Design Aids

Tables 5-1 to 5-8
Lists available yield and rupture strength for typical sections.

Use care!
These tables assume $A_e = 0.75\ A_g$.

You must check this is met in the member and connections!

Table 5-2 (continued)
Available Strength in Axial Tension
Angles

L5–L3 1/2

F_y = 36 ksi
F_u = 58 ksi

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding (kips) P_n/Ω_t	Yielding (kips) $\phi_t P_n$	Rupture (kips) P_n/Ω_t	Rupture (kips) $\phi_t P_n$
	in.²	in.²	ASD	LRFD	ASD	LRFD
L5×3 1/2×3/4	5.85	4.39	126	190	127	191
×5/8	4.93	3.70	106	160	107	161
×1/2	4.00	3.00	86.2	130	87.0	131
×3/8	3.05	2.29	65.7	98.8	66.4	99.6
×5/16	2.56	1.92	55.2	82.9	55.7	83.5
×1/4	2.07	1.55	44.6	67.1	45.0	67.4
L5×3×1/2	3.75	2.81	80.8	122	81.5	122
×7/16	3.31	2.48	71.4	107	71.9	108
×3/8	2.86	2.15	61.7	92.7	62.4	93.5
×5/16	2.41	1.81	52.0	78.1	52.5	78.7
×1/4	1.94	1.46	41.8	62.9	42.3	63.5
L4×4×3/4	5.44	4.08	117	176	118	177
×5/8	4.61	3.46	99.4	149	100	151
×1/2	3.75	2.81	80.8	122	81.5	122
×7/16	3.30	2.48	71.1	107	71.9	108
×3/8	2.86	2.15	61.7	92.7	62.4	93.5
×5/16	2.40	1.80	51.7	77.8	52.2	78.3
×1/4	1.93	1.45	41.6	62.5	42.1	63.1
L4×3 1/2×1/2	3.50	2.63	75.4	113	76.3	114
×3/8	2.68	2.01	57.8	86.8	58.3	87.4
×5/16	2.25	1.69	48.5	72.9	49.0	73.5
×1/4	1.82	1.37	39.2	59.0	39.7	59.6
L4×3×5/8	3.99	2.99	86.0	129	86.7	130
×1/2	3.25	2.44	70.1	105	70.8	106
×3/8	2.49	1.87	53.7	80.7	54.2	81.3
×5/16	2.09	1.57	45.1	67.7	45.5	68.3
×1/4	1.69	1.27	36.4	54.8	36.8	55.2
L3 1/2×3 1/2×1/2	3.25	2.44	70.1	105	70.8	106
×7/16	2.89	2.17	62.3	93.6	62.9	94.4
×3/8	2.50	1.88	53.9	81.0	54.5	81.8
×5/16	2.10	1.58	45.3	68.0	45.8	68.7
×1/4	1.70	1.28	36.6	55.1	37.1	55.7

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.745A_g$.

Design of Tension Members

Strength Limit States – yield, net area fracture, block shear

Serviceability – L/r ≤ 300 preferably

Should check these limits after choose the section.

Design Methodology for Tension members:

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. To prevent yielding,

$$0.90 F_y A_g \ge P_u \quad \text{or} \quad A_g \ge \frac{P_u}{0.90 F_y}$$

To avoid fracture,

$$0.75 F_u A_e \ge P_u \quad \text{or} \quad A_e \ge \frac{P_u}{0.75 F_u}$$

For allowable strength design, if we use the allowable *stress* form, the requirement corresponding to yielding is

$$P_a \le F_t A_g$$

and the required gross area is

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

For the limit state of fracture, the required effective area is

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

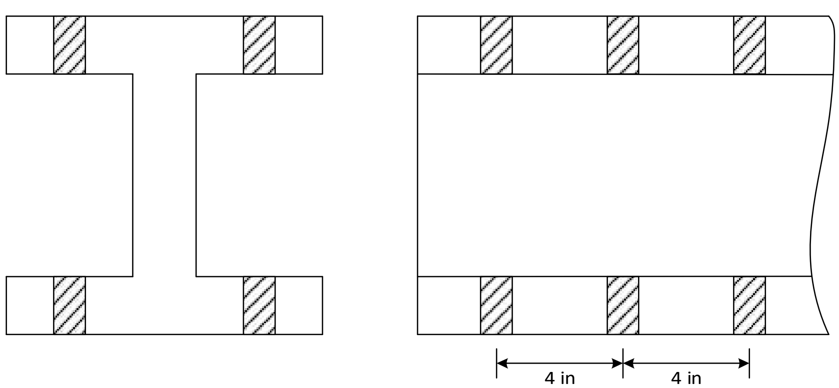
The slenderness ratio limitation will be satisfied if

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

where r is the minimum radius of gyration of the cross section and L is the member length.

Example:

Select a 30 ft long W12 section of A992 steel to support a tensile service dead load PD= 130k and a tensile service live load PL=110k. As shown, the member is to have two lines of bolts in each flange for 7/8 in bolts (at least three in a line 4 in on center).



Example:

- Design a 12ft long, single-single tension member to supports a live load of 45 kips and a dead load of 15 kips. The member is to be connected through one leg. Estimate three bolts in a single line. Use A36 steel and limit the slenderness ratio to 300 Consider yield and net section rupture, and design by LRFD. Assume ¾'' bolts in standard, punched holes and try for the lightest L5x3.5x..., note that the lowest radius of gyration for a single angle is r_z.