0) = 81.0 \text{ kip-in}$$

Determine flexural strength based on lateral-torsional buckling for bending about one of the geometric axes (Section F10.2):

Calculate the elastic lateral-torsional buckling moment, M_e (Equation F10-6b):

$$M_e = \frac{0.66Eb^4tC_b}{L_b^2}\left(\sqrt{1+0.78\left(\frac{L_bt}{b^2}\right)^2}+1\right)$$

$$= \frac{0.66(29{,}000)(4)^4(0.375)(1.0)}{72^2}$$

$$\times\left(\sqrt{1+0.78\left(\frac{72(0.375)}{4^2}\right)^2}+1\right)$$

$$= 991 \text{ kip-in}$$

Because $M_e > M_y = 0.8F_yS_x = 0.8(36)(1.50) = 43.2$ kip-in, use Equation F10-3:

$$M_n = \left(1.92 - 1.17\sqrt{\frac{M_y}{M_e}}\right)M_y \leq 1.5M_y$$

$$= \left(1.92 - 1.17\sqrt{\frac{43.2}{991}}\right)(43.2)$$

$$= 72.39 \leq 1.5(43.20) = 64.8 \text{ kip-in}$$

Determine the controlling nominal flexure strength, M_n:

$M_n = \min[81.0, 64.8] = 64.8$ kip-in.

Determine the design flexure strength, $\phi_b M_n$:

$\phi_b M_n = 0.90(64.8) = 58.3$ kip-in.

Determine the design flexure stresses, $F_{cbx(C)}$ and $F_{cbx(A,B)}$:

$F_{cbx(C)} = \phi_b M_n / S_x = 58.3/1.50 = 38.9$ ksi

$F_{cbx(A,B)} = \phi_b M_n / S_{x(A,B)} = 58.3/3.82 = 15.3$ ksi

3. Calculate the interaction of flexure and axial stresses.

Because the angle is a non-symmetric section subject to compression and single-axis bending about one of the geometric axes, Equation H2-1 should be used and can be written as:

$$\left|\frac{f_{ra}}{F_{ca}} + \frac{f_{rbx}}{F_{cbx}}\right| \leq 1.0$$

This can be rewritten based on signs of bending stress at the points of consideration as follows:

Points A and B:

$$\left|\frac{f_{ra}}{F_{ca}} + \frac{f_{rbx(A,B)}}{F_{cbx(A,B)}}\right| \leq 1.0$$

Point C:

$$\left|\frac{f_{ra}}{F_{ca}} - \frac{f_{rbx(C)}}{F_{cbx(C)}}\right| \leq 1.0$$

where

f_{ra} = required axial stress

$f_{rbx(A,B)}, f_{rbx(C)}$ = required flexure stresses

Determine moment due to axial load, $M_{rx} = B_{1x}(e_x P_r)$ from Equation A-8-1, where:

B_{1x} = multiplier to account for P-δ effect based on Section 8.2 of Appendix 8.

$$B_{1x} = \frac{C_m}{1 - \alpha P_r / P_{e1x}} \geq 1.0 \quad \text{(Equation A-8-3)}$$

α = 1.0 (LRFD) or 1.6 (ASD)

C_m = 1.0 (conservative)

$$P_{e1x} = \frac{\pi^2 EI^*}{(K_1 L)^2} \quad \text{(Equation A-8-5)}$$

$EI^* = 0.8\tau_b EI_x$

$\tau_b = 1.0$, when $\alpha P_r / P_y \leq 0.5$

$= 4(\alpha P_r / P_y)[1 - (\alpha P_r / P_y)]$ otherwise

$\alpha P_r / P_y = 1.0(P_r)/[(36)(2.86)] = P_r/103$

$$P_{e1x} = \frac{\pi^2 EI^*}{(K_1 L)^2} = \frac{\pi^2 (0.8)\tau_b (29{,}000)(4.32)}{[1.0(72)]^2} = 191\tau_b$$

$$B_{1x} = \frac{C_m}{1 - \alpha P_r / P_{e1x}} = \frac{1.0}{1 - 1.0(P_r)/191\tau_b} = \frac{191\tau_b}{191\tau_b - P_r}$$

Determine the required second-order flexural strength, M_{rx}, as follows:

$$M_{rx} = B_{1x}(e_x P_r) = \left[\frac{191\tau_b}{191\tau_b - P_r}\right](e_x P_r)$$

Apply Equation H2-1 at points A and B:

$$\left|\frac{f_{ra}}{F_{ca}} + \frac{f_{rbx(A,B)}}{F_{cbx(A,B)}}\right| = \left|\frac{P_r/2.86}{20.7} + \frac{\left[\dfrac{191\tau_b(e_x P_r)}{191\tau_b - P_r}\right]\dfrac{1}{3.82}}{15.3}\right| \leq 1.0$$

Solving the previous equation, $P_r = 22.5$ kips.

Apply Equation H2-1 at point C:

$$\left|\frac{f_{ra}}{F_{ca}} - \frac{f_{rbx(C)}}{F_{cbx(C)}}\right| = \left|\frac{P_r/2.86}{20.7} - \frac{\left(\dfrac{191\tau_b(e_x P_r)}{191\tau_b - P_r}\right)\dfrac{1}{1.50}}{38.9}\right| \leq 1.0$$

Solving the previous equation, $P_r = 56.7$ kips.

Determine the design compressive strength, $\phi_c P_n$, and the allowable compressive strength, P_n/Ω_c:

$\phi_c P_n = P_r = \min(22.5, 56.7) = 22.5$ kips (LRFD)

$P_n/\Omega_c = (P_r/\phi_c)/\Omega_c = (22.5/0.9)/1.67 = 15.0$ kips (ASD)

Method 3

L4×4×3⁄8, connected to one leg, axial load is applied at mid-point of angle leg and mid-thickness of gusset plate. The angle is designed on the basis of principal axes (*w-w, z-z*) bending. See Figure 6.

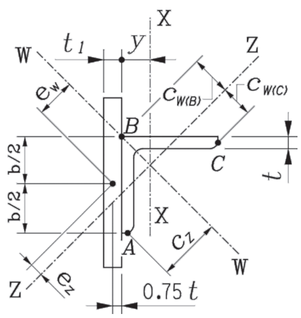


Fig. 6. Method 3.

$t_1 = 1.5t = 9/16$ in.

$I_x = 4.32$ in.^{4}

$I_y = 4.32$ in.^{4}

$e_w = 1.613$ in.

$e_z = 0.382$ in.

$I_z = A_g(r_z)^2 = 1.74$ in.^{4}

$I_w = I_x + I_y - I_z = 6.90$ in.^{4}

$r_w = \sqrt{I_w/A_g} = 1.55$ in.^{4}

See Methods 1 and 2 for additional information.

Solution

1. Calculate the angle concentric design axial stress, F_{ca}:

Same as Method 2.

$F_{ca} = 20.7$ ksi

Determine the required axial stress, f_{ra}:

$f_{ra} = P_r/A_g = P_r/2.86$ ksi

2. Calculate the angle flexural strength about major principal axis, $\phi_b M_{nw}$.

Angle leg compactness for flexure is same as Method 2. Because $b/t < \lambda_p$, the limit state of local buckling does not apply.

Determine the flexural strength based on yielding (Section F10-1):

Points A and C:

$C_z = \sin 45°(b - t/2) = (0.707)(4 - 0.375/2) = 2.70$ in.

$S_w = I_w/C_z = 6.90/2.70 = 2.56$ in.^{3} (compare to 2.56 in.^{3} from AISC Shapes Database V14.0)

$M_{yw} = F_y S_w = 36(2.56) = 92.2$ kip-in.

$M_{nw} = 1.5M_{yw} = 1.5(92.2) = 138$ kip-in.

Determine the flexural strength based on lateral-torsional buckling for bending about the major principal axis (Section F10.2):

The elastic lateral-torsional buckling moment, M_e, from Equation F10-4, is:

$$M_e = \frac{0.46Eb^2t^2C_b}{L}$$
$$= \frac{0.46(29{,}000)(4)^2(0.375)^2(1.0)}{72}$$
$$= 417 \text{ kip-in}$$

Because $M_e > M_{yw}$, use Equation F10-3 to calculate M_{nw}:

$$M_{nw} = \left(1.92 - 1.17\sqrt{\frac{M_{yw}}{M_e}}\right)M_{yw} \le 1.5M_{yw}$$
$$= \left(1.92 - 1.17\sqrt{\frac{92.2}{417}}\right)92.2 \le 138$$
$$= 126 \le 138$$
$$= 126 \text{ kip-in.}$$

Determine the controlling nominal flexure strength, M_{nw}:

$M_{nw} = \min\,[138, 126] = 126$ kip-in.

Determine the design flexure strength, $\phi_b M_{nw}$:

$\phi_b M_{nw} = 0.90(126) = 113$ kip-in.

Determine the design flexure stresses, $F_{cbw(A)}$ and $F_{cbw(C)}$:

$F_{cbw(A)} = F_{cbw(C)} = \phi_b M_{nw}/S_w = 113/2.56 = 44.1$ ksi

3. Calculate the angle flexural strength about minor principal axis, $\phi_b M_{nz}$.

Determine flexural strength based on yielding (Section F10-1):

Point B

$C_{w(B)} = y/\sin 45° = 1.13/0.707 = 1.60$ in.

$S_{z(B)} = I_z/C_{w(B)} = 1.74/1.60 = 1.09$ in.^{3} (compare to 1.08 in.^{3} from AISC Shape Database V14.0)

Points A and C

$$C_{w(A,C)} = \sin 45°(b + t/2) - C_{w(B)}$$
$$= 0.707(4 + 0.375/2) - 1.60 = 1.36 \text{ in.}$$

$S_{z(A,C)} = I_z/C_{w(A,C)} = 1.74/1.36 = 1.27$ in.^{3} (compare to 1.27 in.^{3} from AISC Shape Database V14.0)

Thus,

$$M_{yz} = F_y S_{z(B)} = 36(1.080) = 38.9 \text{ kip-in.}$$

Determine the nominal flexure strength, M_{nz}:

$$M_{nz} = 1.5\, M_{yz} = 1.5(38.9) = 58.3 \text{ kip-in.}$$

Determine the design flexure strength, $\phi_b M_{nz}$:

$$\phi_b M_{nz} = 0.90(58.3) = 52.5 \text{ kip-in.}$$

Determine the design flexure stresses $F_{cbx(B)}$, $F_{cbx(A)}$ and $F_{cbx(C)}$:

$$F_{cbz(B)} = \phi_b M_{nz}/S_{z(B)} = 52.5/1.08 = 48.6 \text{ ksi}$$

$$F_{cbz(A)} = F_{cbz(C)} = \phi_b M_{nz}/S_{z(A,C)} = 52.5/1.27 = 41.3 \text{ ksi}$$

4. Calculate the interaction of flexure and axial stresses.

Because the angle is a non-symmetric section subject to compression and bi-axis bending about the major and minor principal axes of the angle, Equation H2-1 should be used:

$$\left| \frac{f_{ra}}{F_{ca}} + \frac{f_{rbw}}{F_{cbw}} + \frac{f_{rbz}}{F_{cbz}} \right| \le 1.0$$

which can be rewritten based on the signs of bending stress at points A, B and C, respectively, as follows:

$$\left| \frac{f_{ra}}{F_{ca}} + \frac{f_{rbw(A)}}{F_{cbw(A)}} - \frac{f_{rbz(A)}}{F_{cbz(A)}} \right| \le 1.0$$

$$\left| \frac{f_{ra}}{F_{ca}} + \frac{f_{rbz(B)}}{F_{cbz(B)}} \right| \le 1.0$$

$$\left| \frac{f_{ra}}{F_{ca}} - \frac{f_{rbw(C)}}{F_{cbw(C)}} - \frac{f_{rbz(C)}}{F_{cbz(C)}} \right| \le 1.0$$

where

f_{ra} = required axial stress

$f_{rbw(A,\,C)}, f_{rbz(A,\,B,\,C)}$ = required flexure stresses

Determine moments due to axial load M_{rw} and M_{rz} from Equation A-8-1:

$$M_{rw} = B_{1w}(e_w P_r)$$

$$M_{rz} = B_{1z}(e_z P_r)$$

where

B_{1w}, B_{1z} = multiplier to account for P-δ effect based on Section 8.2 of Appendix 8

$$B_1 = \frac{C_m}{1 - \alpha P_r / P_{e1}} \ge 1.0 \qquad \text{(Equation A-8-3)}$$

$\alpha = 1.0$ (LRFD) or 1.6 (ASD)

$C_m = 1.0$ (conservative)

$$P_{e1} = \frac{\pi^2 EI^*}{(K_1 L)^2} \qquad \text{(Equation A-8-5)}$$

$EI^* = 0.8\tau_b EI$

$\tau_b = 1.0$, when $\alpha P_r/P_y \le 0.5$, otherwise

$\tau_b = 4(\alpha P_r/P_y)[1 - (\alpha P_r/P_y)]$

$\alpha P_r/P_y = 1.0(P_r)/[(36)(2.86)] = P_r/103$

$$P_{e1w} = \frac{\pi^2 EI_w^{\,*}}{(K_1 L)^2} = \frac{\pi^2 (0.8)\tau_b (29{,}000)(6.90)}{[1.0(72)]^2} = 305\tau_b \text{ kips}$$

$$P_{e1z} = \frac{\pi^2 EI_z^{\,*}}{(K_1 L)^2} = \frac{\pi^2 (0.8)\tau_b (29{,}000)(1.74)}{[1.0(72)]^2} = 76.7\tau_b \text{ kips}$$

$$B_{1w} = \frac{C_m}{1 - \alpha P_r / P_{e1w}} = \frac{1.0}{1 - 1.0(P_r)/305\tau_b} = \frac{305\tau_b}{305\tau_b - P_r}$$

$$B_{1z} = \frac{C_m}{1 - \alpha P_r / P_{e1z}} = \frac{1.0}{1 - 1.0(P_r)/76.7\tau_b} = \frac{76.7\tau_b}{76.7\tau_b - P_r}$$

The required second-order flexural strengths M_{rw} and M_{rz} for checking stress at points A, B and C are:

$$M_{rw} = B_{1w}(e_w P_r) = \left(\frac{305\tau_b}{305\tau_b - P_r}\right)(e_w P_r)$$

$$M_{rz} = B_{1z}(e_z P_r) = \left(\frac{76.7\tau_b}{76.7\tau_b - P_r}\right)(e_z P_r)$$

Apply Equation H2-1 at point A:

$$\left|\frac{f_{ra}}{F_{ca}}+\frac{f_{rbw(A)}}{F_{cbw(A)}}-\frac{f_{rbz(A)}}{F_{cbz(A)}}\right|=$$

$$\left|\frac{P_r/2.86}{20.7}+\frac{\left(\dfrac{305\tau_b(e_wP_r)}{305\tau_b-P_r}\right)\Big/2.56}{44.4}-\frac{\left(\dfrac{76.7\tau_b(e_zP_r)}{76.7\tau_b-P_r}\right)\Big/1.27}{41.3}\right|\le 1.0$$

Solving the previous equation, $P_r = 62.6$ kips.

Apply Equation H2-1 at point B:

$$\left|\frac{f_{ra}}{F_{ca}}+\frac{f_{rbz(B)}}{F_{cbz(B)}}\right|=\left|\frac{P_r/2.86}{20.7}+\frac{\left(\dfrac{76.7\tau_b(e_zP_r)}{76.7\tau_b-P_r}\right)\Big/1.09}{48.6}\right|\le 1.0$$

Solving the previous equation, $P_\mathrm{r} = 33.5$ kips.

Apply Equation H2-1 at point C:

$$\left|\frac{f_{ra}}{F_{ca}}-\frac{f_{rbw(A)}}{F_{cbw(A)}}-\frac{f_{rbz(A)}}{F_{cbz(A)}}\right|=$$

$$\left|\frac{P_r/2.86}{20.66}-\frac{\left(\dfrac{305\tau_b(e_wP_r)}{305\tau_b-P_r}\right)\Big/2.56}{44.4}-\frac{\left(\dfrac{76.7\tau_b(e_zP_r)}{76.7\tau_b-P_r}\right)\Big/1.27}{41.3}\right|\le 1.0$$

Solving the previous equation, $P_r = 56.2$ kips.

Determine the design compressive strength, $\phi_c P_n$, and the allowable compressive strength, P_n/Ω_c:

$$\phi_c P_n = P_r = \min\,[62.6, 33.5, 56.2] = 33.5 \text{ kips (LRFD)}$$

$$P_n/\Omega_c = (P_r/\phi_c)/\Omega_c = (33.5/0.9)/1.67 = 22.3 \text{ kips (ASD)}$$

Method 4

L4×4×⅜, connected to one leg, axial load is applied at geometric axis *y-y*, and mid-thickness of gusset plate. Angle is designed on the basis of principal axes (*w-w, z-z*) bending. See Figure 7.

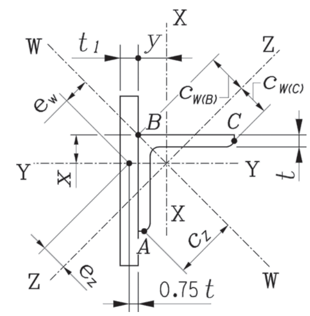


Fig. 7. Method 4.

e_w = 0.998 in.
e_z = 0.998 in.

See Method 3 for additional information.

Solution

All calculations are the same as Method 3, except for replacing values of e_z and e_w in Method 3 with the values provided in this method.

Apply Equation H2-1 at point A, solve for $P_r = 46.7$ kips
Apply Equation H2-1 at point B, solve for $P_r = 22.8$ kips
Apply Equation H2-1 at point C, solve for $P_r = 39.0$ kips

Determine the design compressive strength, $\phi_c P_n$ and the allowable compressive strength, P_n/Ω_c:

$$\phi_c P_n = P_r = \min\,[46.7, 22.8, 39.0] = 22.8 \text{ kips (LRFD)}$$
$$P_n/\Omega_c = (P_r/\phi_c)/\Omega_c = (22.8/0.9)/1.67 = 15.2 \text{ kips (ASD)}$$

DISCUSSION

Axial capacities of an L4×4×⅜ from the design examples are summarized in Table 1. The axial capacities based on Methods 2 and 4 (highlighted) are similar, while Method 1 gives the largest axial capacity and Method 2 yields the smallest capacity. It is further noted that the axial capacities based on Method 3 are slightly smaller than the values from Table 4-12 in the 14th edition AISC *Manual* when the direct analysis method and the flexural rigidity $EI^* = 0.8\tau_b EI$ were used (2010 AISC *Specification* Appendix 8). Further investigation reveals that the axial capacities based on Method 3 match the values from Table 4-12 in the 14th edition AISC *Manual* when $EI^* = EI$ was used in the analysis (example not shown).

