ANSWER This shape satisfies all requirements, so use an L8 × 4 × ½.

ASD SOLUTION The total service load is

$$P_a = D + L = 35 + 70 = 105 \text{ kips}$$

$$\text{Required } A_g = \frac{P_a}{F_t} = \frac{P_a}{0.6F_y} = \frac{105}{0.6(36)} = 4.86 \text{ in.}^2$$

$$\text{Required } A_e = \frac{P_a}{0.5F_u} = \frac{105}{0.5(58)} = 3.62 \text{ in.}^2$$

$$\text{Required } r_{\min} = \frac{L}{300} = \frac{15(12)}{300} = 0.6 \text{ in.}$$

Try L8 × 4 × ½ ($A_g = 5.80$ in.^{2} and $r_{\min} = 0.863$ in.). For a shear lag factor U of 0.80,

$$A_n = A_g - A_{\text{holes}} = 5.80 - 2\left(\frac{3}{4} + \frac{1}{8}\right)\left(\frac{1}{2}\right) = 4.925 \text{ in.}^2$$

$$A_e = A_n U = 4.925(0.80) = 3.94 \text{ in.}^2 > 3.62 \text{ in.}^2 \qquad \text{(OK)}$$

ANSWER This shape satisfies all requirements, so use an L8 × 4 × ½.

The ASD solution in Example 3.12 is somewhat condensed, in that some of the discussion in the LRFD solution is not repeated and only the final trial is shown. All essential computations are included, however.

Tables for the Design of Tension Members

Part 5 of the *Manual* contains tables to assist in the design of tension members of various cross-sectional shapes, including Table 5-2 for angles. The use of these tables will be illustrated in the following example.

EXAMPLE 3.13

Design the tension member of Example 3.12 with the aid of the tables in Part 5 of the *Manual*.

LRFD SOLUTION From Example 3.12,

$$P_u = 154 \text{ kips}$$

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

The tables for design 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 (fracture) are given. All values available for angles are for A36 steel. Starting with the lighter shapes (the ones with the smaller gross area), we find that an L6 × 4 × ½, with $\phi_t P_n = 154$ kips based on the gross section and $\phi_t P_n = 155$ kips based on the net section, is a possibility. From the dimensions and properties tables in Part 1 of the *Manual,* $r_{\min} = 0.864$ in. To check this selection, we must compute the actual net area. If we assume that $U = 0.80$,

$$A_n = A_g - A_{\text{holes}} = 4.75 - 2\left(\frac{3}{4} + \frac{1}{8}\right)\left(\frac{1}{2}\right) = 3.875 \text{ in.}^2$$

$$A_e = A_n U = 3.875(0.80) = 3.10 \text{ in.}^2$$

$$\phi_t P_n = \phi_t F_u A_e = 0.75(58)(3.10) = 135 \text{ kips} < 154 \text{ kips} \qquad \text{(N.G.)}$$

This shape did not work because the ratio of actual effective net area A_e to gross area A_g is not equal to 0.75. The ratio is closer to

$$\frac{3.10}{4.75} = 0.6526$$

This corresponds to a required $\phi_t P_n$ (based on rupture) of

$$\frac{0.75}{\text{actual ratio}} \times P_u = \frac{0.75}{0.6526}(154) = 177 \text{ kips}$$

Try an L8 × 4 × ½, with $\phi_t P_n = 188$ kips (based on yielding) and $\phi_t P_n = 189$ Kips (based on rupture strength, with $A_e = 0.75A_g = 4.31$ in.^{2}). From the dimensions and properties tables in Part 1 of the *Manual,* $r_{\min} = 0.863$ in. The actual effective net area and rupture strength are computed as follows:

$$A_n = A_g - A_{\text{holes}} = 5.80 - 2\left(\frac{3}{4} + \frac{1}{8}\right)\left(\frac{1}{2}\right) = 4.925 \text{ in.}^2$$

$$A_e = A_n U = 4.925(0.80) = 3.94 \text{ in.}^2$$

$$\phi_t P_n = \phi_t F_u A_e = 0.75(58)(3.94) = 171 > 154 \text{ kips} \qquad \text{(OK)}$$

ANSWER Use an L8 × 4 × ½, connected through the 8-inch leg.

ASD SOLUTION From Example 3.12,

$$P_a = 105 \text{ kips}$$

$$\text{Required } r_{\min} = 0.600 \text{ in.}$$

From *Manual* Table 5-2, try an L5 × 3½ × ⅝, with $P_n/\Omega_t = 106$ kips based on yielding of the gross section and $P_n/\Omega_t = 107$ kips based on rupture of the net section. From the dimensions and properties tables in Part 1 of the *Manual,* $r_{\min} = 0.746$ in.