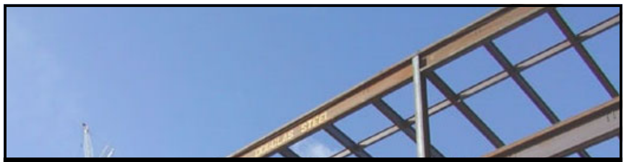


Chapter 3
Tension Members

Chapter 3.6 – Design

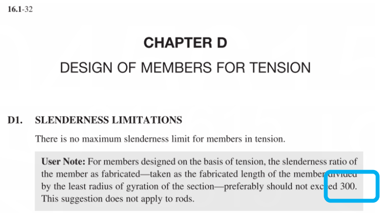
- The ***design of a tension member*** involves finding a member with ***adequate gross and net areas***.
- If the member has a bolted connection, the selection of a suitable cross-section requires an accounting for the ***area lost because of holes***.
- For a member with a rectangular cross-section, the calculations are relatively straightforward.
- If a rolled shape is to be used, however, the area to be ***deducted cannot be predicted in advance*** because the member's thickness at the location of the holes is not known.

Chapter 3.6 – Design

- A secondary consideration in the design of tension members is ***slenderness***.
- If a structural member has a small cross-section in relation to its length, it is said to be ***slender***.
- A more precise measure is the ***slenderness ratio***, ***L/r***, where ***L*** is the member length and ***r*** is the minimum radius of gyration of the cross-sectional area.
- The minimum radius of gyration is the one corresponding to the minor principal axis of the cross-section.

Chapter 3.6 – Design

- Although ***slenderness*** is critical to the strength of a ***compression*** member, it is inconsequential for a tension member.
- In many situations, however, it is ***good practice*** to limit the slenderness of tension members.



16.1-32

CHAPTER D

DESIGN OF MEMBERS FOR TENSION

D1. SLENDERNESS LIMITATIONS

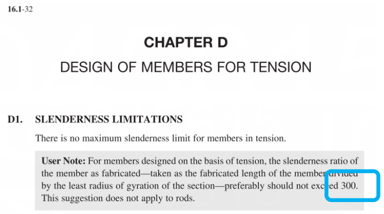
There is no maximum slenderness limit for members in tension.

User Note: For members designed on the basis of tension, the slenderness ratio of the member as fabricated—taken as the fabricated length of the member divided by the least radius of gyration of the section—preferably should not exceed 300. This suggestion does not apply to rods.

$$\frac{L}{r} \le 300$$

Chapter 3.6 – Design

- It is only a recommended value because ***slenderness*** has no structural significance for tension members.
- This limit does not apply to ***cables***, and the user note explicitly excludes ***rods***.



16.1-32

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DESIGN OF MEMBERS FOR TENSION

D1. SLENDERNESS LIMITATIONS

There is no maximum slenderness limit for members in tension.

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$$\frac{L}{r} \le 300$$

Chapter 3.6 – Design

- The central problem of all member ***design***, including tension member design, is to ***find a cross-section*** for which the required strength does not exceed the available strength.
- For tension members designed by ***LRFD***, the requirement is

$$P_u \le \phi_t P_n \quad \text{or} \quad \phi_t P_n \ge P_u$$

where P_u is the sum of the factored loads.

Chapter 3.6 – Design

- To prevent ***yielding***,

$$0.90F_yA_g \geq P_u \qquad \text{or} \qquad A_g \geq \frac{P_u}{0.90F_y}$$

- To prevent ***rupture***,

$$0.75F_uA_e \geq P_u \qquad \text{or} \qquad A_e \geq \frac{P_u}{0.75F_u}$$

- The ***slenderness ratio*** limitation will be satisfied if:

$$r \geq \frac{L}{300}$$

Chapter 3.6 – Design

- For ***ASD***, if we use the allowable ***stress*** form, the requirement corresponding to ***yielding*** is

$$P_a \leq F_tA_g$$

$$A_g \geq \frac{P_a}{F_t} \qquad \text{or} \qquad A_g \geq \frac{P_a}{0.6F_y}$$

- For the limit state of ***rupture***, the required effective area is

$$A_e \geq \frac{P_a}{F_t} \qquad \text{or} \qquad A_e \geq \frac{P_a}{0.5F_u}$$

Chapter 3.6 – Design

- **Example 3.11**: A tension member with a length of 6 ft. must resist a service dead load of 15 *k* and a service live load of 45 *k*.
- Select a member with a **rectangular cross-section**. Use ***A36*** steel and assume a connection with one line of ½-in bolts.
- For ***LRFD***:

$$P_u = 1.2D + 1.6L \quad = 1.2(15k) + 1.6(45k) \ = 90\ k$$

$$A_g = \frac{P_u}{0.90F_y} = \frac{90k}{0.90(36ksi)} = \boxed{2.778\text{ in}^2}$$

$$A_e \geq \frac{P_u}{0.75F_u} = \frac{90k}{0.75(58ksi)} = \boxed{2.069\text{ in}^2}$$