Because the axial compressive design strength of the same angle with the same connection and the same unbraced length varies significantly with the different design methods, it should be interesting to see the variability among the different angles with different unbraced lengths. Figures 8a through 8d graphically illustrate the differences in the axial compressive design strength of the largest equal-leg angle

Table 1. Available Compressive Strength of L4×4×3/8, L = 72 in.		
	$\phi_c P_n$	P_n/Ω
Method 1	45.69	30.40
Method 2	22.54	15.00
Method 3[a]	33.49	22.28
Method 3[b]	35.17	23.40
AISC Table 4-12	35.2	23.2
Method 4	22.76	15.14

[a] $EI^* = 0.8\tau_b EI$
[b] $EI^* = EI$

(L8×8) and one of the smallest equal-leg angles (L3×3) with the thickest and thinnest angle legs. The available axial compressive strength from Table 4-12 of both the 13th and 14th edition AISC *Manuals* are also included for the purpose of comparison. The following can be observed:

1. The axial compressive design strengths of single angles are the greatest based on Method 1 and the smallest based on Method 2 or 4. The magnitude of difference varies with the thickness of angle leg, a heavier section results in a greater difference. The ratios of the design strengths based on Method 1 to the design strengths based on Method 2 or 4 are in the range of 1.5 to 2.0.

2. The axial compressive design strengths of single angles based on Method 2 and Method 4 are similar. For angles with smaller unbraced lengths, the design strengths based on Method 4 are slightly larger than that based on Method 2; however, for angles with larger unbraced lengths, the design strengths based on Method 2 are slightly larger than that predicted based on Method 4.

3. When the axial compressive force is applied at the geometric axis *y-y*, the axial compressive design strengths of single angles based on Method 4 are smaller than those from Table 4-12 of the 13th edition AISC *Manual*, but they are close and almost parallel.

4. When the axial compressive force is applied at mid-point of the connected leg (b/2), the axial compressive design strength of single angles based on Method 3 considering the flexural rigidity $EI^* = 0.8\tau_b EI$ ($0.8\tau_b EI$ is shown in Figure 8) is slightly smaller than that from Table 4-12 of the 14th edition AISC *Manual*. However, when $EI^* = EI$ is used instead, the design strengths based on Method 3 are identical to that from Table 4-12 of the 14th edition AISC *Manual*.

5. As discussed in the design consideration section, because the slight eccentricity between the neutral axis of the single angle and the center of gravity of the weld group has negligible effect on the static strength of the member, the angle should be designed assuming the static axial compressive force is applied at the mid-point of the connected leg (Method 3). However, for angles subject to cyclic force, one could choose to design the angle assuming the axial compressive force is applied at the neutral axis of the single angle, as it is required that the center of gravity of the weld group coincides with the neutral axis of the member.

On the other hand, single angles subject to cyclic loads can be designed assuming that the axial compressive force is applied at the mid-point of the connected leg (Method 3) per 2010 AISC *Specification* Section J1.7, as long as the requirement of center of gravity of the weld group coinciding with the neutral axis of the member is satisfied.

6. While the larger capacities predicted by Method 1 based on Section E5 of the 2010 AISC *Specification* are welcomed by the engineering community, the design engineer may wish to choose the values from Table 4-12 in the 14th edition AISC *Manual* or Design Table 2 presented at end of this paper, as the available strengths from these tables are conservative.

7. The 2005 and 2010 AISC *Specifications* do not address how to determine the eccentricity of applied axial force relative to the connected leg. However, a distance of $0.75t$ (t is the angle thickness) from the back face of the connected leg is used by Table 4-12 of the 13th and 14th edition AISC *Manauls*. As discussed in the design consideration section, this distance can be taken as small as $-0.50t$, instead of $0.75t$. The design strengths based on Method 4 using different eccentricities are presented in Design Tables 3 and 4.

8. It is beneficial to point out that the larger available axial compressive strength of the single angles determined based on the specified effective slenderness ratio, KL/r

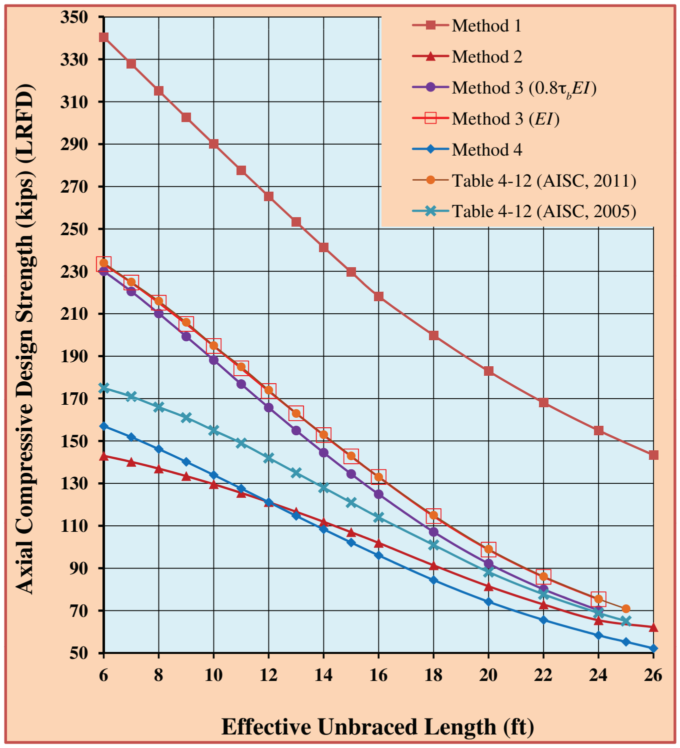


Fig. 8a. Axial compressive design strength (L8×8×1⅛).

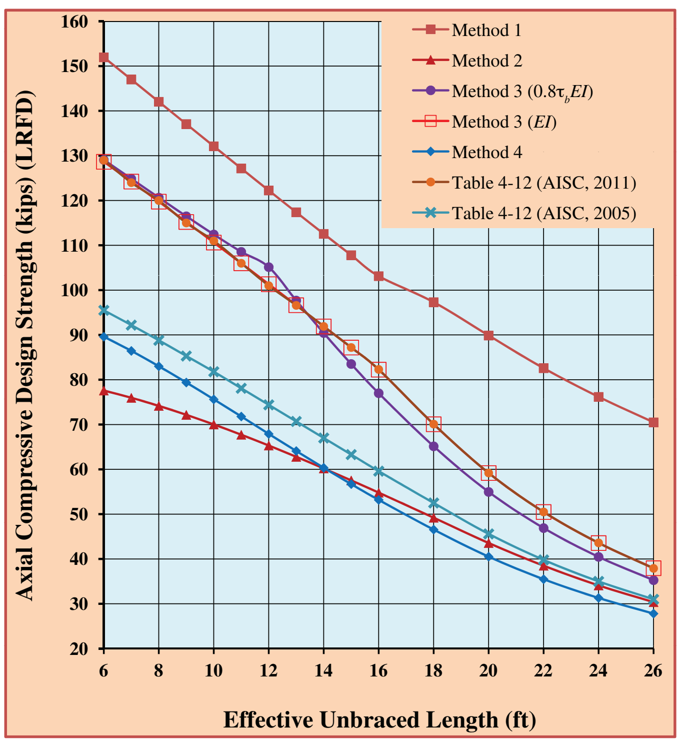


Fig. 8b. Axial compressive design strength (L8×8×½).

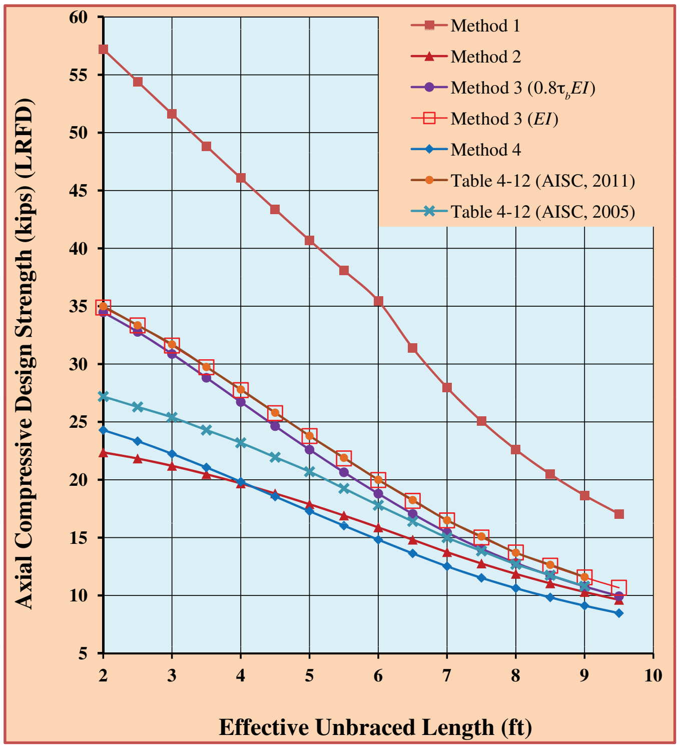


Fig. 8c. Axial compressive design strength (L3×3×½).

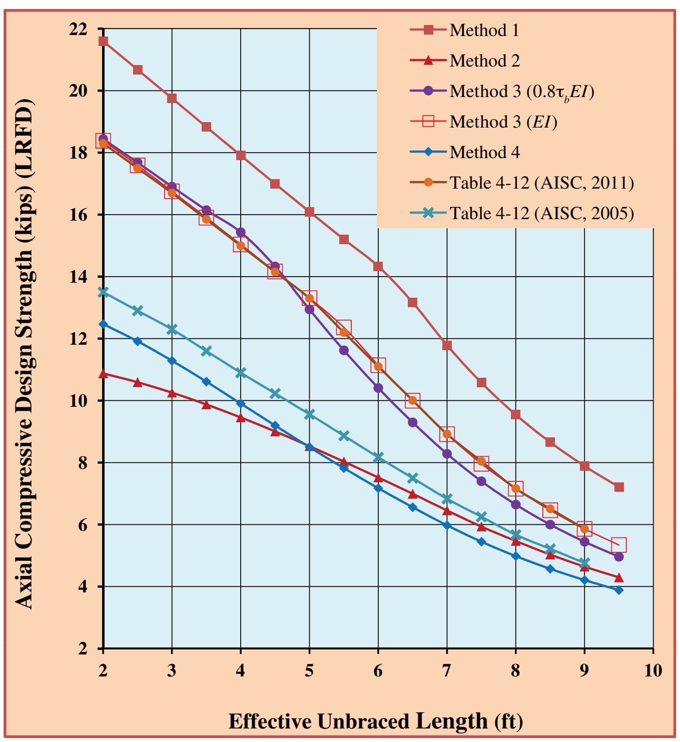


Fig. 8d. Axial compressive design strength (L3×3×13⁄16).

(Method 1) are due to the presumptions that the significant bending and rotational restraints are provided by the end connections; in other words, if another method (Method 2, 3 or 4) is used to evaluate the available compressive strength of the single angles, the reduced unbraced lengths (effective length factor, *K*) and eccentricities due to the end restraints should be considered to avoid overly conservative results, as described in Commentary section E5 of the 2010 AISC *Specification*. However, this could pose some challenges when the design is based on a particular code, where the unbraced length reduction factor is limited to 1.0, as discussed in design considerations of single angles in compression.

DESIGN TABLES

Design tables for the axial compressive design strength of eccentrically loaded equal-leg single angles (grades 36 and 50) are prepared based on previously discussed Methods 1, 3 and 4. The format of the tables follows the format of Table 4-12 of the 14th edition AISC *Manual*.

Design Table 1: Axial compressive design strength of equal-leg angles based on Method 1, see Method 1.

Design Table 2: Axial compressive design strength of equal-leg angles based on Method 3, assuming the axial load is applied at mid-point of the connected leg and mid-thickness of the gusset plate. Angles are designed on the basis of principal axes *(w-w, z-z)* bending. See Method 3.

Design Table 3: Axial compressive design strength of equal-leg angles based on Method 4, assuming the axial load is applied at geometric axis *y-y* and mid-thickness of the gusset plate. Angles are designed on the basis of principal axes (*w-w, z-z*) bending. See Method 4.

Design Table 4: Axial compressive design strength of equal-leg angles based on Method 4, assuming the axial load is applied at geometric axis *y-y*, and mid-thickness of the connected leg. Angles are designed on the basis of principal axes (*w-w, z-z*) bending.

Design Tables 3 and 4 are integrated such that identical angle sizes appear in adjacent tables for ease of comparison.

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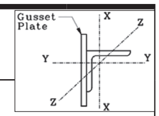
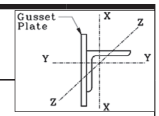
Design Table 1. Available Strength in Axial Compression, kips* Eccentrically Loaded Single Angles



Shape	L8×8×													
	1 1/8		1		7/8		3/4		5/8[c]		9/16[c]		1/2[c, f]	
lb/ft	56.9		51.0		45.0		38.9		32.7		29.6		26.4	
Design	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
	F_y = 36 ksi													
Unbraced Length between Work Points, L (ft) 6	227	340	204	307	180	271	156	234	131	197	116	175	101	152
7	218	328	196	295	173	261	150	226	127	190	112	169	97.8	147
8	210	315	189	284	167	251	144	217	122	183	108	163	94.5	142
9	201	303	182	273	160	241	139	209	117	176	104	157	91.2	137
10	193	290	174	262	154	231	133	200	113	169	100	151	87.9	132
11	185	278	167	251	147	222	128	192	108	162	96.5	145	84.6	127
12	177	265	159	240	141	212	122	184	103	155	92.6	139	81.3	122
13	169	253	152	229	135	203	117	176	98.8	149	88.7	133	78.1	117
14	161	241	145	218	129	193	111	168	94.4	142	84.9	128	74.9	113
15	153	230	138	208	122	184	106	160	90.0	135	81.1	122	71.7	108
16	145	218	131	198	117	175	101	152	85.7	129	77.4	116	68.6	103
18	133	200	121	182	108	162	93.9	141	80.1	120	72.8	109	64.7	97.3
20	122	183	111	167	98.9	149	86.0	129	73.4	110	66.8	100	59.8	89.9
22	112	168	102	153	90.9	137	79.1	119	67.5	101	61.5	92.4	54.9	82.6
24	103	155	93.9	141	83.8	126	72.9	110	62.2	94	56.7	85.2	50.7	76.2
26	95.4	143	86.9	131	77.5	117	67.5	101	57.6	86.6	52.5	78.9	46.9	70.5
Design	F_y = 50 ksi													
	1 1/8		1		7/8		3/4		5/8[c]		9/16[c, f]		1/2[c, f]	
Unbraced Length between Work Points, L (ft) 6	262	394	236	355	209	314	181	271	149	224	132	199	115	172
7	249	374	224	337	198	298	172	258	142	213	126	190	110	165
8	236	354	212	319	188	282	163	244	135	203	121	181	105	158
9	223	334	201	302	178	267	154	231	128	193	115	173	101	151
10	210	315	190	285	168	252	145	219	122	183	109	164	96.0	144
11	197	297	178	268	158	238	137	206	115	173	104	156	91.4	137
12	185	278	167	252	148	223	129	193	109	164	98.3	148	87.0	131
13	174	261	157	236	139	210	121	182	103	154	93.0	140	82.6	124
14	163	246	148	222	131	197	114	171	96.6	145	87.7	132	78.3	118
15	154	232	139	210	124	186	107	161	91.1	137	82.7	124	74.0	111
16	145	219	132	198	117	176	101	152	86.1	129	78.2	118	69.9	105
18	133	200	121	182	108	162	93.9	141	80.1	120	73.0	110	65.2	98.0
20	122	183	111	167	98.9	149	86.0	129	73.4	110	66.8	100	59.8	89.8
22	112	168	102	153	90.9	137	79.1	119	67.5	101	61.5	92.4	54.9	82.6
24	103	155	93.9	141	83.8	126	72.9	110	62.2	93.6	56.7	85.2	50.7	76.2
26	95.4	143	86.9	131	77.5	117	67.5	101	57.6	86.6	52.5	78.9	46.9	70.5
	Properties													
A_g (in.^{2})	16.8		15.1		13.3		11.5		9.69		8.77		7.84	
r_z (in.)	1.56		1.56		1.57		1.57		1.58		1.58		1.59	

ASD	LRFD	
Ω_c = 1.67	ϕ_c = 0.9	[c] Shape is slender for compression. [f] Shape exceeds compact limit for flexure. Notes: Heavy lines indicate L/r_z equal to or greater than 120, 140 and 200, respectively. *Method 1.

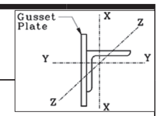
Design Table 1. Available Strength in Axial Compression, kips* Eccentrically Loaded Single Angles



Shape		L6×6×													
		1		7/8		3/4		5/8		9/16		1/2		7/16^c	
lb/ft		37.4		33.1		28.7		24.2		21.9		19.6		17.3	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
		F_y = 36 ksi													
Unbraced Length between Work Points, *L* (ft)	4	152	228	135	203	117	176	98.9	149	89.5	135	80.2	120	69.5	104
	5	144	217	128	193	111	167	94.2	142	85.3	128	76.4	115	66.3	99.7
	6	137	206	122	183	106	159	89.5	135	81.1	122	72.7	109	63.2	94.9
	7	129	195	115	173	100	151	84.8	128	76.9	116	68.9	104	60.0	90.2
	8	122	184	109	164	94.7	142	80.2	121	72.8	109	65.2	98.1	56.9	85.5
	9	115	173	103	154	89.3	134	75.7	114	68.7	103	61.6	92.6	53.8	80.8
	10	108	162	96.3	145	83.9	126	71.2	107	64.6	97.1	58.0	87.2	50.7	76.2
	11	101	152	90.3	136	78.6	118	66.8	100	60.7	91.2	54.5	81.9	47.7	71.7
	12	94.0	141	84.4	127	73.5	111	62.5	94.0	56.8	85.4	51.0	76.7	44.8	67.3
	13	83.2	125	75.1	113	65.7	98.7	56.3	84.6	51.3	77.2	46.3	69.6	40.8	61.3
	14	74.2	111	66.9	101	58.5	88.0	50.2	75.4	45.8	68.8	41.3	62.1	36.4	54.7
	15	66.5	99.9	60.0	90.2	52.5	78.9	45.0	67.7	41.1	61.7	37.1	55.7	32.6	49.0
	16	59.9	90.1	54.1	81.3	47.4	71.2	40.6	61.0	37.1	55.7	33.4	50.3	29.4	44.3
	17	54.3	81.6	49.0	73.7	42.9	64.5	36.8	55.4	33.6	50.5	30.3	45.6	26.7	40.1
	18	49.5	74.3	44.6	67.1	39.1	58.8	33.5	50.4	30.6	46.0	27.6	41.5	24.3	36.6
	19	45.2	68.0	40.8	61.4	35.8	53.7	30.7	46.1	28.0	42.1	25.3	38.0	22.3	33.5
Design		F_y = 50 ksi													
		1		7/8		3/4		5/8		9/16		1/2^c		7/16^c, f	
Unbraced Length between Work Points, *L* (ft)	4	177	266	157	237	137	206	116	174	105	157	92.4	139	79.3	119
	5	165	248	147	221	128	192	108	163	98.0	147	86.7	130	74.7	112
	6	154	231	137	206	119	179	101	151	91.3	137	81.0	122	70.1	105
	7	142	214	127	191	110	166	93.5	141	84.9	128	75.5	114	65.6	98.6
	8	131	197	117	176	102	153	86.5	130	78.5	118	70.2	105	61.2	92.0
	9	120	181	108	162	93.7	141	79.6	120	72.3	109	65.0	97.7	56.9	85.5
	10	111	166	98.9	149	86.2	130	73.3	110	66.6	100	59.8	89.9	52.7	79.2
	11	102	153	91.3	137	79.6	120	67.7	102	61.5	92.5	55.3	83.1	48.7	73.2
	12	94.1	141	84.5	127	73.7	111	62.7	94.3	57.0	85.7	51.3	77.1	45.1	67.8
	13	83.2	125	75.1	113	65.7	98.7	56.3	84.6	51.3	77.2	46.3	69.6	40.8	61.3
	14	74.2	111	66.9	101	58.5	88.0	50.2	75.4	45.8	68.8	41.3	62.1	36.4	54.7
	15	66.5	99.9	60.0	90.2	52.5	78.9	45.0	67.7	41.1	61.7	37.1	55.7	32.6	49.0
	16	59.9	90.1	54.1	81.3	47.4	71.2	40.6	61.0	37.1	55.7	33.4	50.3	29.4	44.3
	17	54.3	81.6	49.0	73.7	42.9	64.5	36.8	55.4	33.6	50.5	30.3	45.6	26.7	40.1
	18	49.5	74.3	44.6	67.1	39.1	58.8	33.5	50.4	30.6	46.0	27.6	41.5	24.3	36.6
	19	45.2	68.0	40.8	61.4	35.8	53.7	30.7	46.1	28.0	42.1	25.3	38.0	22.3	33.5
Properties															
A_g (in.^{2})		11.0		9.75		8.46		7.13		6.45		5.77		5.08	
r_z (in.)		1.17		1.17		1.17		1.17		1.18		1.18		1.18	

ASD	LRFD	
$\Omega_c = 1.67$	$\phi_c = 0.9$	^c Shape is slender for compression. ^f Shape exceeds compact limit for flexure. Notes: Heavy lines indicate L/r_z equal to or greater than 120, 140 and 200, respectively. *Method 1.

