The reduction factor is

$$Q_a = \frac{A_e}{A_g} = \frac{2.427}{2.70} = 0.8989$$

$$Q = Q_s Q_a = 1.0(0.8989) = 0.8989$$

Compute the local buckling strength.

$$4.71\sqrt{\frac{E}{QF_y}} = 4.71\sqrt{\frac{29,000}{0.8989(46)}} = 124.7$$

$$\frac{KL}{r} = 105.3 < 124.7 \qquad \therefore \text{ Use AISC Equation E7-2}$$

$$F_{cr} = Q\left(0.658^{\frac{QF_y}{F_e}}\right)F_y = 0.8989\left(0.658^{\frac{0.8989(46)}{25.81}}\right)46$$

$$= 21.15 \text{ ksi} \quad 21.26 \text{ ksi}$$

Try $f = 21.15$ ksi:

$$b_e = 1.92(0.116)\sqrt{\frac{29,000}{21.15}}\left[1 - \frac{0.38}{(66.0)}\sqrt{\frac{29,000}{21.15}}\right] = 6.489 \text{ in.}$$

The total loss in area is

$$2(b - b_e)t = 2(7.652 - 6.489)(0.116) = 0.2698 \text{ in.}^2$$

and the reduced area is

$$A_e = 2.70 - 0.2698 = 2.430 \text{ in.}^2$$

The reduction factor is

$$Q_a = \frac{A_e}{A_g} = \frac{2.430}{2.70} = 0.9000$$

$$Q = Q_s Q_a = 1.0(0.9000) = 0.9000$$

Compute the local buckling strength.

$$4.71\sqrt{\frac{E}{QF_y}} = 4.71\sqrt{\frac{29,000}{0.9000(46)}} = 124.7$$

$$\frac{KL}{r} = 105.3 < 124.7 \qquad \therefore \text{ Use AISC Equation E7-2}$$

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

$$= 0.9000\left(0.658^{\frac{0.9000(46)}{25.81}}\right)46 = 21.16 \text{ ksi} \quad 21.15 \text{ ksi (convergence)}$$

Recall that AISC Equation E7-18 for b_e applies when $b/t \geq 1.40\sqrt{E/f}$. In the present case,

$$1.40\sqrt{\frac{E}{f}} = 1.40\sqrt{\frac{29,000}{21.16}} = 51.8$$

Since 66 > 51.8, AISC Equation E7-18 does apply.

$$P_n = F_{cr}A_g = 21.16(2.70) = 57.13 \text{ kips} \quad \therefore \text{ Local buckling controls}$$

LRFD SOLUTION

Design strength $= \phi_c P_n = 0.90(57.13) = 51.4$ kips

ASD SOLUTION

Allowable strength $\dfrac{P_n}{\Omega} = \dfrac{57.13}{1.67} = 34.2$ kips

(Allowable stress $= 0.6F_{cr} = 0.6(21.16) = 12.7$ ksi)

4.5 TABLES FOR COMPRESSION MEMBERS

The *Manual* contains many useful tables for analysis and design. For compression members whose strength is governed by flexural buckling (that is, not local buckling), Table 4-22 in Part 4 of the *Manual,* "Design of Compression Members," can be used. This table gives values of $\phi_c F_{cr}$ (for LRFD) and F_{cr}/Ω_c (for ASD) as a function of KL/r for various values of F_y. This table stops at the recommended upper limit of $KL/r = 200$. The available strength tables, however, are the most useful. These tables, which we will refer to as the "column load tables," give the available strengths of selected shapes, both $\phi_c P_n$ for LRFD and P_n/Ω_c for ASD, as a function of the effective length KL. These tables include values of KL up to those corresponding to $KL/r = 200$.

The use of the tables is illustrated in the following example.