Chapter 3.6 – Design

- **Example 3.11**: Let's try a thickness of ***t = 1 in.***

$$w_g = \frac{\text{required } A_g}{t} = \frac{2.778\text{ in}^2}{1\text{ in.}} = \boxed{2.778\text{ in.}}$$

Let's try a **1 in. x 3 in.** cross-section

$$A_g = (1.00in)(3.00in) \ = \boxed{3.00\ in^2}$$

Is trial A_g > required A_g? $3.00\ in^2 > 2.778\text{ in}^2$ **OK**

$$d_{hole} = d_{bolt} + \tfrac{1}{8}\text{in.} = (\tfrac{1}{2}\text{in.}) + (\tfrac{1}{8}\text{in.}) \ = \tfrac{5}{8}\text{in.}$$

$$A_e = A_n = A_g - A_{holes} = 3.00\ in^2 - (1\text{ in.})(\tfrac{5}{8}\text{in.})(1\ hole) = \boxed{2.375\ in^2}$$

Is trial A_e > required A_e? $2.375\ in^2 > 2.069\text{ in}^2$ **OK**

Chapter 3.6 – Design

- **Example 3.11**: Check the slenderness ratio

$$I_{\min} = \frac{wt^3}{12} = \frac{(3.00\text{ in.})(1\text{ in.})^3}{12} \ = 0.250\text{ in}^4$$

$$r_{\min} = \sqrt{\frac{I_{\min}}{A}} \ = \sqrt{\frac{0.250\text{ in}^4}{3.00\text{ in}^2}} \ = 0.2887\text{ in.}$$

$$\frac{L}{r_{\min}} = \frac{72\text{ in.}}{0.2887\text{ in.}} = \boxed{249.4}$$

Is trial **r/L** < 300? 249.4 <300 **OK**

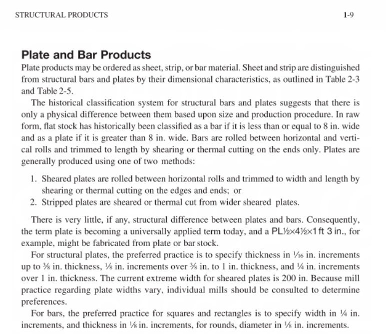
Use a **PL1.0 x 3.0**

Chapter 3.6 – Design

- The member in Example 3.11 is ***less than 8 in. wide*** and thus is classified as a ***bar*** rather than a ***plate***.
- Bars should be specified to the ***nearest ¼-inch in width*** and to the ***nearest ⅛-inch in thickness***.
- The classification system is given in **Part 1 of the Manual** page **1**-9 under the heading "Plate and Bar Products."
- It is common practice to use the **PL** (Plate) designation for both bars and plates.

Chapter 3.6 – Design

- **Part 1 of the Manual** page **1**-9 “Plate and Bar Products.”



STRUCTURAL PRODUCTS 1-9

Plate and Bar Products

Plate products may be ordered as sheet, strip, or bar material. Sheet and strip are distinguished from structural bars and plates by their dimensional characteristics, as outlined in Table 2-3 and Table 2-5.

The historical classification system for structural bars and plates suggests that there is only a physical difference between them based upon size and production procedure. In raw form, flat stock has historically been classified as a bar if it is less than or equal to 8 in. wide and as a plate if it is greater than 8 in. wide. Bars are rolled between horizontal and vertical rolls and trimmed to length by shearing or thermal cutting on the ends only. Plates are generally produced using one of two methods:

1. Sheared plates are rolled between horizontal rolls and trimmed to width and length by shearing or thermal cutting on the edges and ends; or
2. Stripped plates are sheared or thermal cut from wider sheared plates.

There is very little, if any, structural difference between plates and bars. Consequently, the term plate is becoming a universally applied term today, and a PL½×4½×1 ft 3 in., for example, might be fabricated from plate or bar stock.

For structural plates, the preferred practice is to specify thickness in 1⁄16 in. increments up to ⅜ in. thickness, ⅛ in. increments over ⅜ in. to 1 in. thickness, and ¼ in. increments over 1 in. thickness. The current extreme width for sheared plates is 200 in. Because mill practice regarding plate widths vary, individual mills should be consulted to determine preferences.