Design Table 1. Available Strength in Axial Compression, kips* Eccentrically Loaded Single Angles



Shape		L5×5×													
		7/8		3/4		5/8		1/2		7/16		3/8[c]		5/16[c, f]	
lb/ft		27.2		23.6		20.0		16.2		14.3		12.3		10.4	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
		F_y = 36 ksi													
Unbraced Length between Work Points, L (ft)	1	125	188	109	164	92.4	139	75.0	113	66.1	99.4	56.5	85.0	45.2	67.9
	2	119	179	104	156	87.8	132	71.4	107	62.9	94.6	53.9	81.0	43.2	64.9
	3	112	169	98.2	148	83.2	125	67.6	102	59.7	89.7	51.1	76.9	41.2	61.9
	4	106	159	92.6	139	78.5	118	63.9	96.0	56.4	84.7	48.4	72.7	39.1	58.8
	5	99.5	150	87.0	131	73.9	111	60.1	90.3	53.0	79.7	45.6	68.5	37.0	55.7
	6	93.1	140	81.4	122	69.2	104	56.3	84.7	49.8	74.8	42.8	64.4	35.0	52.6
	7	86.7	130	75.9	114	64.6	97.1	52.6	79.1	46.5	69.9	40.1	60.3	32.9	49.5
	8	80.5	121	70.5	106	60.1	90.3	49.0	73.6	43.3	65.1	37.4	56.2	30.9	46.4
	9	74.4	112	65.2	98.0	55.7	83.7	45.4	68.2	40.2	60.4	34.8	52.3	28.9	43.4
	10	68.3	103	60.1	90.4	51.4	77.2	41.9	63.0	37.1	55.8	32.2	48.4	26.9	40.5
	11	59.0	88.7	52.0	78.2	44.9	67.5	36.8	55.3	32.8	49.2	28.6	43.0	24.3	36.5
	12	51.5	77.4	45.4	68.3	39.2	58.9	32.1	48.3	28.6	43.0	25.0	37.6	21.2	31.9
	13	45.3	68.1	40.0	60.1	34.5	51.9	28.3	42.6	25.2	37.9	22.0	33.1	18.7	28.1
	14	40.2	60.4	35.5	53.3	30.6	46.0	25.1	37.8	22.4	33.6	19.6	29.4	16.6	25.0
	15	35.9	54.0	31.7	47.6	27.4	41.1	22.5	33.8	20.0	30.1	17.5	26.3	14.9	22.3
	16	32.3	48.5	28.5	42.8	24.6	37.0	20.2	30.3	18.0	27.0	15.7	23.6	13.4	20.1
Design		F_y = 50 ksi													
		7/8		3/4		5/8		1/2		7/16[c]		3/8[c, f]		5/16[c, f]	
Unbraced Length between Work Points, L (ft)	1	153	231	134	201	113	170	92.0	138	80.2	121	66.9	101	53.1	79.8
	2	143	215	125	188	106	159	85.9	129	75.0	113	62.8	94.4	50.2	75.4
	3	132	199	116	174	98.0	147	79.7	120	69.7	105	58.7	88.2	47.2	70.9
	4	122	183	107	160	90.4	136	73.6	111	64.5	97.0	54.6	82.1	44.2	66.5
	5	112	168	97.7	147	83.0	125	67.6	102	59.4	89.3	50.6	76.0	41.3	62.0
	6	102	153	89.1	134	75.9	114	61.8	92.9	54.5	81.8	46.6	70.1	38.4	57.6
	7	92.1	138	80.7	121	68.9	104	56.2	84.5	49.7	74.6	42.8	64.3	35.5	53.4
	8	83.1	125	72.9	110	62.2	93.5	50.8	76.3	45.0	67.6	39.1	58.8	32.7	49.2
	9	75.3	113	66.1	99.3	56.5	84.9	46.1	69.3	40.9	61.4	35.5	53.4	30.1	45.2
	10	68.3	103	60.2	90.5	51.5	77.4	42.1	63.2	37.3	56.0	32.4	48.7	27.4	41.2
	11	59.0	88.7	52.0	78.2	44.9	67.5	36.8	55.3	32.8	49.2	28.6	43.0	24.3	36.5
	12	51.5	77.4	45.4	68.3	39.2	58.9	32.1	48.3	28.6	43.0	25.0	37.6	21.2	31.9
	13	45.3	68.1	40.0	60.1	34.5	51.9	28.3	42.6	25.2	37.9	22.0	33.1	18.7	28.1
	14	40.2	60.4	35.5	53.3	30.6	46.0	25.1	37.8	22.4	33.6	19.6	29.4	16.6	25.0
	15	35.9	54.0	31.7	47.6	27.4	41.1	22.5	33.8	20.0	30.1	17.5	26.3	14.9	22.3
	16	32.3	48.5	28.5	42.8	24.6	37.0	20.2	30.3	18.0	27.0	15.7	23.6	13.4	20.1
Properties															
A_g (in.^{2})		8.00		6.98		5.90		4.79		4.22		3.65		3.07	
r_z (in.)		0.971		0.972		0.975		0.980		0.983		0.986		0.990	

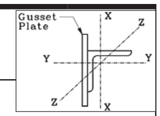
ASD	LRFD
Ω_c = 1.67	ϕ_c = 0.9

[c] Shape is slender for compression. [f] Shape exceeds compact limit for flexure.

Notes: Heavy lines indicate L/r_z equal to or greater than 120, 140 and 200, respectively.

*Method 1.

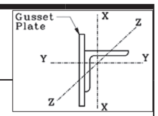
Design Table 1. Available Strength in Axial Compression, kips* Eccentrically Loaded Single Angles



Shape	L4×4×													
	3/4		5/8		1/2		7/16		3/8		5/16[c]		1/4[c, f]	
lb/ft	18.5		15.7		12.8		11.3		9.8		8.2		6.6	
Design	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
	F_y = 36 ksi													
Unbraced Length between Work Points, L (ft)														
2	78.5	118	66.7	100	54.3	81.7	47.9	71.9	41.5	62.4	34.8	52.3	26.5	39.8
2.5	75.8	114	64.4	96.8	52.5	78.9	46.2	69.5	40.1	60.3	33.7	50.6	25.7	38.6
3	73.0	110	62.1	93.3	50.6	76.1	44.6	67.1	38.7	58.2	32.5	48.9	24.9	37.4
3.5	70.2	106	59.8	89.9	48.7	73.3	43.0	64.6	37.3	56.1	31.4	47.1	24.1	36.2
4	67.4	101	57.5	86.4	46.9	70.4	41.4	62.2	35.9	54.0	30.2	45.4	23.3	35.0
4.5	64.7	97.2	55.2	82.9	45.0	67.6	39.7	59.7	34.5	51.9	29.0	43.6	22.5	33.8
5	61.9	93.1	52.9	79.5	43.2	64.9	38.1	57.3	33.1	49.8	27.9	41.9	21.7	32.6
5.5	59.2	89.0	50.6	76.0	41.3	62.1	36.5	54.9	31.8	47.7	26.7	40.2	20.9	31.4
6	56.5	84.9	48.3	72.7	39.5	59.4	34.9	52.5	30.4	45.7	25.6	38.5	20.1	30.2
7	51.3	77.0	43.9	66.0	35.9	54.0	31.8	47.8	27.7	41.7	23.4	35.1	18.5	27.8
8	45.8	68.8	39.7	59.7	32.5	48.9	28.8	43.3	25.1	37.8	21.2	31.9	16.9	25.5
9	38.1	57.3	33.2	49.9	27.3	41.1	24.4	36.6	21.4	32.2	18.2	27.3	14.8	22.3
10	32.3	48.5	28.1	42.3	23.2	34.8	20.7	31.1	18.1	27.3	15.4	23.2	12.6	18.9
11	27.7	41.6	24.1	36.2	19.9	29.9	17.7	26.7	15.6	23.4	13.2	19.9	10.8	16.2
12	24.0	36.1	20.9	31.4	17.3	25.9	15.4	23.1	13.5	20.3	11.5	17.3	9.4	14.1
13											10.0	15.1	8.1	12.2
Design	F_y = 50 ksi													
	3/4		5/8		1/2		7/16		3/8		5/16[c]		1/4[c, f]	
Unbraced Length between Work Points, L (ft)														
2	93.3	140	79.4	119	64.7	97.2	57.0	85.7	49.5	74.3	40.3	60.6	30.6	46.0
2.5	88.8	133	75.6	114	61.6	92.6	54.3	81.7	47.2	70.9	38.6	58.0	29.4	44.2
3	84.3	127	71.8	108	58.6	88.1	51.7	77.7	44.9	67.5	36.8	55.4	28.3	42.5
3.5	79.9	120	68.1	102	55.6	83.6	49.1	73.8	42.7	64.1	35.1	52.8	27.1	40.7
4	75.5	114	64.5	96.9	52.7	79.2	46.5	69.9	40.5	60.8	33.4	50.3	25.9	39.0
4.5	71.3	107	60.9	91.6	49.8	74.8	44.0	66.1	38.3	57.5	31.8	47.8	24.8	37.3
5	67.1	101	57.4	86.3	47.0	70.6	41.5	62.4	36.2	54.3	30.1	45.3	23.7	35.6
5.5	63.0	94.6	54.0	81.2	44.2	66.4	39.1	58.8	34.1	51.2	28.5	42.9	22.6	33.9
6	59.0	88.6	50.6	76.1	41.4	62.3	36.7	55.2	32.0	48.1	27.0	40.5	21.5	32.3
7	52.0	78.2	44.7	67.2	36.6	55.0	32.4	48.8	28.3	42.6	23.9	36.0	19.3	29.1
8	45.7	68.8	39.8	59.8	32.6	49.0	28.9	43.4	25.2	37.9	21.3	32.1	17.3	26.0
9	38.1	57.3	33.2	49.9	27.3	41.1	24.4	36.6	21.4	32.2	18.2	27.3	14.8	22.2
10	32.3	48.5	28.1	42.3	23.2	34.8	20.7	31.1	18.1	27.3	15.4	23.2	12.6	18.9
11	27.7	41.6	24.1	36.2	19.9	29.9	17.7	26.7	15.6	23.4	13.2	19.9	10.8	16.2
12	24.0	36.1	20.9	31.4	17.3	25.9	15.4	23.1	13.5	20.3	11.5	17.3	9.4	14.1
13											10.0	15.1	8.1	12.2
	Properties													
A_g (in.^{2})	5.43		4.61		3.75		3.30		2.86		2.40		1.93	
r_z (in.)	0.774		0.774		0.776		0.777		0.779		0.781		0.783	

ASD	LRFD	
Ω_c = 1.67	ϕ_c = 0.9	[c] Shape is slender for compression. [f] Shape exceeds compact limit for flexure. Notes: Heavy lines indicate L/r_z equal to or greater than 120, 140 and 200, respectively. *Method 1.

Design Table 1. Available Strength in Axial Compression, kips* Eccentrically Loaded Single Angles



Shape		L3½×3½×									
		½		7/16		3/8		5/16		¼ᶜ	
lb/ft		11.1		9.80		8.50		7.20		5.80	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
		F_y = 36 ksi									
Unbraced Length between Work Points, L (ft)	2	46.1	69.3	41.1	61.7	35.6	53.5	29.9	45.0	23.8	35.7
	2.5	44.2	66.5	39.4	59.3	34.2	51.4	28.8	43.2	22.9	34.4
	3	42.4	63.7	37.8	56.8	32.8	49.2	27.6	41.5	22.0	33.0
	3.5	40.5	60.9	36.1	54.3	31.4	47.1	26.4	39.7	21.1	31.7
	4	38.7	58.1	34.5	51.8	29.9	45.0	25.2	37.9	20.2	30.4
	4.5	36.8	55.3	32.9	49.4	28.6	42.9	24.1	36.2	19.3	29.0
	5	35.0	52.6	31.3	47.0	27.2	40.8	22.9	34.5	18.4	27.7
	5.5	33.2	49.9	29.7	44.6	25.8	38.8	21.8	32.8	17.6	26.4
	6	31.4	47.2	28.1	42.3	24.5	36.8	20.7	31.1	16.7	25.1
	6.5	29.7	44.6	26.6	40.0	23.2	34.8	19.6	29.4	15.9	23.8
	7	28.0	42.1	25.1	37.7	21.9	32.9	18.5	27.8	15.0	22.6
	7.5	25.2	37.9	22.8	34.2	20.0	30.0	17.0	25.6	14.0	21.0
	8	22.8	34.3	20.6	31.0	18.1	27.2	15.4	23.2	12.7	19.0
	9	18.9	28.5	17.1	25.7	15.0	22.6	12.8	19.2	10.5	15.8
	10	16.0	24.0	14.4	21.7	12.7	19.0	10.8	16.2	8.9	13.3
	11	13.7	20.5	12.3	18.5	10.8	16.3	9.2	13.9	7.6	11.4
Design		F_y = 50 ksi									
		½		7/16		3/8		5/16		¼ᶜ	
Unbraced Length between Work Points, L (ft)	2	54.4	81.8	48.5	72.9	42.0	63.2	35.2	52.9	27.3	41.1
	2.5	51.4	77.3	45.8	68.9	39.8	59.8	33.3	50.1	26.0	39.1
	3	48.4	72.8	43.2	64.9	37.5	56.4	31.5	47.3	24.7	37.1
	3.5	45.5	68.3	40.6	61.0	35.3	53.0	29.6	44.6	23.4	35.2
	4	42.6	64.0	38.1	57.2	33.1	49.7	27.9	41.9	22.2	33.3
	4.5	39.8	59.8	35.6	53.5	31.0	46.6	26.1	39.3	20.9	31.4
	5	37.0	55.7	33.2	49.8	28.9	43.5	24.4	36.7	19.7	29.6
	5.5	34.4	51.7	30.8	46.3	26.9	40.4	22.7	34.2	18.5	27.8
	6	32.1	48.2	28.7	43.2	25.1	37.7	21.2	31.9	17.3	26.0
	6.5	29.9	45.0	26.9	40.4	23.4	35.2	19.8	29.8	16.2	24.3
	7	28.0	42.1	25.1	37.8	21.9	33.0	18.6	27.9	15.2	22.8
	7.5	25.2	37.9	22.8	34.2	20.0	30.0	17.0	25.6	14.0	21.0
	8	22.8	34.3	20.6	31.0	18.1	27.2	15.4	23.2	12.7	19.0
	9	18.9	28.5	17.1	25.7	15.0	22.6	12.8	19.2	10.5	15.8
	10	16.0	24.0	14.4	21.7	12.7	19.0	10.8	16.2	8.9	13.3
	11	13.7	20.5	12.3	18.5	10.8	16.3	9.2	13.9	7.6	11.4
Properties											
A_g (in.^{2})		3.25		2.89		2.50		2.10		1.70	
r_z (in.)		0.679		0.681		0.683		0.685		0.688	

ASD	LRFD
$\Omega_c = 1.67$	$\phi_c = 0.9$

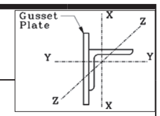
ᶜ Shape is slender for compression.

ᶠ Shape exceeds compact limit for flexure.

Notes: Heavy lines indicate L/r_z equal to or greater than 120, 140 and 200, respectively.

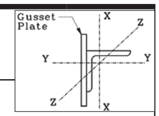
*Method 1.

Design Table 1. Available Strength in Axial Compression, kips* Eccentrically Loaded Single Angles



Shape		L3×3×											
		1/2		7/16		3/8		5/16		1/4		3/16[c, f]	
lb/ft		9.40		8.30		7.20		6.10		4.90		3.71	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
		F_y = 36 ksi											
Unbraced Length between Work Points, L (ft)	2	38.1	57.2	33.6	50.5	29.2	43.9	24.7	37.1	20.0	30.0	14.4	21.6
	2.5	36.2	54.4	31.9	48.0	27.8	41.8	23.5	35.3	19.1	28.6	13.8	20.7
	3	34.3	51.6	30.3	45.6	26.4	39.7	22.3	33.6	18.1	27.2	13.1	19.8
	3.5	32.5	48.8	28.7	43.1	25.0	37.6	21.2	31.8	17.2	25.8	12.5	18.8
	4	30.7	46.1	27.1	40.7	23.6	35.5	20.0	30.1	16.3	24.4	11.9	17.9
	4.5	28.9	43.4	25.5	38.4	22.3	33.5	18.9	28.4	15.3	23.0	11.3	17.0
	5	27.1	40.7	24.0	36.0	20.9	31.4	17.7	26.7	14.4	21.7	10.7	16.1
	5.5	25.3	38.1	22.5	33.8	19.6	29.5	16.7	25.0	13.6	20.4	10.1	15.2
	6	23.6	35.5	21.0	31.5	18.3	27.6	15.6	23.4	12.7	19.1	9.5	14.3
	6.5	20.9	31.4	18.6	28.0	16.4	24.6	14.0	21.1	11.5	17.3	8.8	13.2
	7	18.6	28.0	16.6	25.0	14.6	21.9	12.5	18.8	10.2	15.4	7.8	11.8
	7.5	16.7	25.1	14.9	22.4	13.1	19.7	11.2	16.8	9.2	13.8	7.0	10.6
	8	15.0	22.6	13.4	20.2	11.8	17.8	10.1	15.2	8.3	12.5	6.4	9.5
	8.5	13.6	20.5	12.2	18.3	10.7	16.1	9.2	13.8	7.5	11.3	5.8	8.7
	9	12.4	18.7	11.1	16.7	9.8	14.7	8.3	12.5	6.8	10.3	5.2	7.9
	9.5	11.3	17.1	10.1	15.2	8.9	13.4	7.6	11.5	6.3	9.4	4.8	7.2
Design		F_y = 50 ksi											
		1/2		7/16		3/8		5/16		1/4		3/16[c]	
Unbraced Length between Work Points, L (ft)	2	44.4	66.8	39.2	58.9	34.1	51.3	28.9	43.4	23.0	34.6	16.4	24.6
	2.5	41.4	62.3	36.6	55.0	31.9	47.9	27.0	40.5	21.6	32.5	15.5	23.3
	3	38.5	57.9	34.1	51.2	29.7	44.6	25.1	37.8	20.2	30.3	14.6	22.0
	3.5	35.7	53.6	31.6	47.4	27.5	41.4	23.3	35.1	18.8	28.3	13.8	20.7
	4	32.9	49.5	29.1	43.8	25.4	38.2	21.6	32.4	17.5	26.3	12.9	19.4
	4.5	30.2	45.4	26.8	40.2	23.4	35.1	19.8	29.8	16.2	24.3	12.1	18.2
	5	27.7	41.7	24.6	37.0	21.5	32.3	18.3	27.5	14.9	22.4	11.3	16.9
	5.5	25.6	38.5	22.7	34.1	19.9	29.8	16.9	25.4	13.8	20.7	10.5	15.7
	6	23.6	35.5	21.0	31.6	18.4	27.6	15.6	23.5	12.7	19.2	9.7	14.6
	6.5	20.9	31.4	18.6	28.0	16.4	24.6	14.0	21.1	11.5	17.3	8.8	13.2
	7	18.6	28.0	16.6	25.0	14.6	21.9	12.5	18.8	10.2	15.4	7.8	11.8
	7.5	16.7	25.1	14.9	22.4	13.1	19.7	11.2	16.8	9.2	13.8	7.0	10.6
	8	15.0	22.6	13.4	20.2	11.8	17.8	10.1	15.2	8.3	12.5	6.4	9.5
	8.5	13.6	20.5	12.2	18.3	10.7	16.1	9.2	13.8	7.5	11.3	5.8	8.7
	9	12.4	18.7	11.1	16.7	9.8	14.7	8.3	12.5	6.8	10.3	5.2	7.9
	9.5	11.3	17.1	10.1	15.2	8.9	13.4	7.6	11.5	6.3	9.4	4.8	7.2
Properties													
A_g (in.^{2})		2.76		2.43		2.11		1.78		1.44		1.09	
r_z (in.)		0.580		0.580		0.581		0.583		0.585		0.586	
ASD		LRFD		[c] Shape is slender for compression. [f] Shape exceeds compact limit for flexure. Notes: Heavy lines indicate L/r_z equal to or greater than 120, 140 and 200, respectively. *Method 1.									
Ω_c = 1.67		ϕ_c = 0.9											

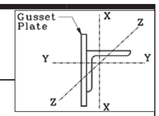
Design Table 2. **Available Strength in Axial Compression, kips*
Eccentrically Loaded Single Angles**



Shape	L8×8×													
	1 1/8		1		7/8		3/4		5/8 c		9/16 c		1/2 c, f	
lb/ft	56.9		51.0		45.0		38.9		32.7		29.6		26.4	
Design	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
	F_y = 36 ksi													
Effective Length, *KL* (ft) 6	153	230	147	220	139.7	210	131	196	119	180	103	155	85.9	129
7	147	221	140	211	133.5	201	125	187	114	171	99.9	150	83.1	125
8	140	210	133	201	126.8	191	118	178	108	162	96.9	146	80.3	121
9	133	199	126	190	119.9	180	112	168	102	153	93.7	141	77.5	116
10	125	188	119	179	112.7	169	105	157	95.3	143	87.9	132	74.8	112
11	118	177	112	168	105.5	159	97.7	147	88.9	134	82.1	123	72.2	109
12	110	166	104	157	98.5	148	91.0	137	82.6	124	76.3	115	69.9	105
13	103	155	97.4	146	91.7	138	84.4	127	76.5	115	70.7	106	65.0	97.7
14	96.1	144	90.6	136	85.1	128	78.2	117	70.6	106	65.4	98.2	60.2	90.4
15	89.5	134	84.1	126	78.9	119	72.2	109	65.1	97.9	60.3	90.6	55.6	83.5
16	83.1	125	78.0	117	73.0	110	66.6	100	60.0	90.1	55.5	83.4	51.2	77.0
18	71.3	107	66.6	100	62.1	93.3	56.4	84.8	50.5	75.9	46.8	70.4	43.3	65.1
20	61.3	92.2	57.1	85.8	53.0	79.7	47.9	72.1	42.7	64.2	39.5	59.4	36.6	55.0
22	53.3	80.1	49.5	74.3	45.8	68.8	41.2	61.9	36.6	55.0	33.8	50.8	31.2	46.9
24	46.7	70.1	43.2	65.0	39.9	59.9	35.8	53.8	31.7	47.6	29.2	43.9	26.9	40.5
26	41.2	61.9	38.1	57.2	35.0	52.7	31.4	47.1	27.7	41.6	25.5	38.3	23.5	35.3
Design	F_y = 50 ksi													
	1 1/8		1		7/8		3/4		5/8 c		9/16 c, f		1/2 c, f	
Effective Length, *KL* (ft) 6	203	305	194	292	185	277	172	259	153	230	130	195	104	157
7	192	288	183	275	174	261	162	243	144	216	125	188	102	154
8	180	270	171	257	162	244	151	227	134	201	120	181	98.6	148
9	167	252	159	239	150	226	139	210	124	187	114	172	94.3	142
10	155	234	147	221	139	209	128	193	114	172	105	158	90.2	136
11	144	216	136	204	128	192	118	177	105	158	96.7	145	86.3	130
12	132	199	125	187	117	176	107	161	95.9	144	88.5	133	81.0	122
13	121	182	114	171	107	161	97.8	147	87.4	131	80.7	121	74.1	111
14	111	167	104	157	97.4	146	88.8	133	79.4	119	73.3	110	67.5	101
15	102	153	95.0	143	88.5	133	80.5	121	72.0	108	66.6	100	61.4	92.3
16	92.7	139	86.5	130	80.5	121	72.9	110	65.2	98.0	60.4	90.7	55.8	83.9
18	78.2	117	72.6	109	67.2	101	60.6	91.1	54.0	81.1	49.8	74.9	46.1	69.2
20	66.7	100	61.8	92.8	57.0	85.6	51.2	76.9	45.4	68.2	41.8	62.8	38.6	58.0
22	57.5	86.4	53.1	79.9	48.9	73.5	43.8	65.8	38.6	58.1	35.6	53.4	32.8	49.2
24	50.1	75.2	46.2	69.4	42.4	63.7	37.8	56.8	33.3	50.1	30.6	46.0	28.2	42.3
26	44.0	66.1	40.5	60.8	37.1	55.7	33.0	49.6	29.0	43.6	26.6	40.0	24.5	36.8
Properties														
A_g (in.^{2})	16.8		15.1		13.3		11.5		9.69		8.77		7.84	
r_z (in.)	1.56		1.56		1.57		1.57		1.58		1.58		1.59	

ASD	LRFD	
Ω_c = 1.67	ϕ_c = 0.9	c Shape is slender for compression. f Shape exceeds compact limit for flexure. Notes: Heavy lines indicate KL/r_z equal to or greater than 120, 140 and 200, respectively. *Method 3 (flexural rigidity EI^* = 0.8$\tau_b EI$).

Design Table 2. Available Strength in Axial Compression, kips* Eccentrically Loaded Single Angles



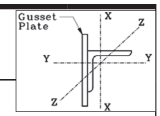
Shape	L6×6×													
	1		7/8		3/4		5/8		9/16		1/2		7/16^c	
lb/ft	37.4		33.1		28.7		24.2		21.9		19.6		17.3	
Design	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
	F_y = 36 ksi													
Effective Length, KL (ft) 4	92.1	138	89.5	135	84.4	127	78.6	118	74.6	112	71.1	107	62.7	94.3
5	87.5	132	84.9	128	79.9	120	74.2	112	70.4	106	67.1	101	60.4	90.7
6	82.5	124	79.8	120	74.9	113	69.3	104	65.8	98.8	62.5	93.9	56.8	85.4
7	77.1	116	74.2	112	69.4	104	64.0	96.3	60.7	91.3	57.6	86.6	52.4	78.7
8	71.5	108	68.6	103	64.0	96.1	58.7	88.3	55.7	83.7	52.7	79.2	47.9	72.0
9	66.0	99.2	63.1	94.8	58.6	88.0	53.5	80.4	50.7	76.2	47.8	71.9	43.5	65.4
10	60.6	91.1	57.7	86.7	53.3	80.1	48.5	72.9	45.9	69.0	43.2	64.9	39.2	59.0
11	55.4	83.3	52.5	78.9	48.4	72.7	43.8	65.8	41.4	62.2	38.8	58.3	35.2	53.0
12	50.5	75.9	47.6	71.6	43.7	65.7	39.4	59.2	37.2	55.9	34.8	52.3	31.5	47.4
13	45.9	68.9	43.1	64.8	39.4	59.2	35.4	53.1	33.3	50.1	31.1	46.7	28.2	42.4
14	41.5	62.4	38.9	58.4	35.4	53.2	31.7	47.6	29.8	44.8	27.7	41.7	25.1	37.7
15	37.8	56.8	35.2	53.0	32.0	48.1	28.5	42.8	26.8	40.3	24.9	37.4	22.5	33.8
16	34.5	51.8	32.1	48.2	29.0	43.7	25.8	38.7	24.2	36.4	22.4	33.7	20.2	30.4
17	31.6	47.5	29.3	44.0	26.5	39.8	23.4	35.2	22.0	33.0	20.3	30.5	18.3	27.5
18	29.0	43.6	26.9	40.4	24.2	36.4	21.4	32.1	20.0	30.1	18.5	27.8	16.6	25.0
19	26.8	40.2	24.7	37.1	22.2	33.4	19.6	29.4	18.3	27.6	16.9	25.4	15.2	22.8
Design	F_y = 50 ksi													
	1		7/8		3/4		5/8		9/16		1/2^c		7/16^c, f	
Effective Length, KL (ft) 4	123	186	120	180	113	170	105	158	99.5	150	92.9	140	79.8	120
5	115	173	112	168	105	157	96.9	146	92.0	138	85.9	129	76.0	114
6	107	160	103	154	95.9	144	88.4	133	83.9	126	78.4	118	70.3	106
7	97.4	146	93.4	140	87.0	131	79.8	120	75.6	114	70.6	106	63.5	95.5
8	88.4	133	84.3	127	78.2	118	71.3	107	67.5	101	63.0	94.8	56.8	85.4
9	79.8	120	75.7	114	69.9	105	63.3	95.2	59.9	90.0	55.9	83.9	50.4	75.8
10	71.6	108	67.6	102	62.1	93.3	56.0	84.1	52.9	79.5	49.3	74.0	44.5	66.9
11	64.0	96.1	60.1	90.3	54.9	82.6	49.3	74.1	46.5	69.9	43.3	65.1	39.2	58.8
12	56.9	85.5	53.2	80.0	48.5	72.9	43.3	65.1	40.8	61.3	37.9	57.0	34.3	51.6
13	50.9	76.5	47.5	71.3	43.1	64.7	38.3	57.6	36.0	54.1	33.4	50.2	30.2	45.3
14	45.8	68.8	42.5	63.9	38.5	57.9	34.1	51.3	32.0	48.1	29.6	44.5	26.7	40.1
15	41.4	62.2	38.3	57.6	34.6	52.0	30.6	45.9	28.7	43.1	26.4	39.7	23.8	35.8
16	37.6	56.5	34.7	52.2	31.3	47.0	27.5	41.4	25.8	38.8	23.7	35.7	21.4	32.1
17	34.3	51.5	31.6	47.5	28.4	42.6	24.9	37.5	23.3	35.1	21.4	32.2	19.3	29.0
18	31.4	47.1	28.8	43.3	25.9	38.9	22.7	34.1	21.2	31.9	19.5	29.2	17.5	26.2
19	28.8	43.3	26.4	39.7	23.7	35.6	20.7	31.1	19.3	29.1	17.7	26.6	15.9	23.9
Properties														
A_g (in.^{2})	11.0		9.75		8.46		7.13		6.45		5.77		5.08	
r_z (in.)	1.17		1.17		1.17		1.17		1.18		1.18		1.18	

ASD	LRFD
$\Omega_c = 1.67$	$\phi_c = 0.9$

^c Shape is slender for compression. ^f Shape exceeds compact limit for flexure.

Notes: Heavy lines indicate KL/r_z equal to or greater than 120, 140 and 200, respectively.

*Method 3 (flexural rigidity $EI^* = 0.8\tau_b EI$).

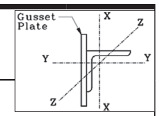


Design Table 2. Available Strength in Axial Compression, kips* Eccentrically Loaded Single Angles

Shape	L5×5×													
	7/8		3/4		5/8		1/2		7/16		3/8[c]		5/16[c, f]	
lb/ft	27.2		23.6		20.0		16.2		14.3		12.3		10.4	
Design	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective Length, KL (ft)	F_y = 36 ksi													
1	71.3	107.2	68.2	102.5	65.1	97.9	60.2	90.5	55.9	84.0	46.3	69.6	35.3	53.1
2	69.5	104.4	66.3	99.7	63.3	95.1	58.5	87.9	54.2	81.5	45.9	69.0	35.0	52.6
3	66.7	100.2	63.5	95.4	60.4	90.8	55.7	83.8	51.7	77.7	45.3	68.0	34.4	51.7
4	63.0	94.7	59.8	89.9	56.8	85.3	52.2	78.5	48.4	72.8	43.7	65.7	33.0	49.6
5	58.8	88.3	55.6	83.6	52.5	78.9	48.1	72.3	44.5	66.9	41.3	62.0	31.2	46.9
6	54.1	81.3	51.0	76.7	48.0	72.1	43.7	65.7	40.4	60.8	37.4	56.2	29.5	44.3
7	49.4	74.3	46.4	69.7	43.3	65.1	39.3	59.1	36.3	54.5	33.5	50.3	27.8	41.8
8	44.7	67.3	41.8	62.8	38.8	58.4	35.0	52.6	32.2	48.4	29.7	44.6	25.9	38.9
9	40.3	60.5	37.5	56.3	34.6	52.0	31.0	46.5	28.4	42.7	26.1	39.2	22.8	34.3
10	36.1	54.2	33.4	50.2	30.6	46.0	27.2	41.0	25.0	37.5	22.9	34.4	20.0	30.1
11	32.1	48.2	29.6	44.5	27.0	40.6	23.9	35.9	21.8	32.8	20.0	30.0	17.5	26.4
12	28.6	42.9	26.2	39.4	23.8	35.8	20.9	31.5	19.1	28.7	17.4	26.1	15.3	23.0
13	25.5	38.4	23.4	35.1	21.1	31.8	18.5	27.8	16.8	25.3	15.3	22.9	13.4	20.1
14	23.0	34.5	21.0	31.5	18.9	28.4	16.4	24.7	14.9	22.4	13.5	20.3	11.8	17.8
15	20.8	31.2	18.9	28.4	16.9	25.5	14.7	22.1	13.3	20.0	12.0	18.1	10.5	15.8
16	18.9	28.3	17.1	25.7	15.3	23.0	13.2	19.9	12.0	18.0	10.8	16.2	9.4	14.1
Design	F_y = 50 ksi													
	7/8		3/4		5/8		1/2		7/16[c]		3/8[c, f]		5/16[c, f]	
Effective Length, KL (ft)														
1	98.7	148.4	94.3	141.7	90.1	135.4	83.3	125.2	76.4	114.8	61.1	91.9	43.1	64.8
2	95.3	143.2	90.9	136.6	86.6	130.2	80.0	120.3	73.4	110.2	60.4	90.7	42.5	63.9
3	90.0	135.2	85.6	128.6	81.3	122.3	74.9	112.6	68.7	103.3	58.6	88.1	41.6	62.5
4	83.4	125.3	79.0	118.8	74.7	112.2	68.5	103.0	62.9	94.5	55.2	83.0	40.3	60.6
5	75.9	114.0	71.6	107.6	67.3	101.1	61.4	92.3	56.3	84.7	51.1	76.8	38.4	57.7
6	68.2	102.4	64.0	96.1	59.7	89.8	54.2	81.4	49.7	74.7	45.2	67.9	35.7	53.7
7	60.6	91.0	56.5	85.0	52.4	78.8	47.2	70.9	43.2	64.9	39.3	59.1	33.2	50.0
8	53.4	80.3	49.5	74.4	45.6	68.5	40.7	61.2	37.3	56.0	33.9	51.0	29.5	44.4
9	46.7	70.2	43.1	64.8	39.4	59.3	35.0	52.6	32.0	48.0	29.1	43.8	25.5	38.3
10	40.6	61.1	37.4	56.1	33.9	51.0	29.9	44.9	27.3	41.0	24.9	37.4	21.8	32.8
11	35.6	53.5	32.6	49.0	29.5	44.3	25.8	38.8	23.5	35.3	21.3	32.0	18.7	28.1
12	31.5	47.3	28.7	43.1	25.8	38.8	22.5	33.8	20.4	30.7	18.5	27.7	16.1	24.3
13	28.0	42.0	25.4	38.2	22.8	34.2	19.7	29.7	17.9	26.9	16.1	24.2	14.1	21.2
14	25.0	37.6	22.7	34.1	20.2	30.4	17.5	26.3	15.8	23.8	14.2	21.4	12.4	18.6
15	22.5	33.8	20.3	30.5	18.1	27.2	15.6	23.4	14.1	21.2	12.6	19.0	11.0	16.5
16	20.3	30.5	18.3	27.5	16.3	24.4	14.0	21.0	12.6	18.9	11.3	17.0	9.8	14.7
Properties														
A_g (in.^{2})	8.00		6.98		5.90		4.79		4.22		3.65		3.07	
r_z (in.)	0.971		0.972		0.975		0.980		0.983		0.986		0.990	

ASD	LRFD	
Ω_c = 1.67	ϕ_c = 0.9	[c] Shape is slender for compression. [f] Shape exceeds compact limit for flexure. Notes: Heavy lines indicate KL/r_z equal to or greater than 120, 140 and 200, respectively. *Method 3 (flexural rigidity $EI^* = 0.8\tau_b EI$).