For bars, the preferred practice for squares and rectangles is to specify width in ¼ in. increments, and thickness in ⅛ in. increments, for rounds, diameter in ⅛ in. increments.

Chapter 3.6 – Design

- If an ***angle*** shape is used as a tension member and the connection is made by bolting, there must be enough room for the bolts.

- Space will be a problem only when there are two lines of bolts in a leg.

- The usual fabrication practice is to punch or drill holes in standard locations in the angle legs.

Chapter 3.6 – Design

- These hole locations are given in **Table 1-7A** “Workable Gages in Angle Legs” in **Part 1 of the Manual**, page **1**-52.

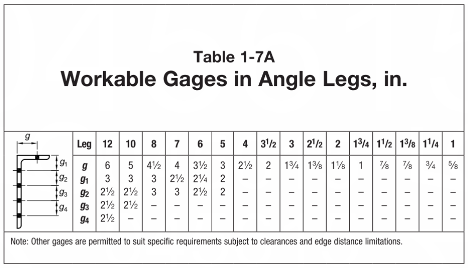


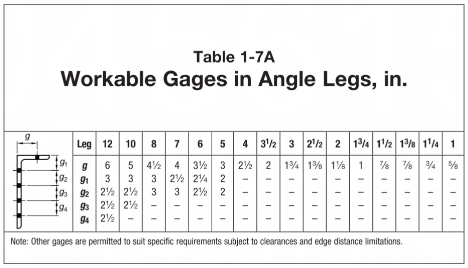
Table 1-7A
Workable Gages in Angle Legs, in.

Leg	12	10	8	7	6	5	4	3½	3	2½	2	1¾	1½	1⅜	1¼	1
g	6	5	4½	4	3½	3	2½	2	1¾	1⅜	1⅛	1	⅞	⅞	¾	⅝
g_1	3	3	3	2½	2¼	2	–	–	–	–	–	–	–	–	–	–
g_2	2½	2½	3	3	2½	2	–	–	–	–	–	–	–	–	–	–
g_3	2½	2½	–	–	–	–	–	–	–	–	–	–	–	–	–	–
g_4	2½	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Note: Other gages are permitted to suit specific requirements subject to clearances and edge distance limitations.

Chapter 3.6 – Design

- Gage distance ***g*** applies when there is one line of bolts
- Gage distances g_1 and g_2 apply when there are two lines.



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Workable Gages in Angle Legs, in.

Leg	12	10	8	7	6	5	4	3½	3	2½	2	1¾	1½	1⅜	1¼	1
g	6	5	4½	4	3½	3	2½	2	1¾	1⅜	1⅛	1	⅞	⅞	¾	⅝
g_1	3	3	3	2½	2¼	2	–	–	–	–	–	–	–	–	–	–
g_2	2½	2½	3	3	2½	2	–	–	–	–	–	–	–	–	–	–
g_3	2½	2½	–	–	–	–	–	–	–	–	–	–	–	–	–	–
g_4	2½	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Note: Other gages are permitted to suit specific requirements subject to clearances and edge distance limitations.

Chapter 3.6 – Design

- The values g_1, g_2, and g_3 apply are for three lines.

- The values g_1, g_2, g_3, and g_4 apply are for four lines.

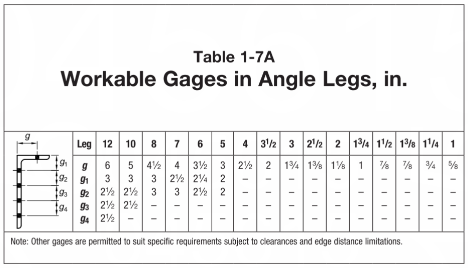


Table 1-7A
Workable Gages in Angle Legs, in.

Leg	12	10	8	7	6	5	4	3½	3	2½	2	1¾	1½	1⅜	1¼	1
g	6	5	4½	4	3½	3	2½	2	1¾	1⅜	1⅛	1	⅞	⅞	¾	⅝
g_1	3	3	3	2½	2¼	2	–	–	–	–	–	–	–	–	–	–
g_2	2½	2½	3	3	2½	2	–	–	–	–	–	–	–	–	–	–
g_3	2½	2½	–	–	–	–	–	–	–	–	–	–	–	–	–	–
g_4	2½	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Note: Other gages are permitted to suit specific requirements subject to clearances and edge distance limitations.

Chapter 3.6 – Design

- The table shows that a:
  - ***5-inch*** leg is needed to accommodate two lines,
  - ***10-inch*** leg is needed for three lines, and
  - ***12-inch*** leg is needed for four lines.

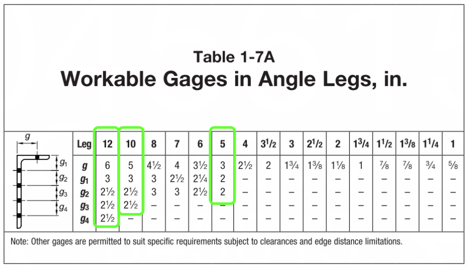


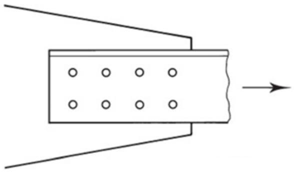
Table 1-7A
Workable Gages in Angle Legs, in.

Leg	12	10	8	7	6	5	4	3½	3	2½	2	1¾	1½	1⅜	1¼	1
g	6	5	4½	4	3½	3	2½	2	1¾	1⅜	1⅛	1	⅞	⅞	¾	⅝
g_1	3	3	3	2½	2¼	2	–	–	–	–	–	–	–	–	–	–
g_2	2½	2½	3	3	2½	2	–	–	–	–	–	–	–	–	–	–
g_3	2½	2½	–	–	–	–	–	–	–	–	–	–	–	–	–	–
g_4	2½	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Note: Other gages are permitted to suit specific requirements subject to clearances and edge distance limitations.

Chapter 3.6 – Design

- **Example 3.12**: Select an unequal-leg angle tension member 12 ft. long to resist a service dead load of 35 *k* and a service live load of 75 *k*.
- Use ***A572 Grade 50*** with two lines of ⅞-in bolts.



Chapter 3.6 – Design

- **Example 3.12**: Select an unequal-leg angle tension member 12 ft. long to resist a service dead load of 35 *k* and a service live load of 75 *k*.
- For ***LRFD***:

$$P_u = 1.2D + 1.6L = 1.2(35k) + 1.6(75k) = 162.0\ k$$

$$A_g = \frac{P_u}{0.90F_y} = \frac{162.0k}{0.90(50ksi)} = \boxed{3.600\ \text{in}^2}$$

$$A_e = \frac{P_u}{0.75F_u} = \frac{162.0k}{0.75(65ksi)} = \boxed{3.323\ \text{in}^2}$$

Chapter 3.6 – Design

- **Example 3.12**: Select an unequal-leg angle tension member 12 ft. long to resist a service dead load of 35 *k* and a service live load of 75 *k*.
- The radius of gyration should be at least:

$$\frac{L}{300} = \frac{144\ in.}{300} = \boxed{0.480\,in}$$

- To find the ***lightest shape*** that satisfies these criteria, we search the dimensions and properties table for the unequal-leg angle that has the ***smallest acceptable gross area*** and then check the ***effective net area***.

Chapter 3.6 – Design

- **Example 3.12**: Select an unequal-leg angle tension member 12 ft. long to resist a service dead load of 35 *k* and a service live load of 75 *k*.
- The radius of gyration should be at least:

$$\frac{L}{300} = \frac{144\ in.}{300} = \boxed{0.480\,in}$$

- The radius of gyration can be checked by inspection.
- There are two lines of bolts, so the connected leg must be at least **5 inches long** (see **AISC Table 1-7A**).

Chapter 3.6 – Design

- **Example 3.12**: Select an unequal-leg angle tension member 12 ft. long to resist a service dead load of 35 *k* and a service live load of 75 *k*.
- The radius of gyration should be at least:

$$\frac{L}{300} = \frac{144\ in.}{300} = \boxed{0.480\,in}$$

- Starting at either end of the table, we find that the shape with the ***smallest area*** that is at least equal to **3.60 in²** and a minimum radius of gyration of **0.48 in**.

Chapter 3.6 – Design

- **Example 3.12**: Select an unequal-leg angle tension member 12 ft. long to resist a service dead load of 35 *k* and a service live load of 75 *k*.
- Let's try a **L5 x 3 x ½**