Design Table 2. Available Strength in Axial Compression, kips* Eccentrically Loaded Single Angles



Shape		L4×4×													
		3/4		5/8		1/2		7/16		3/8		5/16[c]		1/4[c, f]	
lb/ft		18.5		15.7		12.8		11.3		9.8		8.2		6.6	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
		F_y = 36 ksi													
Effective Length, *KL* (ft)	2	43.5	65.4	42.1	63.2	38.9	58.4	37.2	55.9	34.6	52.0	31.3	47.0	22.0	33.0
	2.5	42.3	63.5	40.8	61.4	37.6	56.5	36.0	54.0	33.4	50.3	30.2	45.4	21.7	32.6
	3	40.9	61.4	39.4	59.2	36.2	54.4	34.5	51.9	32.1	48.3	29.0	43.6	21.2	31.9
	3.5	39.3	59.1	37.7	56.7	34.6	52.0	33.0	49.6	30.6	46.0	27.6	41.5	20.5	30.8
	4	37.6	56.6	36.0	54.1	32.9	49.5	31.3	47.1	29.0	43.6	26.1	39.3	19.8	29.8
	4.5	35.9	53.9	34.2	51.4	31.1	46.8	29.6	44.4	27.4	41.1	24.6	37.0	19.1	28.8
	5	34.1	51.2	32.3	48.6	29.3	44.1	27.8	41.7	25.6	38.5	23.0	34.6	18.5	27.8
	5.5	32.2	48.4	30.4	45.7	27.5	41.3	26.0	39.0	23.9	36.0	21.5	32.3	17.9	26.8
	6	30.4	45.6	28.6	42.9	25.7	38.6	24.2	36.4	22.3	33.5	19.9	30.0	17.0	25.6
	7	26.8	40.3	25.0	37.5	22.3	33.5	20.9	31.4	19.1	28.7	17.0	25.6	14.6	21.9
	8	23.4	35.2	21.6	32.5	19.2	28.8	17.9	26.8	16.3	24.5	14.4	21.7	12.4	18.6
	9	20.3	30.5	18.6	28.0	16.4	24.6	15.2	22.8	13.8	20.7	12.1	18.3	10.4	15.7
	10	17.6	26.5	16.1	24.1	14.0	21.1	12.9	19.5	11.7	17.6	10.3	15.5	8.8	13.2
	11	15.5	23.2	14.0	21.0	12.2	18.3	11.2	16.8	10.1	15.1	8.8	13.2	7.5	11.3
	12	13.6	20.5	12.3	18.5	10.6	16.0	9.7	14.6	8.7	13.1	7.6	11.5	6.5	9.7
	13											6.7	10.0	5.6	8.5
Design		F_y = 50 ksi													
		3/4		5/8		1/2		7/16		3/8		5/16[c]		1/4[c, f]	
Effective Length, *KL* (ft)	2	59.2	89.0	57.2	86.0	52.8	79.3	50.4	75.8	46.9	70.5	40.9	61.4	26.6	40.0
	2.5	57.0	85.7	54.9	82.5	50.5	75.9	48.2	72.5	44.8	67.3	39.1	58.8	26.2	39.4
	3	54.4	81.8	52.3	78.5	47.9	72.0	45.7	68.6	42.4	63.7	37.1	55.7	25.7	38.7
	3.5	51.7	77.7	49.4	74.2	45.1	67.8	42.9	64.5	39.7	59.7	34.8	52.3	25.2	37.9
	4	48.8	73.3	46.4	69.7	42.2	63.4	40.0	60.1	37.0	55.6	32.4	48.8	24.3	36.6
	4.5	45.7	68.7	43.3	65.0	39.2	58.9	37.0	55.7	34.2	51.4	30.0	45.2	23.3	35.0
	5	42.7	64.2	40.2	60.4	36.2	54.5	34.2	51.3	31.4	47.3	27.7	41.6	22.3	33.5
	5.5	39.7	59.7	37.2	55.9	33.4	50.2	31.4	47.1	28.8	43.3	25.3	38.1	21.4	32.2
	6	36.8	55.4	34.3	51.6	30.6	46.1	28.7	43.1	26.3	39.5	23.1	34.8	19.7	29.6
	7	31.4	47.2	29.0	43.5	25.6	38.5	23.8	35.8	21.7	32.6	19.1	28.7	16.3	24.5
	8	26.5	39.9	24.2	36.4	21.3	31.9	19.7	29.5	17.8	26.8	15.7	23.6	13.5	20.2
	9	22.6	34.0	20.5	30.8	17.8	26.8	16.4	24.7	14.8	22.3	13.0	19.5	11.1	16.6
	10	19.5	29.2	17.5	26.4	15.2	22.8	13.9	20.9	12.5	18.8	10.9	16.4	9.3	13.9
	11	16.9	25.4	15.2	22.8	13.1	19.6	11.9	17.9	10.7	16.1	9.3	14.0	7.9	11.8
	12	14.8	22.3	13.2	19.9	11.3	17.1	10.3	15.5	9.2	13.9	8.0	12.1	6.8	10.2
	13											7.0	10.5	5.9	8.8
Properties															
A_g (in.^{2})		5.44		4.61		3.75		3.30		2.86		2.40		1.93	
r_z (in.)		0.774		0.774		0.776		0.777		0.779		0.781		0.783	

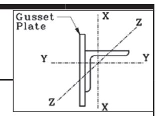
ASD	LRFD
Ω_c = 1.67	ϕ_c = 0.9

[c] Shape is slender for compression. [f] Shape exceeds compact limit for flexure.

Notes: Heavy lines indicate KL/r_z equal to or greater than 120, 140 and 200, respectively.

*Method 3 (flexural rigidity $EI^* = 0.8\tau_b EI$).

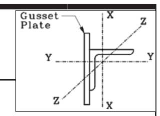
Design Table 2. Available Strength in Axial Compression, kips* Eccentrically Loaded Single Angles



Shape		L3[1]/2×3[1]/2×									
		1/2		7/16		3/8		5/16		1/4[c]	
lb/ft		11.1		9.80		8.50		7.20		5.80	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
		F_y = 36 ksi									
Effective Length, *KL* (ft)	2	31.1	46.8	29.6	44.4	28.4	42.6	25.9	38.9	20.7	31.0
	2.5	29.9	45.0	28.4	42.6	27.2	40.8	24.7	37.2	20.2	30.3
	3	28.5	42.8	27.0	40.6	25.8	38.8	23.5	35.3	19.5	29.3
	3.5	27.0	40.5	25.5	38.3	24.3	36.5	22.1	33.2	18.8	28.3
	4	25.4	38.1	23.9	36.0	22.7	34.2	20.6	31.0	18.0	27.1
	4.5	23.7	35.6	22.3	33.6	21.1	31.8	19.1	28.7	16.7	25.1
	5	22.0	33.1	20.7	31.2	19.6	29.4	17.6	26.5	15.4	23.2
	5.5	20.4	30.7	19.2	28.8	18.0	27.1	16.2	24.4	14.1	21.3
	6	18.9	28.4	17.7	26.5	16.5	24.9	14.8	22.3	12.9	19.4
	6.5	17.4	26.1	16.2	24.4	15.1	22.8	13.5	20.4	11.8	17.7
	7	16.0	24.0	14.9	22.4	13.8	20.8	12.3	18.5	10.7	16.1
	7.5	14.6	22.0	13.6	20.5	12.6	19.0	11.2	16.8	9.7	14.6
	8	13.4	20.1	12.4	18.7	11.5	17.2	10.2	15.3	8.8	13.2
	9	11.3	17.0	10.4	15.7	9.6	14.4	8.4	12.7	7.3	10.9
	10	9.7	14.5	8.9	13.4	8.1	12.2	7.1	10.7	6.1	9.2
	11	8.3	12.5	7.7	11.5	7.0	10.5	6.1	9.2	5.2	7.8
Design		F_y = 50 ksi									
		1/2		7/16		3/8		5/16		1/4[c]	
Effective Length, *KL* (ft)	2	42.0	63.2	39.9	59.9	38.2	57.4	34.6	52.0	26.4	39.7
	2.5	39.8	59.8	37.7	56.7	36.0	54.2	32.6	49.0	25.6	38.4
	3	37.3	56.1	35.3	53.0	33.6	50.5	30.4	45.7	24.5	36.8
	3.5	34.6	52.1	32.7	49.1	31.0	46.6	28.0	42.1	23.4	35.2
	4	31.9	48.0	30.1	45.2	28.4	42.7	25.6	38.4	21.9	32.9
	4.5	29.3	44.0	27.5	41.3	25.9	38.9	23.2	34.9	19.9	30.0
	5	26.7	40.1	25.0	37.5	23.4	35.2	21.0	31.5	18.0	27.1
	5.5	24.2	36.4	22.6	34.0	21.1	31.7	18.8	28.3	16.2	24.4
	6	21.9	32.9	20.4	30.7	19.0	28.5	16.9	25.4	14.6	21.9
	6.5	19.8	29.7	18.4	27.6	17.0	25.5	15.1	22.7	13.0	19.6
	7	17.8	26.7	16.5	24.8	15.2	22.9	13.5	20.2	11.6	17.5
	7.5	16.1	24.2	14.9	22.4	13.7	20.6	12.1	18.1	10.4	15.6
	8	14.6	22.0	13.5	20.3	12.4	18.6	10.9	16.4	9.3	14.0
	9	12.2	18.4	11.3	16.9	10.3	15.4	9.0	13.5	7.7	11.5
	10	10.4	15.6	9.5	14.3	8.6	13.0	7.5	11.3	6.4	9.6
	11	8.9	13.4	8.2	12.3	7.4	11.1	6.4	9.6	5.4	8.2
Properties											
A_g (in.^{2})		3.25		2.89		2.50		2.10		1.70	
r_z (in.)		0.679		0.681		0.683		0.685		0.688	
ASD	LRFD										
$\Omega_c = 1.67$	$\phi_c = 0.9$										

[c] Shape is slender for compression.
[f] Shape exceeds compact limit for flexure.
Notes: Heavy lines indicate KL/r_z equal to or greater than 120, 140 and 200, respectively.
*Method 3 (flexural rigidity $EI^* = 0.8\tau_b EI$).

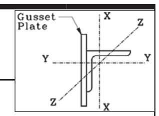
Design Table 2. Available Strength in Axial Compression, kips* Eccentrically Loaded Single Angles



Shape	L3×3×											
	1/2		7/16		3/8		5/16		1/4		3/16[c, f]	
lb/ft	9.40		8.30		7.20		6.10		4.90		3.71	
Design	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective Length, *KL* (ft)	F_y = 36 ksi											
2	22.9	34.5	22.0	33.1	21.0	31.5	19.5	29.3	17.5	26.3	12.3	18.4
2.5	21.8	32.8	20.9	31.4	19.9	29.8	18.4	27.7	16.5	24.8	11.8	17.7
3	20.5	30.9	19.6	29.4	18.6	27.9	17.2	25.9	15.4	23.1	11.2	16.9
3.5	19.2	28.8	18.2	27.4	17.2	25.9	15.9	23.9	14.1	21.3	10.7	16.1
4	17.8	26.7	16.8	25.3	15.9	23.8	14.6	21.9	12.9	19.4	10.3	15.4
4.5	16.4	24.6	15.5	23.2	14.5	21.8	13.3	20.0	11.7	17.6	9.5	14.3
5	15.0	22.6	14.1	21.2	13.2	19.8	12.0	18.1	10.6	15.9	8.6	12.9
5.5	13.7	20.6	12.9	19.3	12.0	18.0	10.9	16.3	9.5	14.3	7.7	11.6
6	12.5	18.8	11.7	17.5	10.8	16.2	9.8	14.7	8.5	12.8	6.9	10.4
6.5	11.3	17.1	10.5	15.8	9.7	14.6	8.8	13.2	7.6	11.4	6.2	9.3
7	10.3	15.4	9.5	14.3	8.7	13.1	7.8	11.8	6.8	10.2	5.5	8.3
7.5	9.3	14.0	8.6	12.9	7.9	11.9	7.1	10.6	6.1	9.1	4.9	7.4
8	8.5	12.8	7.8	11.8	7.2	10.8	6.4	9.6	5.5	8.2	4.4	6.6
8.5	7.8	11.7	7.2	10.8	6.5	9.8	5.8	8.7	5.0	7.5	4.0	6.0
9	7.2	10.8	6.6	9.9	6.0	9.0	5.3	8.0	4.5	6.8	3.6	5.4
9.5	6.6	9.9	6.0	9.1	5.5	8.2	4.9	7.3	4.1	6.2	3.3	5.0
Design	F_y = 50 ksi											
	1/2		7/16		3/8		5/16		1/4		3/16[c]	
Effective Length, *KL* (ft)												
2	30.8	46.2	29.4	44.3	28.0	42.1	26.0	39.1	22.9	34.4	14.8	22.2
2.5	28.7	43.2	27.4	41.2	26.0	39.1	24.1	36.2	21.1	31.8	14.4	21.7
3	26.5	39.8	25.2	37.8	23.8	35.8	21.9	33.0	19.2	28.9	13.8	20.8
3.5	24.2	36.4	22.9	34.4	21.5	32.4	19.8	29.7	17.3	26.0	13.0	19.6
4	22.0	33.0	20.7	31.1	19.4	29.1	17.7	26.6	15.5	23.2	12.4	18.6
4.5	19.8	29.7	18.5	27.9	17.3	26.0	15.7	23.6	13.7	20.6	11.0	16.5
5	17.7	26.7	16.5	24.9	15.3	23.0	13.9	20.9	12.1	18.1	9.7	14.6
5.5	15.8	23.8	14.7	22.1	13.6	20.4	12.2	18.4	10.6	15.9	8.6	12.9
6	14.1	21.1	13.0	19.6	12.0	18.0	10.7	16.1	9.3	13.9	7.5	11.3
6.5	12.6	18.9	11.6	17.4	10.6	16.0	9.5	14.3	8.2	12.3	6.6	9.9
7	11.3	17.0	10.4	15.6	9.5	14.3	8.5	12.7	7.2	10.9	5.8	8.8
7.5	10.2	15.4	9.4	14.1	8.5	12.8	7.6	11.4	6.5	9.7	5.2	7.8
8	9.3	14.0	8.5	12.8	7.7	11.6	6.8	10.3	5.8	8.7	4.6	7.0
8.5	8.5	12.7	7.7	11.6	7.0	10.5	6.2	9.3	5.2	7.9	4.2	6.3
9	7.7	11.6	7.1	10.6	6.4	9.6	5.6	8.4	4.8	7.2	3.8	5.7
9.5	7.1	10.7	6.5	9.7	5.8	8.8	5.1	7.7	4.3	6.5	3.4	5.2
Properties												
A_g (in.^{2})	2.76		2.43		2.11		1.78		1.44		1.09	
r_z (in.)	0.580		0.580		0.581		0.583		0.585		0.586	

ASD	LRFD	
Ω_c = 1.67	ϕ_c = 0.9	[c] Shape is slender for compression. [f] Shape exceeds compact limit for flexure. Notes: Heavy lines indicate KL/r_z equal to or greater than 120, 140 and 200, respectively. *Method 3 (flexural rigidity $EI^* = 0.8\tau_b EI$).

Design Table 3. Available Strength in Axial Compression, kips* Eccentrically Loaded Single Angles



Shape		L8×8×													
		1 1/8		1		7/8		3/4		5/8^c		9/16^c		1/2^c, f	
lb/ft		56.9		51.0		45.0		38.9		32.7		29.6		26.4	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
		F_y = 36 ksi													
Effective Length, *KL* (ft)	6	104	157	97.7	147	90.4	136	82.1	123	72.5	109	66.1	99.3	59.6	89.6
	7	101	152	94.4	142	87.3	131	79.1	119	69.9	105	63.7	95.8	57.5	86.4
	8	97.3	146	90.8	136	83.9	126	75.9	114	67.0	101	61.1	91.9	55.2	83.0
	9	93.3	140	86.9	131	80.3	121	72.6	109	64.0	96.2	58.4	87.8	52.8	79.4
	10	89.1	134	83.0	125	76.6	115	69.1	104	60.9	91.5	55.6	83.5	50.3	75.6
	11	84.9	128	78.9	119	72.8	109	65.6	98.6	57.7	86.8	52.7	79.2	47.8	71.8
	12	80.6	121	74.9	113	68.9	104	62.0	93.2	54.5	81.9	49.8	74.8	45.2	67.9
	13	76.3	115	70.8	106	65.1	97.8	58.5	87.9	51.4	77.2	46.9	70.5	42.6	64.1
	14	72.1	108	66.8	100	61.3	92.2	55.0	82.7	48.3	72.6	44.1	66.3	40.2	60.4
	15	67.9	102	62.9	94.5	57.7	86.7	51.7	77.6	45.3	68.1	41.4	62.3	37.7	56.7
	16	63.9	96.1	59.0	88.8	54.1	81.4	48.4	72.8	42.4	63.8	38.8	58.3	35.4	53.2
	18	56.2	84.4	51.8	77.8	47.4	71.2	42.2	63.5	37.0	55.6	33.9	50.9	31.0	46.6
	20	49.4	74.2	45.4	68.2	41.5	62.3	36.9	55.4	32.2	48.4	29.5	44.3	27.0	40.5
	22	43.6	65.6	40.1	60.2	36.5	54.9	32.4	48.7	28.2	42.4	25.8	38.8	23.6	35.5
	24	38.8	58.4	35.6	53.5	32.4	48.7	28.7	43.1	25.0	37.5	22.8	34.3	20.8	31.3
	26	34.7	52.2	31.8	47.8	28.9	43.4	25.5	38.4	22.2	33.4	20.3	30.5	18.5	27.8
Design		F_y = 50 ksi													
		1 1/8		1		7/8		3/4		5/8^c		9/16^c, f		1/2^c, f	
Effective Length, *KL* (ft)	6	140	210	131	196	121	182	110	165	94.9	143	86.1	129	77.2	116
	7	134	201	125	188	115	173	104	157	90.5	136	82.1	123	73.8	111
	8	127	191	118	178	109	164	98.8	148	85.7	129	77.9	117	70.1	105
	9	120	181	112	168	103	155	93.0	140	80.8	121	73.5	110	66.2	99.5
	10	113	170	105	158	96.8	146	87.1	131	75.7	114	68.9	104	62.3	93.6
	11	106	160	98.5	148	90.6	136	81.4	122	70.8	106	64.5	96.9	58.4	87.7
	12	99.3	149	92.0	138	84.5	127	75.7	114	65.9	99.1	60.1	90.4	54.5	81.9
	13	92.6	139	85.6	129	78.5	118	70.3	106	61.3	92.1	55.9	84.0	50.8	76.3
	14	86.0	129	79.4	119	72.8	109	65.0	97.8	56.8	85.3	51.8	77.9	47.2	70.9
	15	79.7	120	73.5	110	67.3	101	60.0	90.2	52.5	78.8	48.0	72.1	43.7	65.7
	16	73.8	111	67.9	102	62.1	93.3	55.3	83.1	48.3	72.7	44.3	66.5	40.5	60.8
	18	63.6	95.6	58.4	87.8	53.3	80.1	47.3	71.1	41.3	62.0	37.7	56.7	34.5	51.9
	20	55.3	83.1	50.7	76.2	46.1	69.4	40.9	61.4	35.6	53.5	32.5	48.9	29.7	44.6
	22	48.4	72.8	44.3	66.6	40.3	60.6	35.6	53.5	31.0	46.5	28.3	42.5	25.8	38.8
	24	42.8	64.3	39.1	58.7	35.5	53.3	31.3	47.0	27.2	40.8	24.8	37.2	22.6	34.0
	26	38.0	57.1	34.7	52.1	31.4	47.2	27.7	41.6	24.0	36.1	21.9	32.9	20.0	30.0
Properties															
A_g (in.^{2})		16.8		15.1		13.3		11.5		9.69		8.77		7.84	
r_z (in.)		1.56		1.56		1.57		1.57		1.58		1.58		1.59	

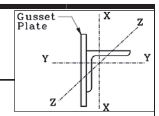
ASD	LRFD
$\Omega_c = 1.67$	$\phi_c = 0.9$

^c Shape is slender for compression. ^f Shape exceeds compact limit for flexure.

Notes: Heavy lines indicate L/r_z equal to or greater than 120, 140 and 200, respectively.