$$A_g = 3.75\ in^2 > 3.60\ in^2$$

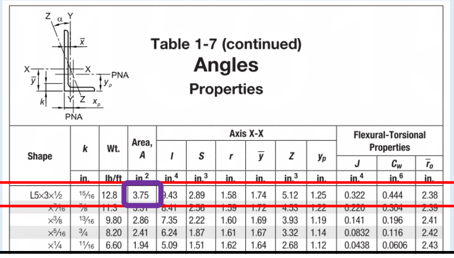


Table 1-7 (continued)
Angles
Properties

Shape	k	Wt.	Area, A	Axis X-X						Flexural-Torsional Properties		
				I	S	r	$\bar{y}$	Z	y_p	J	C_w	$\bar{r}_o$
	in.	lb/ft	in.²	in.⁴	in.³	in.	in.	in.³	in.	in.⁴	in.⁶	in.
L5×3×½	15/16	12.8	3.75	9.43	2.89	1.58	1.74	5.12	1.25	0.322	0.444	2.38
×7/16	7/8	11.3	3.31	8.41	2.56	1.59	1.72	4.53	1.22	0.220	0.304	2.39
×3/8	13/16	9.80	2.86	7.35	2.22	1.60	1.69	3.93	1.19	0.141	0.196	2.41
×5/16	3/4	8.20	2.41	6.24	1.87	1.61	1.67	3.32	1.14	0.0832	0.116	2.42
×1/4	11/16	6.60	1.94	5.09	1.51	1.62	1.64	2.68	1.12	0.0438	0.0606	2.43

Chapter 3.6 – Design

- **Example 3.12**: Select an unequal-leg angle tension member 12 ft. long to resist a service dead load of 35 *k* and a service live load of 75 *k*.
- Let's try a **$\boxed{\text{L5 x 3 x ½}}$** $A_g = 3.75\ in^2$ $r_{\min} = 0.642\ in$

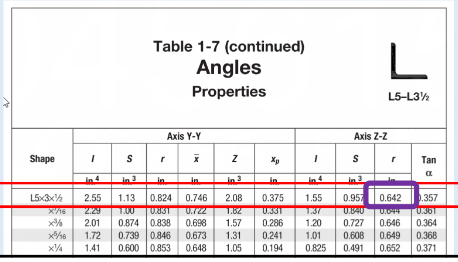


Table 1-7 (continued)
Angles
Properties

L5–L3½

Shape	Axis Y-Y						Axis Z-Z			
	I	S	r	$\bar{x}$	Z	x_p	I	S	r	Tan α
	in.⁴	in.³	in.	in.	in.³	in.	in.⁴	in.³	in.	
L5×3×½	2.55	1.13	0.824	0.746	2.08	0.375	1.55	0.957	0.642	0.357
×7/16	2.29	1.00	0.831	0.722	1.82	0.331	1.37	0.840	0.644	0.361
×3/8	2.01	0.874	0.838	0.698	1.57	0.286	1.20	0.727	0.646	0.364
×5/16	1.72	0.739	0.846	0.673	1.31	0.241	1.01	0.608	0.649	0.368
×¼	1.41	0.600	0.853	0.648	1.05	0.194	0.825	0.491	0.652	0.371

Chapter 3.6 – Design

- **Example 3.12**:

$$d_{hole} = d_{bolt} + \tfrac{1}{8}\text{in.} = \left(\tfrac{7}{8}\text{in.}\right) + \left(\tfrac{1}{8}\text{in.}\right) = 1\text{ in.}$$

$$A_n = A_g - A_{holes} = 3.75\ in^2 - \left(\tfrac{1}{2}\text{in.}\right)(1\text{ in.})(2\ holes) = \boxed{2.75\ in^2}$$

- Because the length of the connection is not known, we cannot compute the shear lag factor *U*.
- Since there are four bolts in the direction of the load, we will use the alternative value of ***U* = 0.80**.

$$A_e = A_n U = (0.80)2.75\text{ in}^2 = \boxed{2.200\text{ in}^2}$$

- Is $A_e >$ required A_e? $2.200\text{ in}^2 < 3.323\text{ in}^2$ $\boxed{\textbf{N.G.}}$

Chapter 3.6 – Design

- **Example 3.12**:

$$A_e = A_n U = U\left(A_g - A_{holes}\right) \quad \therefore\ A_g = \frac{A_e}{U} + A_{holes}$$

$$A_g = \frac{3.323\ in^2}{0.80} + \left(\tfrac{1}{2}\text{in.}\right)(1\text{ in.})(2\ holes) = \boxed{5.15\ in^2}$$