*Method 4 (flexural rigidity $EI^* = 0.8\tau_b EI$).

Design Table 3. Available Strength in Axial Compression, kips*
Eccentrically Loaded Single Angles



Shape		L6×6×													
		1		7/8		3/4		5/8		9/16		1/2		7/16[c]	
lb/ft		37.4		33.1		28.7		24.2		21.9		19.6		17.3	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
		F_y = 36 ksi													
Effective Length, *KL* (ft)	4	64.9	97.6	61.2	92.0	55.9	84.1	50.0	75.2	46.6	70.0	43.4	65.2	38.7	58.2
	5	62.4	93.8	58.7	88.2	53.6	80.5	47.8	71.9	44.6	67.0	41.4	62.3	37.0	55.6
	6	59.5	89.5	55.9	84.0	50.9	76.5	45.4	68.2	42.2	63.5	39.2	58.9	35.0	52.6
	7	56.4	84.8	52.8	79.4	48.0	72.2	42.7	64.2	39.8	59.8	36.9	55.4	32.9	49.4
	8	53.1	79.9	49.6	74.6	45.0	67.6	39.9	60.0	37.1	55.8	34.4	51.7	30.7	46.1
	9	49.7	74.8	46.3	69.7	42.0	63.1	37.1	55.8	34.5	51.9	31.9	48.0	28.5	42.8
	10	46.4	69.7	43.1	64.8	38.9	58.5	34.3	51.6	32.0	48.0	29.5	44.3	26.3	39.5
	11	43.1	64.7	39.9	60.0	36.0	54.1	31.7	47.6	29.4	44.3	27.1	40.7	24.2	36.4
	12	39.8	59.8	36.8	55.3	33.1	49.8	29.1	43.7	27.0	40.6	24.8	37.3	22.2	33.3
	13	36.7	55.1	33.8	50.9	30.4	45.6	26.6	40.0	24.7	37.2	22.7	34.1	20.3	30.4
	14	33.7	50.6	31.0	46.6	27.8	41.7	24.3	36.5	22.6	33.9	20.7	31.1	18.4	27.7
	15	31.0	46.6	28.5	42.8	25.5	38.3	22.2	33.4	20.6	31.0	18.9	28.4	16.8	25.3
	16	28.6	43.0	26.2	39.4	23.4	35.2	20.4	30.6	18.9	28.4	17.3	26.0	15.4	23.2
	17	26.5	39.8	24.2	36.4	21.6	32.4	18.7	28.2	17.4	26.2	15.9	23.9	14.1	21.3
	18	24.5	36.9	22.4	33.7	20.0	30.0	17.3	26.0	16.1	24.1	14.6	22.0	13.0	19.6
	19	22.8	34.3	20.8	31.3	18.5	27.8	16.0	24.1	14.9	22.3	13.5	20.3	12.0	18.1
Design		F_y = 50 ksi													
		1		7/8		3/4		5/8		9/16		1/2[c]		7/16[c, f]	
Effective Length, *KL* (ft)	4	87.7	132	82.5	124	75.4	113	67.3	101	62.8	94.4	57.6	86.6	50.9	76.5
	5	83.1	125	78.0	117	71.1	107	63.4	95.3	59.0	88.7	54.2	81.5	47.9	72.0
	6	78.1	117	73.1	110	66.4	99.9	59.1	88.8	54.9	82.6	50.4	75.8	44.7	67.1
	7	72.6	109	67.8	102	61.5	92.4	54.5	81.9	50.7	76.2	46.5	69.9	41.2	61.9
	8	67.1	101	62.4	93.8	56.5	84.9	49.9	75.0	46.4	69.8	42.6	64.0	37.8	56.8
	9	61.6	92.6	57.2	85.9	51.6	77.5	45.4	68.3	42.3	63.5	38.7	58.2	34.4	51.7
	10	56.3	84.6	52.0	78.2	46.8	70.4	41.1	61.8	38.3	57.5	35.1	52.7	31.2	46.9
	11	51.1	76.8	47.1	70.9	42.3	63.6	37.1	55.7	34.5	51.8	31.6	47.5	28.1	42.3
	12	46.2	69.5	42.5	63.9	38.1	57.2	33.3	50.0	30.9	46.5	28.3	42.6	25.3	38.0
	13	42.0	63.1	38.5	57.9	34.4	51.7	30.0	45.1	27.9	41.9	25.5	38.3	22.7	34.1
	14	38.2	57.4	35.0	52.6	31.2	46.9	27.1	40.8	25.2	37.9	23.0	34.6	20.5	30.8
	15	34.9	52.5	31.9	48.0	28.4	42.7	24.7	37.1	22.9	34.4	20.9	31.4	18.6	27.9
	16	32.0	48.1	29.2	43.9	26.0	39.0	22.5	33.8	20.9	31.4	19.0	28.6	16.9	25.4
	17	29.4	44.3	26.8	40.3	23.8	35.8	20.6	31.0	19.1	28.7	17.4	26.1	15.5	23.2
	18	27.2	40.8	24.7	37.1	21.9	32.9	18.9	28.5	17.5	26.4	16.0	24.0	14.2	21.3
	19	25.1	37.8	22.8	34.3	20.2	30.4	17.4	26.2	16.2	24.3	14.7	22.1	13.0	19.6
Properties															
A_g (in.^{2})		11.0		9.75		8.46		7.13		6.45		5.77		5.08	
r_z (in.)		1.17		1.17		1.17		1.17		1.18		1.18		1.18	

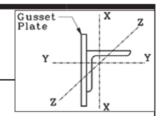
ASD	LRFD
Ω_c = 1.67	ϕ_c = 0.9

[c] Shape is slender for compression. [f] Shape exceeds compact limit for flexure.

Notes: Heavy lines indicate L/r_z equal to or greater than 120, 140 and 200, respectively.

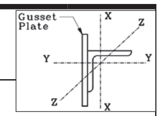
*Method 4 (flexural rigidity $EI^* = 0.8\tau_b EI$).

Design Table 3. Available Strength in Axial Compression, kips* Eccentrically Loaded Single Angles



Shape		L5×5×													
		7/8		3/4		5/8		1/2		7/16		3/8[c]		5/16[c, f]	
lb/ft		27.2		23.6		20.0		16.2		14.3		12.3		10.4	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
		F_y = 36 ksi													
Effective Length, *KL* (ft)	1	50.0	75.1	46.0	69.2	42.1	63.3	37.2	55.9	33.6	50.5	30.4	45.7	25.7	38.6
	2	48.9	73.6	45.1	67.7	41.2	61.9	36.3	54.6	32.8	49.4	29.7	44.6	25.1	37.7
	3	47.4	71.2	43.5	65.5	39.8	59.7	35.0	52.6	31.6	47.5	28.5	42.9	24.2	36.4
	4	45.3	68.0	41.6	62.5	37.9	56.9	33.3	50.0	30.0	45.1	27.1	40.7	23.0	34.6
	5	42.8	64.4	39.2	59.0	35.6	53.6	31.2	46.9	28.2	42.3	25.4	38.2	21.6	32.5
	6	40.1	60.3	36.7	55.1	33.2	49.9	29.0	43.6	26.1	39.3	23.5	35.4	20.0	30.1
	7	37.2	56.0	34.0	51.0	30.6	46.0	26.7	40.1	24.0	36.1	21.6	32.5	18.4	27.7
	8	34.3	51.6	31.2	46.9	28.1	42.2	24.4	36.6	21.9	32.9	19.7	29.6	16.8	25.3
	9	31.4	47.2	28.5	42.9	25.6	38.4	22.1	33.2	19.9	29.9	17.8	26.8	15.3	23.0
	10	28.6	43.0	25.9	39.0	23.2	34.8	20.0	30.0	17.9	26.9	16.1	24.1	13.8	20.7
	11	25.9	39.0	23.4	35.2	20.8	31.3	17.9	26.9	16.1	24.2	14.4	21.6	12.4	18.6
	12	23.4	35.2	21.1	31.7	18.7	28.2	16.1	24.1	14.4	21.6	12.9	19.3	11.1	16.7
	13	21.2	31.9	19.1	28.7	16.9	25.4	14.4	21.7	12.9	19.5	11.5	17.3	9.9	14.9
	14	19.3	29.1	17.4	26.1	15.3	23.0	13.1	19.6	11.7	17.6	10.4	15.6	9.0	13.5
	15	17.7	26.5	15.8	23.8	13.9	21.0	11.9	17.8	10.6	15.9	9.4	14.2	8.1	12.2
	16	16.2	24.3	14.5	21.8	12.7	19.1	10.8	16.2	9.7	14.5	8.6	12.9	7.4	11.1
Design		F_y = 50 ksi													
		7/8		3/4		5/8		1/2		7/16[c]		3/8[c, f]		5/16[c, f]	
Effective Length, *KL* (ft)	1	69.2	104	63.8	95.9	58.3	87.7	51.5	77.4	46.2	69.4	41.0	61.6	34.2	51.5
	2	67.3	101	61.9	93.1	56.6	85.1	49.9	75.0	44.7	67.3	39.7	59.7	33.2	50.0
	3	64.3	96.6	59.1	88.8	53.9	81.0	47.4	71.2	42.5	63.9	37.7	56.7	31.7	47.6
	4	60.5	90.9	55.5	83.4	50.4	75.8	44.2	66.5	39.7	59.6	35.2	53.0	29.7	44.6
	5	56.1	84.4	51.3	77.1	46.5	69.8	40.6	61.0	36.4	54.7	32.4	48.7	27.4	41.1
	6	51.4	77.3	46.9	70.5	42.3	63.6	36.8	55.3	33.0	49.6	29.4	44.2	24.9	37.5
	7	46.7	70.1	42.4	63.8	38.1	57.3	33.0	49.7	29.6	44.6	26.4	39.7	22.5	33.8
	8	42.0	63.1	38.1	57.2	34.1	51.2	29.4	44.2	26.4	39.7	23.5	35.3	20.1	30.2
	9	37.5	56.3	33.9	50.9	30.2	45.4	26.0	39.1	23.3	35.1	20.8	31.3	17.9	26.8
	10	33.3	50.0	30.0	45.1	26.6	40.0	22.8	34.3	20.5	30.8	18.3	27.5	15.8	23.7
	11	29.6	44.5	26.6	40.0	23.6	35.4	20.1	30.2	18.0	27.1	16.1	24.2	13.9	20.8
	12	26.5	39.9	23.8	35.8	21.0	31.5	17.9	26.9	16.0	24.1	14.2	21.4	12.3	18.4
	13	23.9	35.8	21.4	32.1	18.8	28.3	16.0	24.0	14.3	21.5	12.7	19.1	10.9	16.4
	14	21.5	32.4	19.3	29.0	16.9	25.4	14.3	21.5	12.8	19.3	11.4	17.1	9.8	14.7
	15	19.6	29.4	17.5	26.2	15.3	23.0	12.9	19.4	11.6	17.4	10.2	15.4	8.8	13.2
	16	17.8	26.8	15.9	23.9	13.9	20.9	11.7	17.6	10.5	15.8	9.3	13.9	8.0	12.0
Properties															
A_g (in.^{2})		8.00		6.98		5.90		4.79		4.22		3.65		3.07	
γ_z (in.)		0.971		0.972		0.975		0.980		0.983		0.986		0.990	

ASD	LRFD	Notes
$\Omega_c = 1.67$	$\phi_c = 0.9$	[c] Shape is slender for compression. [f] Shape exceeds compact limit for flexure. Notes: Heavy lines indicate L/r_z equal to or greater than 120, 140 and 200, respectively. *Method 4 (flexural rigidity $EI^* = 0.8\tau_b EI$).



Design Table 3. Available Strength in Axial Compression, kips* Eccentrically Loaded Single Angles

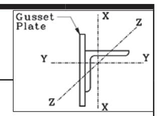
Shape	L4×4×													
	3/4		5/8		1/2		7/16		3/8		5/16[c]		1/4[c, f]	
lb/ft	18.5		15.7		12.8		11.3		9.8		8.2		6.6	
Design	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
	F_y = 36 ksi													
Effective Length, *KL* (ft) 2	31.3	47.0	28.9	43.4	25.4	38.2	23.5	35.3	21.3	32.0	18.7	28.1	15.4	23.1
2.5	30.6	46.0	28.2	42.4	24.8	37.3	22.9	34.4	20.7	31.1	18.2	27.3	15.0	22.5
3	29.8	44.8	27.4	41.2	24.1	36.2	22.2	33.4	20.1	30.2	17.6	26.4	14.5	21.8
3.5	28.9	43.4	26.5	39.9	23.2	34.9	21.4	32.2	19.3	29.1	16.9	25.5	14.0	21.0
4	27.9	41.9	25.5	38.4	22.3	33.6	20.6	30.9	18.6	27.9	16.2	24.4	13.4	20.2
4.5	26.8	40.3	24.5	36.8	21.4	32.2	19.7	29.6	17.7	26.7	15.5	23.3	12.8	19.3
5	25.7	38.6	23.4	35.2	20.4	30.7	18.8	28.2	16.9	25.4	14.7	22.1	12.2	18.3
5.5	24.6	36.9	22.3	33.6	19.4	29.2	17.8	26.8	16.0	24.1	14.0	21.0	11.6	17.4
6	23.4	35.2	21.2	31.9	18.4	27.7	16.9	25.4	15.1	22.8	13.2	19.8	10.9	16.4
7	21.1	31.7	19.0	28.6	16.4	24.7	15.0	22.5	13.4	20.2	11.7	17.5	9.7	14.6
8	18.8	28.3	16.9	25.4	14.5	21.8	13.2	19.9	11.8	17.8	10.2	15.4	8.5	12.8
9	16.6	25.0	14.9	22.3	12.7	19.1	11.5	17.4	10.3	15.5	8.9	13.4	7.4	11.2
10	14.7	22.1	13.1	19.7	11.2	16.8	10.1	15.2	9.0	13.5	7.8	11.7	6.5	9.7
11	13.1	19.7	11.6	17.4	9.8	14.8	8.9	13.4	7.9	11.9	6.8	10.2	5.7	8.5
12	11.7	17.6	10.3	15.5	8.7	13.1	7.9	11.9	7.0	10.5	6.0	9.0	5.0	7.5
13											5.4	8.1	4.4	6.7
Design	F_y = 50 ksi													
	3/4		5/8		1/2		7/16		3/8		5/16[c]		1/4[c, f]	
Effective Length, *KL* (ft) 2	42.8	64.3	39.5	59.3	34.7	52.2	32.1	48.2	29.0	43.6	24.9	37.4	20.3	30.5
2.5	41.5	62.4	38.2	57.4	33.5	50.4	31.0	46.5	28.0	42.0	24.0	36.1	19.6	29.4
3	40.0	60.1	36.7	55.2	32.2	48.4	29.7	44.6	26.8	40.3	23.0	34.6	18.8	28.3
3.5	38.4	57.7	35.1	52.8	30.7	46.2	28.3	42.5	25.5	38.3	21.9	32.9	17.9	27.0
4	36.6	55.0	33.4	50.2	29.2	43.8	26.8	40.3	24.1	36.3	20.7	31.2	17.0	25.6
4.5	34.7	52.2	31.6	47.6	27.5	41.4	25.3	38.0	22.7	34.2	19.5	29.4	16.1	24.1
5	32.9	49.4	29.8	44.8	25.9	38.9	23.7	35.6	21.3	32.0	18.3	27.5	15.1	22.7
5.5	30.9	46.5	28.0	42.1	24.2	36.4	22.2	33.3	19.9	29.9	17.1	25.7	14.1	21.2
6	29.0	43.6	26.2	39.4	22.6	34.0	20.6	31.0	18.5	27.8	15.9	24.0	13.2	19.8
7	25.4	38.1	22.7	34.2	19.5	29.3	17.8	26.7	15.9	23.9	13.7	20.6	11.4	17.1
8	21.9	32.9	19.5	29.3	16.7	25.1	15.1	22.7	13.5	20.3	11.7	17.5	9.7	14.6
9	19.0	28.6	16.9	25.3	14.4	21.6	13.0	19.5	11.5	17.4	10.0	15.0	8.3	12.4
10	16.6	25.0	14.7	22.1	12.5	18.7	11.2	16.9	10.0	15.0	8.6	12.9	7.1	10.7
11	14.6	22.0	12.9	19.4	10.9	16.4	9.8	14.8	8.7	13.1	7.5	11.2	6.2	9.3
12	13.0	19.5	11.4	17.1	9.6	14.4	8.6	13.0	7.6	11.5	6.6	9.9	5.4	8.1
13											5.8	8.7	4.8	7.2
	Properties													
A_g (in.^{2})	5.43		4.61		3.75		3.30		2.86		2.40		1.93	
r_z (in.)	0.774		0.774		0.776		0.777		0.779		0.781		0.783	
ASD	LRFD													
Ω_c = 1.67	ϕ_c = 0.9													

[c] Shape is slender for compression. [f] Shape exceeds compact limit for flexure.

Notes: Heavy lines indicate L/r_z equal to or greater than 120, 140 and 200, respectively.

*Method 4 (flexural rigidity $EI^* = 0.8\tau_b EI$).

Design Table 3. Available Strength in Axial Compression, kips* Eccentrically Loaded Single Angles



Shape		L3$^1/_2$×3$^1/_2$×									
		$^1/_2$		$^7/_{16}$		$^3/_8$		$^5/_{16}$		$^1/_4$^{c}	
lb/ft		11.1		9.80		8.50		7.20		5.80	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
		F_y = 36 ksi									
Effective Length, KL (ft)	2	21.0	31.6	19.4	29.1	17.9	26.9	15.8	23.7	13.3	20.1
	2.5	20.4	30.6	18.8	28.2	17.3	26.1	15.3	22.9	12.9	19.4
	3	19.6	29.5	18.1	27.2	16.7	25.0	14.6	22.0	12.4	18.6
	3.5	18.8	28.3	17.3	26.0	15.9	23.9	14.0	21.0	11.8	17.7
	4	17.9	26.9	16.5	24.7	15.1	22.7	13.3	19.9	11.2	16.8
	4.5	17.0	25.5	15.6	23.4	14.3	21.5	12.5	18.8	10.6	15.9
	5	16.0	24.1	14.7	22.1	13.4	20.2	11.8	17.7	9.9	14.9
	5.5	15.1	22.7	13.8	20.7	12.6	18.9	11.0	16.5	9.3	13.9
	6	14.1	21.2	12.9	19.4	11.8	17.7	10.3	15.4	8.7	13.0
	6.5	13.2	19.8	12.1	18.1	11.0	16.5	9.6	14.4	8.0	12.1
	7	12.3	18.5	11.2	16.9	10.2	15.3	8.9	13.3	7.5	11.2
	7.5	11.4	17.2	10.4	15.7	9.5	14.2	8.2	12.3	6.9	10.4
	8	10.6	15.9	9.7	14.5	8.7	13.1	7.6	11.4	6.4	9.6
	9	9.2	13.8	8.3	12.5	7.5	11.3	6.5	9.8	5.4	8.2
	10	8.0	12.0	7.2	10.9	6.5	9.8	5.6	8.4	4.7	7.1
	11	7.0	10.5	6.3	9.5	5.7	8.5	4.9	7.4	4.1	6.1
Design		F_y = 50 ksi									
		$^1/_2$		$^7/_{16}$		$^3/_8$		$^5/_{16}$		$^1/_4$^{c}	
Effective Length, KL (ft)	2	28.6	43.0	26.3	39.6	24.3	36.6	21.3	32.1	17.6	26.5
	2.5	27.4	41.2	25.2	37.9	23.2	34.9	20.4	30.6	16.9	25.3
	3	26.0	39.1	23.9	36.0	22.0	33.1	19.3	29.0	16.0	24.0
	3.5	24.6	36.9	22.6	33.9	20.7	31.1	18.1	27.2	15.0	22.6
	4	23.0	34.6	21.1	31.7	19.3	29.1	16.9	25.4	14.0	21.1
	4.5	21.5	32.2	19.7	29.5	18.0	27.0	15.7	23.5	13.0	19.6
	5	19.9	29.9	18.2	27.4	16.6	24.9	14.5	21.7	12.1	18.1
	5.5	18.4	27.6	16.8	25.3	15.3	23.0	13.3	20.0	11.1	16.7
	6	16.9	25.4	15.5	23.2	14.0	21.1	12.2	18.3	10.2	15.3
	6.5	15.5	23.3	14.1	21.3	12.8	19.2	11.1	16.7	9.3	14.0
	7	14.2	21.3	12.9	19.4	11.7	17.5	10.1	15.2	8.5	12.8
	7.5	13.0	19.6	11.8	17.8	10.7	16.0	9.2	13.9	7.8	11.7
	8	12.0	18.0	10.9	16.4	9.8	14.7	8.5	12.7	7.1	10.7
	9	10.2	15.4	9.3	14.0	8.3	12.5	7.2	10.8	6.0	9.0
	10	8.8	13.2	8.0	12.0	7.1	10.7	6.1	9.2	5.1	7.7
	11	7.7	11.5	6.9	10.4	6.2	9.3	5.3	8.0	4.4	6.7
Properties											
A_g (in.^{2})		3.25		2.89		2.50		2.10		1.70	
r_z (in.)		0.679		0.681		0.683		0.685		0.688	

ASD	LRFD
$\Omega_c = 1.67$	$\phi_c = 0.9$

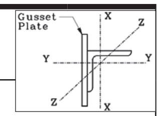
^{c} Shape is slender for compression.

^{f} Shape exceeds compact limit for flexure.

Notes: Heavy lines indicate L/r_z equal to or greater than 120, 140 and 200, respectively.

*Method 4 (flexural rigidity $EI^* = 0.8\tau_b EI$).

Design Table 3. Available Strength in Axial Compression, kips*
Eccentrically Loaded Single Angles



Shape	L3×3×											
	1/2		7/16		3/8		5/16		1/4		3/16[c, f]	
lb/ft	9.40		8.30		7.20		6.10		4.90		3.71	
Design	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
	F_y = 36 ksi											
Effective Length, *KL* (ft) 2	16.2	24.3	15.0	22.6	13.9	20.9	12.4	18.6	10.6	16.0	8.3	12.5
2.5	15.5	23.3	14.4	21.7	13.3	20.0	11.9	17.8	10.1	15.3	7.9	11.9
3	14.8	22.2	13.7	20.6	12.6	19.0	11.2	16.9	9.6	14.4	7.5	11.3
3.5	14.0	21.1	13.0	19.5	11.9	17.9	10.6	15.9	9.0	13.6	7.1	10.6
4	13.2	19.8	12.2	18.3	11.1	16.7	9.9	14.9	8.4	12.7	6.6	9.9
4.5	12.3	18.6	11.4	17.1	10.4	15.6	9.2	13.8	7.8	11.7	6.1	9.2
5	11.5	17.3	10.6	15.9	9.6	14.5	8.5	12.8	7.2	10.8	5.7	8.5
5.5	10.7	16.0	9.8	14.7	8.9	13.4	7.8	11.8	6.6	10.0	5.2	7.8
6	9.9	14.8	9.0	13.6	8.2	12.3	7.2	10.8	6.1	9.1	4.8	7.2
6.5	9.1	13.6	8.3	12.4	7.5	11.3	6.6	9.9	5.5	8.3	4.4	6.6
7	8.3	12.5	7.6	11.4	6.8	10.3	6.0	9.0	5.0	7.6	4.0	6.0
7.5	7.7	11.5	7.0	10.5	6.3	9.4	5.5	8.3	4.6	6.9	3.6	5.4
8	7.1	10.6	6.4	9.6	5.8	8.7	5.0	7.6	4.2	6.4	3.3	5.0
8.5	6.5	9.8	5.9	8.9	5.3	8.0	4.6	7.0	3.9	5.8	3.0	4.6
9	6.1	9.1	5.5	8.3	4.9	7.4	4.3	6.4	3.6	5.4	2.8	4.2
9.5	5.6	8.5	5.1	7.7	4.6	6.9	4.0	6.0	3.3	5.0	2.6	3.9
Design	F_y = 50 ksi											
	1/2		7/16		3/8		5/16		1/4		3/16[c]	
Effective Length, *KL* (ft) 2	21.8	32.8	20.3	30.5	18.7	28.1	16.7	25.1	14.1	21.2	10.8	16.3
2.5	20.7	31.1	19.2	28.8	17.6	26.5	15.7	23.6	13.3	20.0	10.2	15.3
3	19.4	29.1	17.9	27.0	16.5	24.7	14.6	22.0	12.4	18.6	9.5	14.3
3.5	18.0	27.1	16.6	25.0	15.2	22.9	13.5	20.3	11.4	17.1	8.8	13.2
4	16.6	25.0	15.3	23.0	14.0	21.0	12.4	18.6	10.4	15.7	8.1	12.1
4.5	15.3	23.0	14.0	21.1	12.7	19.2	11.3	16.9	9.5	14.2	7.4	11.1
5	13.9	20.9	12.8	19.2	11.6	17.4	10.2	15.3	8.6	12.9	6.7	10.1
5.5	12.6	19.0	11.5	17.4	10.4	15.7	9.2	13.8	7.7	11.6	6.0	9.1
6	11.4	17.2	10.4	15.6	9.4	14.1	8.2	12.4	6.9	10.4	5.4	8.2
6.5	10.4	15.6	9.4	14.2	8.5	12.8	7.4	11.2	6.2	9.4	4.9	7.3
7	9.4	14.2	8.6	12.9	7.7	11.6	6.7	10.1	5.6	8.5	4.4	6.6
7.5	8.6	13.0	7.8	11.7	7.0	10.5	6.1	9.2	5.1	7.7	4.0	6.0
8	7.9	11.9	7.2	10.8	6.4	9.6	5.6	8.4	4.7	7.0	3.6	5.5
8.5	7.3	10.9	6.6	9.9	5.9	8.8	5.1	7.7	4.3	6.4	3.3	5.0
9	6.7	10.1	6.0	9.1	5.4	8.1	4.7	7.0	3.9	5.9	3.0	4.6
9.5	6.2	9.3	5.6	8.4	5.0	7.5	4.3	6.5	3.6	5.4	2.8	4.2
Properties												
A_g (in.^{2})	2.76		2.43		2.11		1.78		1.44		1.09	
r_z (in.)	0.580		0.580		0.581		0.583		0.585		0.586	

ASD	LRFD
$\Omega_c = 1.67$	$\phi_c = 0.9$

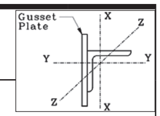
[c] Shape is slender for compression.

[f] Shape exceeds compact limit for flexure.

Notes: Heavy lines indicate L/r_z equal to or greater than 120, 140 and 200, respectively.

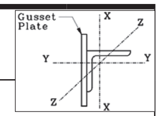
*Method 4 (flexural rigidity $EI^* = 0.8\tau_b EI$).

Design Table 4. Available Strength in Axial Compression, kips* Eccentrically Loaded Single Angles



Shape		L8×8×													
		1 1/8		1		7/8		3/4		5/8[c]		9/16[c]		1/2[c, f]	
lb/ft		56.9		51.0		45.0		38.9		32.7		29.6		26.4	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
		F_y = 36 ksi													
Effective Length, *KL* (ft)	6	145	218	131	197	117	176	102	154	87.2	131	77.9	117	68.7	103
	7	139	209	125	189	112	169	98.1	147	83.7	126	74.8	112	66.1	99.4
	8	133	200	120	180	107	161	93.6	141	79.9	120	71.5	107	63.3	95.1
	9	126	190	114	171	102	153	88.9	134	75.9	114	68.0	102	60.3	90.7
	10	119	179	108	162	96.1	145	84.1	126	71.8	108	64.3	96.7	57.2	86.0
	11	112	169	101	152	90.5	136	79.1	119	67.6	102	60.7	91.2	54.1	81.3
	12	106	159	95.1	143	85.0	128	74.3	112	63.4	95.4	57.0	85.7	50.9	76.6
	13	98.8	149	89.0	134	79.6	120	69.5	105	59.4	89.3	53.5	80.4	47.9	71.9
	14	92.3	139	83.2	125	74.4	112	64.9	97.6	55.5	83.4	50.0	75.2	44.8	67.4
	15	86.1	129	77.5	117	69.4	104	60.5	91.0	51.8	77.8	46.7	70.2	41.9	63.0
	16	80.1	120	72.1	108	64.6	97.1	56.3	84.6	48.2	72.4	43.5	65.4	39.2	58.9
	18	68.9	104	62.1	93.3	55.6	83.6	48.4	72.8	41.5	62.3	37.6	56.5	34.0	51.1
	20	59.5	89.4	53.6	80.5	48.0	72.1	41.8	62.8	35.7	53.7	32.4	48.7	29.3	44.1
	22	51.8	77.9	46.6	70.1	41.7	62.7	36.3	54.6	31.1	46.7	28.2	42.3	25.5	38.3
	24	45.5	68.4	41.0	61.6	36.6	55.1	31.9	47.9	27.3	41.0	24.7	37.1	22.4	33.6
	26	40.2	60.5	36.2	54.4	32.4	48.7	28.2	42.3	24.1	36.2	21.8	32.8	19.8	29.7
Design		F_y = 50 ksi													
		1 1/8		1		7/8		3/4		5/8[c]		9/16[c, f]		1/2[c, f]	
Effective Length, *KL* (ft)	6	193	290	174	261	155	233	136	204	113	170	101	151	88.4	133
	7	182	274	164	247	147	221	128	193	107	161	95.6	144	84.2	127
	8	171	257	154	232	138	207	121	181	101	152	90.2	136	79.6	120
	9	160	240	144	216	129	194	113	169	94.5	142	84.6	127	74.9	113
	10	149	223	134	201	120	180	105	157	88.1	132	78.9	119	70.1	105
	11	138	207	124	186	111	167	96.8	146	81.8	123	73.4	110	65.4	98.3
	12	127	191	114	172	102	154	89.3	134	75.6	114	68.0	102	60.8	91.3
	13	117	176	105	158	94.2	142	82.2	123	69.8	105	62.8	94.5	56.3	84.6
	14	107	161	96.6	145	86.5	130	75.4	113	64.2	96.5	57.9	87.1	52.1	78.2
	15	98.2	148	88.4	133	79.2	119	69.0	104	59.0	88.6	53.3	80.1	48.0	72.2
	16	89.8	135	80.9	122	72.4	109	63.1	94.8	54.0	81.2	48.9	73.5	44.2	66.5
	18	75.9	114	68.4	103	61.2	92.0	53.3	80.1	45.6	68.5	41.3	62.1	37.4	56.2
	20	65.0	97.6	58.5	87.9	52.3	78.6	45.5	68.4	38.9	58.5	35.3	53.0	31.9	48.0
	22	56.1	84.4	50.5	75.9	45.2	67.9	39.3	59.1	33.6	50.5	30.4	45.8	27.6	41.4
	24	49.0	73.6	44.1	66.3	39.4	59.3	34.3	51.5	29.3	44.0	26.5	39.9	24.0	36.1
	26	43.1	64.8	38.8	58.3	34.7	52.1	30.1	45.3	25.8	38.7	23.3	35.1	21.1	31.7
Properties															
A_g (in.^{2})		16.8		15.1		13.3		11.5		9.69		8.77		7.84	
r_z (in.)		1.56		1.56		1.57		1.57		1.58		1.58		1.59	
ASD	LRFD	[c] Shape is slender for compression. [f] Shape exceeds compact limit for flexure. Notes: Heavy lines indicate L/r_z equal to or greater than 120, 140 and 200, respectively. *Method 4, except the axial load is applied at mid-thickness of connected leg.													
Ω_c = 1.67	ϕ_c = 0.9														

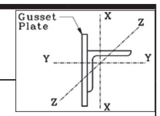
Design Table 4. Available Strength in Axial Compression, kips* Eccentrically Loaded Single Angles



Shape		L6×6×													
		1		7/8		3/4		5/8		9/16		1/2		7/16[c]	
lb/ft		37.4		33.1		28.7		24.2		21.9		19.6		17.3	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
		F_y = 36 ksi													
Effective Length, KL (ft)	4	95.9	144	86.2	130	75.2	113	64.1	96.4	58.3	87.6	52.9	79.6	46.1	69.2
	5	91.1	137	81.9	123	71.4	107	60.9	91.5	55.4	83.3	50.3	75.6	43.8	65.8
	6	85.8	129	77.0	116	67.1	101	57.2	86.0	52.1	78.3	47.3	71.0	41.2	61.9
	7	80.0	120	71.8	108	62.6	94.1	53.3	80.1	48.6	73.0	44.0	66.2	38.4	57.8
	8	74.1	111	66.5	99.9	57.9	87.1	49.3	74.1	45.0	67.6	40.8	61.3	35.6	53.5
	9	68.3	103	61.2	92.0	53.3	80.1	45.4	68.2	41.4	62.3	37.5	56.4	32.8	49.3
	10	62.6	94.0	56.0	84.2	48.8	73.4	41.5	62.4	37.9	57.0	34.3	51.6	30.1	45.2
	11	57.1	85.8	51.1	76.8	44.5	66.9	37.8	56.9	34.6	52.0	31.3	47.0	27.4	41.3
	12	51.9	78.1	46.5	69.8	40.5	60.8	34.4	51.7	31.5	47.3	28.4	42.7	25.0	37.5
	13	47.1	70.8	42.1	63.3	36.6	55.1	31.1	46.8	28.5	42.9	25.8	38.7	22.6	34.0
	14	42.6	64.0	38.1	57.2	33.1	49.8	28.1	42.2	25.8	38.8	23.3	35.0	20.5	30.8
	15	38.7	58.1	34.5	51.9	30.0	45.2	25.5	38.3	23.4	35.2	21.1	31.7	18.6	27.9
	16	35.2	53.0	31.5	47.3	27.4	41.1	23.2	34.9	21.3	32.0	19.2	28.8	16.9	25.4
	17	32.2	48.5	28.8	43.2	25.0	37.6	21.2	31.9	19.5	29.3	17.5	26.4	15.4	23.2
	18	29.6	44.5	26.4	39.7	23.0	34.5	19.5	29.3	17.9	26.9	16.1	24.2	14.2	21.3
	19	27.3	41.0	24.3	36.5	21.1	31.8	17.9	26.9	16.4	24.7	14.8	22.3	13.0	19.6
Design		F_y = 50 ksi													
		1		7/8		3/4		5/8		9/16		1/2[c]		7/16[c, f]	
Effective Length, KL (ft)	4	129	193	116	174	101	151	85.9	129	78.1	117	69.9	105	60.1	90.3
	5	120	180	108	162	93.9	141	80.1	120	72.9	110	65.3	98.1	56.3	84.6
	6	111	166	99.2	149	86.5	130	73.7	111	67.1	101	60.2	90.4	52.0	78.2
	7	101	152	90.5	136	78.8	119	67.1	101	61.3	92.1	55.0	82.6	47.7	71.6
	8	91.4	137	81.9	123	71.3	107	60.7	91.2	55.5	83.3	49.8	74.9	43.3	65.1
	9	82.2	124	73.6	111	64.1	96.4	54.5	82.0	49.9	75.0	44.9	67.4	39.1	58.8
	10	73.6	111	65.9	99.0	57.4	86.2	48.8	73.3	44.6	67.1	40.2	60.4	35.2	52.8
	11	65.6	98.6	58.7	88.2	51.1	76.7	43.4	65.2	39.8	59.8	35.8	53.9	31.4	47.3
	12	58.3	87.6	52.1	78.3	45.3	68.1	38.5	57.8	35.3	53.0	31.8	47.9	28.0	42.1
	13	52.1	78.3	46.5	69.9	40.5	60.8	34.3	51.6	31.5	47.3	28.4	42.7	25.0	37.6
	14	46.8	70.3	41.7	62.7	36.3	54.6	30.8	46.3	28.3	42.5	25.5	38.3	22.4	33.7
	15	42.2	63.5	37.7	56.6	32.8	49.2	27.8	41.7	25.5	38.3	23.0	34.5	20.2	30.4
	16	38.3	57.5	34.1	51.3	29.7	44.6	25.2	37.8	23.1	34.7	20.8	31.3	18.3	27.5
	17	34.9	52.4	31.1	46.7	27.0	40.6	22.9	34.4	21.0	31.6	18.9	28.4	16.7	25.0
	18	31.9	47.9	28.4	42.7	24.7	37.1	20.9	31.4	19.2	28.9	17.3	26.0	15.2	22.9
	19	29.2	44.0	26.1	39.2	22.7	34.1	19.2	28.8	17.6	26.5	15.8	23.8	13.9	21.0
Properties															
A_g (in.^{2})		11.0		9.75		8.46		7.13		6.45		5.77		5.08	
r_z (in.)		1.17		1.17		1.17		1.17		1.18		1.18		1.18	

ASD	LRFD	
$\Omega_c = 1.67$	$\phi_c = 0.9$	[c] Shape is slender for compression. [f] Shape exceeds compact limit for flexure. Notes: Heavy lines indicate L/r_z equal to or greater than 120, 140 and 200, respectively. *Method 4, except the axial load is applied at mid-thickness of connected leg.