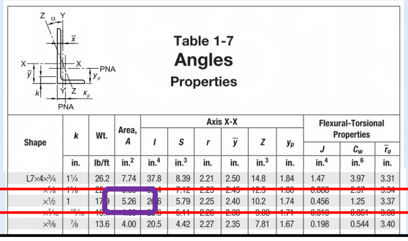


Table 1-7
Angles
Properties

Shape	k	Wt.	Area, A	Axis X-X						Flexural-Torsional Properties		
				I	S	r	$\bar{y}$	Z	y_p	J	C_w	$\bar{r}_o$
	in.	lb/ft	in.²	in.⁴	in.³	in.	in.	in.³	in.	in.⁴	in.⁶	in.
L7×4×¾	1¼	26.2	7.74	37.8	8.39	2.21	2.50	14.8	1.84	1.47	3.97	3.31
×5/8	1⅛	[illegible]	[illegible]	[illegible]	7.12	2.23	2.45	12.5	1.80	0.868	2.37	3.34
×½	1	17.9	5.26	26.6	5.79	2.25	2.40	10.2	1.74	0.456	1.25	3.37
×7/16	15/16	[illegible]	[illegible]	[illegible]	5.11	2.26	2.38	9.03	1.71	0.310	0.851	3.38
×⅜	⅞	13.6	4.00	20.5	4.42	2.27	2.35	7.81	1.67	0.198	0.544	3.40

Chapter 3.6 – Design

- **Example 3.12**:
- Let's try a **$\boxed{\text{L7 x 4 x ½}}$** $A_g = 5.26\ in^2$

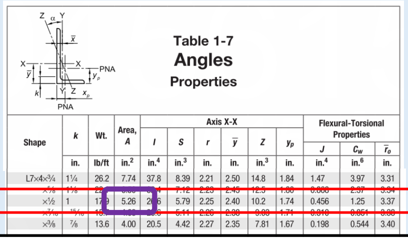


Table 1-7
Angles
Properties

Shape	k	Wt.	Area, A	Axis X-X						Flexural-Torsional Properties		
				I	S	r	$\bar{y}$	Z	y_p	J	C_w	$\bar{r}_o$
	in.	lb/ft	in.²	in.⁴	in.³	in.	in.	in.³	in.	in.⁴	in.⁶	in.
L7×4×¾	1¼	26.2	7.74	37.8	8.39	2.21	2.50	14.8	1.84	1.47	3.97	3.31
×5/8	1⅛	[illegible]	[illegible]	[illegible]	7.12	2.23	2.45	12.5	1.80	0.868	2.37	3.34
×½	1	17.9	5.26	26.6	5.79	2.25	2.40	10.2	1.74	0.456	1.25	3.37
×7/16	15/16	[illegible]	[illegible]	[illegible]	5.11	2.26	2.38	9.03	1.71	0.310	0.851	3.38
×⅜	⅞	13.6	4.00	20.5	4.42	2.27	2.35	7.81	1.67	0.198	0.544	3.40

Chapter 3.6 – Design

- **Example 3.12**:
- Let's try a **$\boxed{\text{L7 x 4 x ½}}$** $A_g = 5.26\ in^2$ $r_{\min} = 0.866\ in$

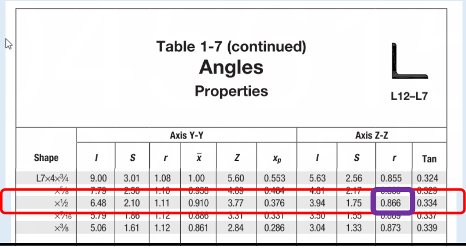


Table 1-7 (continued)
Angles
Properties

L12–L7

Shape	Axis Y-Y						Axis Z-Z			
	I	S	r	$\bar{x}$	Z	x_p	I	S	r	Tan
L7×4×¾	9.00	3.01	1.08	1.00	5.60	0.553	5.63	2.56	0.855	0.324
×5/8	7.79	2.56	1.10	0.958	4.69	0.464	4.81	2.17	[illegible]	0.329
×½	6.48	2.10	1.11	0.910	3.77	0.376	3.94	1.75	0.866	0.334
×7/16	5.79	1.86	1.12	0.886	3.31	0.331	3.50	1.55	0.869	0.337
×⅜	5.06	1.61	1.12	0.861	2.84	0.286	3.04	1.33	0.873	0.339

Chapter 3.6 – Design

- **Example 3.12**:
- Let's try a **$\boxed{\text{L7 x 4 x ½}}$** $A_g = 5.26\ in^2$ $r_{\min} = 0.866\ in$

$$A_n = A_g - A_{holes} = 5.26\ in^2 - \left(\tfrac{1}{2}\text{in.}\right)(1\text{in.})(2\ holes) = \boxed{4.260\ in^2}$$

$$A_e = A_n U = (0.80)4.260\text{ in}^2 = \boxed{3.408\text{ in}^2}$$

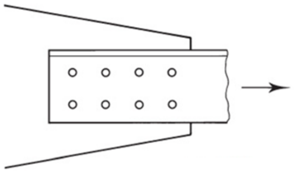
- Is $A_e >$ required A_e? $3.408\text{ in}^2 > 3.323\text{ in}^2$ $\boxed{\textbf{O.K.}}$
- Is $r_{min} >$ required r_{min}? $0.866\text{ in} > 0.48\text{ in}^2$ $\boxed{\textbf{O.K.}}$

Chapter 3.6 – Design

Let's work on some problems

Chapter 3.6 – Design

- **Example 3.13**: Repeat Example 3.12 with the aid of the design tables in ***Part 5 of the Manual***.
- Select an unequal-leg angle tension member 12 ft. long to resist a service dead load of 35 *k* and a service live load of 75 *k*.
- Use **A572 Grade 50** with two lines of ⅞-in bolts.



Chapter 3.6 – Design

- **Example 3.13**: Repeat Example 3.12 with the aid of the design tables in ***Part 5 of the Manual***. ***LRDF*** Solution

$$P_u = 1.2D + 1.6L = 1.2(35k) + 1.6(75k) = \boxed{162\ k}$$

$$r_{\min} \geq 0.600 \text{ in.}$$

- Design tables of tension members give values of A_g and A_e for various shapes based on the assumption that $A_e = 0.75A_g$.
- In addition, the corresponding available strengths based on ***yielding*** and ***rupture*** are given.
- All values available for angles are for **A572 Grade 50 steel**.

Chapter 3.6 – Design

- **Example 3.13**:

L7 x 4 x $^7/_{16}$

$$A_g = 4.63\ in^2$$

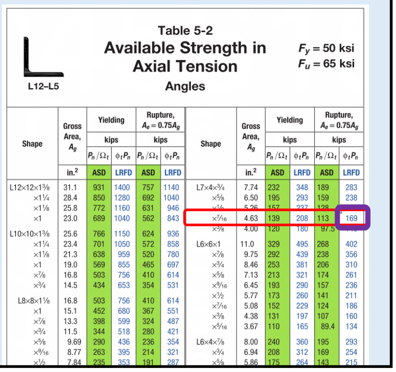


Table 5-2
Available Strength in Axial Tension
Angles

L12–L5

$F_y = 50$ ksi
$F_u = 65$ ksi

Shape	Gross Area, A_g	Yielding, kips		Rupture, $A_e = 0.75A_g$, kips		Shape	Gross Area, A_g	Yielding, kips		Rupture, $A_e = 0.75A_g$, kips	
		P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.^{2}	ASD	LRFD	ASD	LRFD		in.^{2}	ASD	LRFD	ASD	LRFD
L12×12×1⅜	31.1	931	1400	757	1140	L7×4×¾	7.74	232	348	189	283
×1¼	28.4	850	1280	692	1040	×⅝	6.50	195	293	159	238
×1⅛	25.8	772	1160	631	946	×½	5.26	157	237	128	[illegible]
×1	23.0	689	1040	562	843	×7⁄16	4.63	139	208	113	169
L10×10×1⅜	25.6	766	1150	624	936	×⅜	4.00	120	180	97.5	[illegible]
×1¼	23.4	701	1050	572	858	L6×6×1	11.0	329	495	268	402
×1⅛	21.3	638	959	520	780	×⅞	9.75	292	439	238	356
×1	19.0	569	855	465	697	×¾	8.46	253	381	206	310
×⅞	16.8	503	756	410	614	×⅝	7.13	213	321	174	261
×¾	14.5	434	653	354	531	×9⁄16	6.45	193	290	157	236
						×½	5.77	173	260	141	211
L8×8×1⅛	16.8	503	756	410	614	×7⁄16	5.08	152	229	124	186
×1	15.1	452	680	367	551	×⅜	4.38	131	197	107	160
×⅞	13.3	398	599	324	487	×5⁄16	3.67	110	165	89.4	134
×¾	11.5	344	518	280	421						
×⅝	9.69	290	436	236	354	L6×4×⅞	8.00	240	360	195	293
×9⁄16	8.77	263	395	214	321	×¾	6.94	208	312	169	254
×½	7.84	235	353	191	287	×⅝	5.86	175	264	143	215

Chapter 3.6 – Design

- **Example 3.13**: From the dimensions and properties tables in ***Part 1 of the Manual***:

L7 x 4 x $^7/_{16}$ $A_g = 4.63\text{ in}^2$ $r_{\min} = 0.869$ in.