Design Table 4. Available Strength in Axial Compression, kips* Eccentrically Loaded Single Angles



Shape		L5×5×													
		7/8		3/4		5/8		1/2		7/16		3/8 [c]		5/16 [c, f]	
lb/ft		27.2		23.6		20.0		16.2		14.3		12.3		10.4	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
		F_y = 36 ksi													
Effective Length, *KL* (ft)	1	76.6	115	66.8	100	57.5	86.5	47.8	71.8	41.9	63.0	36.7	55.1	29.9	44.9
	2	74.6	112	65.0	97.7	56.0	84.2	46.5	69.9	40.8	61.3	35.7	53.6	29.2	43.8
	3	71.5	107	62.2	93.5	53.6	80.6	44.5	66.9	39.1	58.8	34.2	51.4	28.0	42.1
	4	67.4	101	58.7	88.2	50.6	76.0	42.0	63.1	36.9	55.4	32.3	48.5	26.5	39.9
	5	62.7	94.2	54.6	82.1	47.0	70.7	39.0	58.6	34.3	51.6	30.0	45.1	24.8	37.2
	6	57.5	86.5	50.1	75.4	43.1	64.9	35.8	53.8	31.5	47.3	27.6	41.5	22.8	34.3
	7	52.3	78.6	45.6	68.6	39.2	59.0	32.5	48.9	28.6	43.1	25.1	37.7	20.9	31.4
	8	47.2	71.0	41.2	61.9	35.4	53.2	29.3	44.1	25.8	38.8	22.7	34.1	18.9	28.4
	9	42.3	63.6	36.9	55.5	31.7	47.7	26.3	39.5	23.2	34.8	20.3	30.5	17.0	25.6
	10	37.8	56.8	32.9	49.5	28.3	42.5	23.4	35.2	20.7	31.1	18.1	27.3	15.3	23.0
	11	33.5	50.3	29.2	43.9	25.1	37.7	20.8	31.2	18.4	27.6	16.1	24.2	13.6	20.5
	12	29.7	44.6	25.9	39.0	22.2	33.4	18.4	27.7	16.3	24.4	14.3	21.4	12.1	18.2
	13	26.5	39.8	23.1	34.8	19.8	29.8	16.4	24.7	14.5	21.8	12.7	19.1	10.8	16.2
	14	23.8	35.7	20.8	31.2	17.8	26.7	14.7	22.1	13.0	19.5	11.4	17.1	9.7	14.5
	15	21.4	32.2	18.7	28.1	16.0	24.1	13.3	19.9	11.7	17.6	10.3	15.4	8.7	13.1
	16	19.4	29.2	17.0	25.5	14.5	21.8	12.0	18.0	10.6	15.9	9.3	14.0	7.9	11.8
Design		F_y = 50 ksi													
		7/8		3/4		5/8		1/2		7/16 [c]		3/8 [c, f]		5/16 [c, f]	
Effective Length, *KL* (ft)	1	106	159	92.3	139	79.6	120	66.1	99.3	57.5	86.4	49.1	73.8	39.6	59.5
	2	102	154	89.0	134	76.7	115	63.7	95.7	55.4	83.3	47.5	71.3	38.4	57.7
	3	96.4	145	83.9	126	72.3	109	60.0	90.2	52.3	78.6	44.9	67.4	36.4	54.8
	4	89.0	134	77.5	117	66.8	100	55.4	83.3	48.4	72.7	41.6	62.6	34.0	51.0
	5	80.7	121	70.3	106	60.5	90.9	50.2	75.5	43.9	66.0	37.9	57.0	31.1	46.8
	6	72.2	108	62.9	94.6	54.1	81.3	44.9	67.5	39.3	59.1	34.1	51.2	28.1	42.3
	7	63.9	96.0	55.7	83.7	47.9	71.9	39.7	59.6	34.8	52.4	30.3	45.5	25.2	37.8
	8	56.0	84.2	48.8	73.4	42.0	63.1	34.8	52.3	30.6	46.0	26.7	40.1	22.3	33.5
	9	48.8	73.3	42.6	64.0	36.6	54.9	30.3	45.5	26.7	40.1	23.4	35.1	19.7	29.5
	10	42.3	63.6	36.9	55.5	31.7	47.6	26.2	39.4	23.2	34.8	20.3	30.6	17.2	25.9
	11	37.0	55.6	32.3	48.5	27.7	41.6	22.9	34.4	20.2	30.4	17.7	26.6	15.0	22.6
	12	32.5	48.9	28.4	42.7	24.3	36.6	20.1	30.2	17.8	26.7	15.6	23.4	13.2	19.9
	13	28.8	43.4	25.2	37.9	21.6	32.4	17.8	26.8	15.7	23.7	13.8	20.7	11.7	17.6
	14	25.7	38.7	22.5	33.8	19.2	28.9	15.9	23.9	14.0	21.1	12.3	18.5	10.4	15.7
	15	23.1	34.7	20.2	30.3	17.3	25.9	14.2	21.4	12.6	18.9	11.0	16.6	9.4	14.1
	16	20.8	31.3	18.2	27.3	15.6	23.4	12.8	19.3	11.4	17.1	9.9	14.9	8.4	12.7
Properties															
A_g (in.^{2})		8.00		6.98		5.90		4.79		4.22		3.65		3.07	
r_z (in.)		0.971		0.972		0.975		0.980		0.983		0.986		0.990	

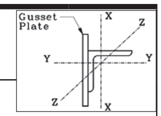
ASD	LRFD
Ω_c = 1.67	ϕ_c = 0.9

[c] Shape is slender for compression. [f] Shape exceeds compact limit for flexure.

Notes: Heavy lines indicate KL/r_z equal to or greater than 120, 140 and 200, respectively.

*Method 4, except that the axial load is applied at mid-thickness of connected leg.

Design Table 4. Available Strength in Axial Compression, kips* Eccentrically Loaded Single Angles



Shape	L4×4×													
	3/4		5/8		1/2		7/16		3/8		5/16[c]		1/4[c, f]	
lb/ft	18.5		15.7		12.8		11.3		9.8		8.2		6.6	
Design	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
	F_y = 36 ksi													
Effective Length, *KL* (ft) 2	48.9	73.6	42.1	63.3	34.5	51.8	30.8	46.3	26.8	40.3	22.6	34.0	17.9	26.8
2.5	47.5	71.4	40.8	61.4	33.5	50.3	29.8	44.8	26.0	39.1	22.0	33.0	17.3	26.1
3	45.8	68.8	39.4	59.2	32.3	48.5	28.8	43.2	25.1	37.7	21.2	31.8	16.8	25.2
3.5	43.9	66.0	37.8	56.8	30.9	46.5	27.6	41.4	24.0	36.1	20.3	30.5	16.1	24.2
4	41.9	63.0	36.0	54.1	29.5	44.3	26.3	39.5	22.9	34.4	19.4	29.1	15.4	23.1
4.5	39.8	59.8	34.2	51.4	28.0	42.1	25.0	37.5	21.8	32.7	18.4	27.6	14.7	22.0
5	37.7	56.6	32.3	48.6	26.5	39.8	23.6	35.5	20.6	30.9	17.4	26.1	13.9	20.9
5.5	35.5	53.3	30.4	45.7	24.9	37.5	22.2	33.4	19.3	29.1	16.4	24.6	13.1	19.7
6	33.3	50.1	28.6	42.9	23.4	35.2	20.8	31.3	18.2	27.3	15.4	23.1	12.3	18.5
7	29.1	43.8	25.0	37.5	20.5	30.7	18.2	27.4	15.9	23.9	13.4	20.2	10.8	16.3
8	25.3	38.0	21.6	32.5	17.7	26.7	15.8	23.7	13.8	20.7	11.6	17.5	9.4	14.2
9	21.8	32.7	18.6	28.0	15.3	22.9	13.6	20.4	11.8	17.8	10.0	15.0	8.2	12.3
10	18.8	28.3	16.1	24.1	13.2	19.8	11.7	17.6	10.2	15.3	8.6	13.0	7.0	10.6
11	16.4	24.6	14.0	21.0	11.5	17.2	10.2	15.3	8.9	13.3	7.5	11.3	6.1	9.2
12	14.4	21.6	12.3	18.5	10.1	15.1	8.9	13.4	7.8	11.7	6.6	9.9	5.4	8.1
13											5.8	8.7	4.7	7.1
Design	F_y = 50 ksi													
	3/4		5/8		1/2		7/16		3/8		5/16[c]		1/4[c, f]	
Effective Length, *KL* (ft) 2	66.5	100	57.3	86.1	46.9	70.5	41.8	62.9	36.4	54.8	30.0	45.1	23.4	35.1
2.5	63.9	96.0	54.9	82.6	45.0	67.6	40.1	60.3	35.0	52.5	28.8	43.3	22.5	33.8
3	60.8	91.4	52.3	78.6	42.8	64.4	38.2	57.4	33.3	50.0	27.5	41.3	21.5	32.4
3.5	57.5	86.4	49.4	74.3	40.5	60.8	36.1	54.2	31.4	47.2	26.0	39.1	20.5	30.8
4	54.0	81.2	46.4	69.7	38.0	57.1	33.9	50.9	29.5	44.4	24.5	36.8	19.3	29.1
4.5	50.4	75.8	43.3	65.1	35.5	53.3	31.6	47.5	27.5	41.4	22.9	34.4	18.2	27.3
5	46.9	70.5	40.2	60.5	33.0	49.5	29.3	44.1	25.6	38.4	21.3	32.1	17.0	25.5
5.5	43.4	65.3	37.2	56.0	30.5	45.8	27.1	40.8	23.7	35.6	19.8	29.7	15.8	23.8
6	40.1	60.3	34.3	51.6	28.1	42.3	25.0	37.6	21.8	32.8	18.3	27.5	14.7	22.1
7	33.9	50.9	29.0	43.6	23.7	35.7	21.1	31.7	18.4	27.7	15.5	23.3	12.5	18.8
8	28.4	42.6	24.3	36.5	19.9	29.9	17.7	26.5	15.4	23.1	13.0	19.6	10.6	16.0
9	24.0	36.1	20.5	30.8	16.8	25.2	14.9	22.4	13.0	19.5	11.0	16.5	9.0	13.5
10	20.6	30.9	17.5	26.4	14.4	21.6	12.7	19.2	11.1	16.7	9.4	14.1	7.7	11.5
11	17.8	26.7	15.2	22.8	12.4	18.7	11.0	16.5	9.6	14.4	8.1	12.2	6.6	9.9
12	15.5	23.3	13.2	19.9	10.8	16.3	9.6	14.4	8.4	12.6	7.1	10.6	5.8	8.7
13											6.2	9.3	5.1	7.6
Properties														
A_g (in.^{2})	5.44		4.61		3.75		3.30		2.86		2.40		1.93	
r_z (in.)	0.774		0.774		0.776		0.777		0.779		0.781		0.783	

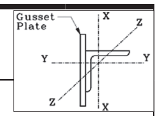
ASD	LRFD
$\Omega_c = 1.67$	$\phi_c = 0.9$

[c] Shape is slender for compression. [f] Shape exceeds compact limit for flexure.

Notes: Heavy lines indicate KL/r_z equal to or greater than 120, 140 and 200, respectively.

*Method 4, except that the axial load is applied at mid-thickness of connected leg.

Design Table 4. Available Strength in Axial Compression, kips* Eccentrically Loaded Single Angles



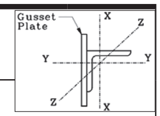
Shape		L3½×3½×									
		½		7/16		3/8		5/16		¼[c]	
lb/ft		11.1		9.80		8.50		7.20		5.80	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
		F_y = 36 ksi									
Effective Length, *KL* (ft)	2	29.6	44.5	26.2	39.4	23.2	34.9	19.6	29.5	15.9	23.8
	2.5	28.5	42.8	25.2	37.9	22.3	33.6	18.9	28.4	15.3	22.9
	3	27.2	40.8	24.1	36.2	21.3	32.0	18.0	27.1	14.6	21.9
	3.5	25.7	38.7	22.8	34.3	20.2	30.4	17.1	25.7	13.8	20.8
	4	24.2	36.4	21.5	32.3	19.0	28.6	16.1	24.2	13.1	19.6
	4.5	22.7	34.1	20.2	30.3	17.8	26.8	15.1	22.6	12.2	18.4
	5	21.2	31.8	18.8	28.2	16.6	25.0	14.0	21.1	11.4	17.2
	5.5	19.6	29.5	17.5	26.2	15.4	23.2	13.0	19.6	10.6	16.0
	6	18.2	27.3	16.2	24.3	14.3	21.4	12.1	18.1	9.8	14.8
	6.5	16.8	25.2	14.9	22.4	13.2	19.8	11.1	16.7	9.1	13.7
	7	15.4	23.2	13.7	20.7	12.1	18.2	10.3	15.4	8.4	12.6
	7.5	14.2	21.3	12.6	19.0	11.1	16.7	9.4	14.2	7.7	11.6
	8	13.0	19.5	11.6	17.4	10.2	15.3	8.6	13.0	7.1	10.6
	9	11.0	16.5	9.8	14.7	8.6	13.0	7.3	11.0	6.0	9.0
	10	9.4	14.2	8.4	12.6	7.4	11.1	6.2	9.4	5.1	7.7
	11	8.1	12.2	7.3	10.9	6.4	9.6	5.4	8.1	4.4	6.6
Design		F_y = 50 ksi									
		½		7/16		3/8		5/16		¼[c]	
Effective Length, *KL* (ft)	2	40.0	60.1	35.5	53.3	31.4	47.2	26.4	39.7	20.8	31.3
	2.5	37.9	57.0	33.6	50.6	29.8	44.7	25.0	37.6	19.8	29.8
	3	35.6	53.5	31.6	47.5	28.0	42.0	23.5	35.4	18.7	28.1
	3.5	33.1	49.8	29.4	44.2	26.0	39.1	21.9	32.9	17.5	26.3
	4	30.6	46.0	27.2	40.9	24.0	36.1	20.2	30.4	16.2	24.4
	4.5	28.1	42.2	25.0	37.5	22.1	33.1	18.6	28.0	15.0	22.5
	5	25.7	38.6	22.8	34.3	20.2	30.3	17.0	25.6	13.7	20.6
	5.5	23.4	35.1	20.8	31.3	18.3	27.6	15.5	23.3	12.6	18.9
	6	21.2	31.9	18.9	28.4	16.6	25.0	14.1	21.1	11.4	17.2
	6.5	19.2	28.8	17.1	25.6	15.0	22.6	12.7	19.1	10.4	15.6
	7	17.3	26.0	15.4	23.2	13.6	20.4	11.5	17.2	9.4	14.2
	7.5	15.7	23.6	14.0	21.0	12.3	18.5	10.4	15.6	8.5	12.8
	8	14.3	21.5	12.7	19.1	11.2	16.8	9.5	14.2	7.8	11.7
	9	12.0	18.0	10.7	16.0	9.4	14.1	7.9	11.9	6.5	9.8
	10	10.2	15.3	9.1	13.6	8.0	12.0	6.7	10.1	5.5	8.3
	11	8.7	13.1	7.8	11.7	6.8	10.3	5.8	8.7	4.7	7.1
Properties											
A_g (in.^{2})		3.25		2.89		2.50		2.10		1.70	
r_z (in.)		0.679		0.681		0.683		0.685		0.688	
ASD		LRFD									
Ω_c = 1.67		ϕ_c = 0.9									

[c] Shape is slender for compression. [f] Shape exceeds compact limit for flexure.

Notes: Heavy lines indicate L/r_z equal to or greater than 120, 140 and 200, respectively.

*Method 4, except that the axial load is applied at mid-thickness of connected leg.

Design Table 4. Available Strength in Axial Compression, kips* Eccentrically Loaded Single Angles



Shape		L3×3×											
		1/2		7/16		3/8		5/16		1/4		3/16[c, f]	
lb/ft		9.40		8.30		7.20		6.10		4.90		3.71	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
		F_y = 36 ksi											
Effective Length, *KL* (ft)	2	23.9	35.9	21.2	31.9	18.7	28.1	15.9	23.9	13.0	19.5	9.6	14.4
	2.5	22.7	34.1	20.2	30.3	17.7	26.6	15.1	22.7	12.3	18.5	9.1	13.7
	3	21.3	32.1	18.9	28.5	16.7	25.0	14.2	21.3	11.6	17.4	8.6	13.0
	3.5	19.9	29.9	17.7	26.5	15.5	23.3	13.2	19.9	10.8	16.2	8.1	12.1
	4	18.4	27.7	16.3	24.5	14.3	21.6	12.2	18.4	10.0	15.0	7.5	11.2
	4.5	16.9	25.5	15.0	22.6	13.2	19.8	11.2	16.9	9.2	13.8	6.9	10.4
	5	15.5	23.3	13.8	20.7	12.1	18.1	10.3	15.5	8.4	12.6	6.3	9.5
	5.5	14.1	21.3	12.5	18.8	11.0	16.5	9.4	14.1	7.7	11.5	5.8	8.7
	6	12.9	19.3	11.4	17.1	10.0	15.0	8.5	12.8	7.0	10.5	5.3	7.9
	6.5	11.6	17.5	10.3	15.5	9.0	13.6	7.7	11.6	6.3	9.5	4.8	7.2
	7	10.5	15.8	9.3	14.0	8.2	12.3	7.0	10.5	5.7	8.5	4.4	6.5
	7.5	9.6	14.4	8.5	12.7	7.4	11.1	6.3	9.5	5.2	7.8	3.9	5.9
	8	8.7	13.1	7.7	11.6	6.7	10.1	5.8	8.6	4.7	7.1	3.6	5.4
	8.5	8.0	12.0	7.0	10.6	6.2	9.3	5.3	7.9	4.3	6.5	3.3	4.9
	9	7.3	11.0	6.5	9.7	5.7	8.5	4.8	7.2	3.9	5.9	3.0	4.5
	9.5	6.7	10.1	6.0	8.9	5.2	7.8	4.4	6.7	3.6	5.4	2.8	4.2
Design		F_y = 50 ksi											
		1/2		7/16		3/8		5/16		1/4		3/16[c]	
Effective Length, *KL* (ft)	2	32.0	48.1	28.4	42.7	25.0	37.6	21.3	32.0	17.1	25.8	12.4	18.7
	2.5	29.9	44.9	26.5	39.8	23.3	35.0	19.9	29.9	16.0	24.1	11.7	17.6
	3	27.5	41.3	24.4	36.7	21.4	32.2	18.3	27.5	14.8	22.2	10.8	16.3
	3.5	25.1	37.7	22.2	33.4	19.5	29.3	16.6	25.0	13.5	20.2	10.0	15.0
	4	22.7	34.1	20.1	30.2	17.6	26.5	15.0	22.6	12.2	18.3	9.1	13.6
	4.5	20.4	30.6	18.1	27.2	15.9	23.8	13.5	20.3	11.0	16.5	8.2	12.4
	5	18.2	27.4	16.2	24.3	14.2	21.3	12.1	18.2	9.8	14.8	7.4	11.1
	5.5	16.2	24.4	14.4	21.6	12.6	18.9	10.7	16.1	8.8	13.2	6.7	10.0
	6	14.4	21.7	12.7	19.2	11.2	16.8	9.5	14.3	7.8	11.7	6.0	8.9
	6.5	12.9	19.3	11.4	17.1	10.0	15.0	8.5	12.8	6.9	10.4	5.3	8.0
	7	11.6	17.4	10.2	15.4	9.0	13.5	7.6	11.5	6.2	9.4	4.8	7.2
	7.5	10.4	15.7	9.2	13.9	8.1	12.1	6.9	10.3	5.6	8.4	4.3	6.4
	8	9.5	14.2	8.4	12.6	7.3	11.0	6.2	9.4	5.1	7.6	3.9	5.8
	8.5	8.6	12.9	7.6	11.4	6.7	10.0	5.7	8.5	4.6	7.0	3.5	5.3
	9	7.9	11.8	7.0	10.5	6.1	9.1	5.2	7.8	4.2	6.4	3.2	4.9
	9.5	7.2	10.9	6.4	9.6	5.6	8.4	4.8	7.1	3.9	5.8	3.0	4.4
Properties													
A_g (in.^{2})		2.76		2.43		2.11		1.78		1.44		1.09	
r_z (in.)		0.580		0.580		0.581		0.583		0.585		0.586	

ASD	LRFD
Ω_c = 1.67	ϕ_c = 0.9

[c] Shape is slender for compression. [f] Shape exceeds compact limit for flexure.
Notes: Heavy lines indicate L/r_z equal to or greater than 120, 140 and 200, respectively.
*Method 4, except that the axial load is applied at mid-thickness of connected leg.