- To check this selection, we must compute the actual net area. If we assume that ***U* = 0.80**

$$A_n = A_g - A_{holes} = 4.63\ in^2 - \left(\tfrac{7}{16}\text{in.}\right)(1\text{in.})(2\ holes) = \boxed{3.754\ in^2}$$

$$A_e = A_n U = (0.80)3.754\text{ in}^2 = \boxed{3.003\text{ in}^2}$$

$$\phi_t P_n = \phi_t F_u A_e = 0.75(65ksi)(3.003\text{ in}^2)$$

$$= 146.4k < 162k \quad \boxed{\textbf{N.G.}}$$

Chapter 3.6 – Design

- **Example 3.13**: From the dimensions and properties tables in ***Part 1 of the Manual***:

L7 x 4 x $^7/_{16}$ $A_g = 4.63\text{ in}^2$ $r_{\min} = 0.869$ in.

- This shape did not work because the ratio of A_e to $A_g \neq 0.75$.
- The ratio is: $\dfrac{3.003in^2}{4.630in^2} = 0.648$

Chapter 3.6 – Design

- **Example 3.13**: From the dimensions and properties tables in ***Part 1 of the Manual***:
- This corresponds to a required $\phi_t P_n$ (based on rupture) of:

$$\frac{0.75}{actual\ ratio}\times P_u = \frac{0.75}{0.648}\times 162k = \boxed{187.5\,k}$$

Chapter 3.6 – Design

- **Example 3.13**:

$\boxed{\text{L7 x 4 x ½}}$

$A_g = 5.26\,in^2$

Rupture on net section

$\phi_t P_n = 193k$

Yielding on gross section

$\phi_t P_n = 237k$

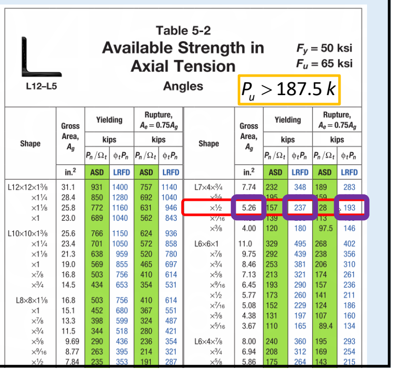


Table 5-2
Available Strength in Axial Tension
Angles

L12–L5

$F_y = 50$ ksi
$F_u = 65$ ksi

$\boxed{P_u > 187.5\,k}$

Shape	Gross Area, A_g	Yielding		Rupture, $A_e = 0.75A_g$	
		kips		kips	
		P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.²	ASD	LRFD	ASD	LRFD
L12×12×1⅜	31.1	931	1400	757	1140
×1¼	28.4	850	1280	692	1040
×1⅛	25.8	772	1160	631	946
×1	23.0	689	1040	562	843
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×1	19.0	569	855	465	697
×⅞	16.8	503	756	410	614
×¾	14.5	434	653	354	531
L8×8×1⅛	16.8	503	756	410	614
×1	15.1	452	680	367	551
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×¾	11.5	344	518	280	421
×⅝	9.69	290	436	236	354
×9⁄16	8.77	263	395	214	321
×½	7.84	235	353	191	287
L7×4×¾	7.74	232	348	189	283
×⅝	[illegible]	195	[illegible]	159	[illegible]
×½	5.26	157	237	28	193
×7⁄16	[illegible]	139	[illegible]	113	[illegible]
×⅜	4.00	120	180	97.5	146
L6×6×1	11.0	329	495	268	402
×⅞	9.75	292	439	238	356
×¾	8.46	253	381	206	310
×⅝	7.13	213	321	174	261
×9⁄16	6.45	193	290	157	236
×½	5.77	173	260	141	211
×7⁄16	5.08	152	229	124	186
×⅜	4.38	131	197	107	160
×5⁄16	3.67	110	165	89.4	134
L6×4×⅞	8.00	240	360	195	293
×¾	6.94	208	312	169	254
×⅝	5.86	175	264	143	215

Chapter 3.6 – Design

- **Example 3.13**:
- The actual effective net area and rupture strength are computed as follows:

$$A_n = A_g - A_{holes} = 5.26\,in^2 - \left(\tfrac{1}{2}\text{in.}\right)(1\text{in.})(2\ holes) = \boxed{4.26\,in^2}$$

$$A_e = A_n U = (0.80)4.26\,\text{in}^2 = \boxed{3.408\,\text{in}^2}$$

$$\phi_t P_n = \phi_t F_u A_e = 0.75(65ksi)(3.408\,\text{in}^2)$$

$$= 166.1k \quad > 162k \qquad \boxed{\textbf{OK}}$$

- Use an **$\boxed{\text{L7 x 4 x ½}}$** connected through the 7-inch leg.

Chapter 3.6 – Design

Let's work on some problems

Chapter 3.6 – Design

Any questions?