Enter the tables with $KL = 10.34$ feet. A W8 × 58 has an interpolated strength of

$$\frac{P_n}{\Omega_c} = 397 \text{ kips} < 400 \text{ kips} \qquad \text{(N.G.)}$$

The next lightest W8 that will work is a W8 × 67.

$$\frac{K_x L}{r_x / r_y} = \frac{18}{1.75} = 10.29 \text{ ft} > 9 \text{ ft}$$

The interpolated allowable strength is

$$\frac{P_n}{\Omega_c} = 460 \text{ kips} > 400 \text{ kips} \qquad \text{(OK)}$$

Next, investigate the W10 shapes. Try a W10 × 60.

$$\frac{K_x L}{r_x / r_y} = \frac{18}{1.71} = 10.53 \text{ ft} > 9 \text{ ft}$$

The interpolated strength is

$$\frac{P_n}{\Omega_c} = 444 \text{ kips} > 400 \text{ kips} \qquad \text{(OK)}$$

Check the W12 shapes. Try a W12 × 53 ($P_n/\Omega_c = 407$ kips for $KL = 9$ ft):

$$\frac{K_x L}{r_x / r_y} = \frac{18}{2.11} = 8.53 \text{ ft} < 9 \text{ ft}$$

$\therefore K_y L$ controls for this shape, and $P_n/\Omega_c = 407$ kips.

Find the lightest W14. The lightest one with a possibility of working is a W14 × 61. Since it is heavier than the lightest one found so far, it will not be considered.

ANSWER Use a W12 × 53.

Whenever possible, the designer should provide extra support for the weak direction of a column. Otherwise, the member is inefficient: It has an excess of strength in one direction. When $K_x L$ and $K_y L$ are different, $K_y L$ will control unless r_x/r_y is smaller than $K_x L/K_y L$. When the two ratios are equal, the column has equal strength in both directions. For most of the W-shapes in the column load tables, r_x/r_y ranges between 1.6 and 1.8, but it is as high as 3.1 for some shapes.

EXAMPLE 4.11

The column shown in Figure 4.13 is subjected to a service dead load of 140 kips and a service live load of 420 kips. Use A992 steel and select a W-shape.

SOLUTION $K_xL = 20$ ft and maximum $K_yL = 8$ ft. The effective length K_xL will control whenever

$$\frac{K_xL}{r_x/r_y} > K_yL$$

or

$$r_x/r_y < \frac{K_xL}{K_yL}$$

In this example,

$$\frac{K_xL}{K_yL} = \frac{20}{8} = 2.5$$

so K_xL will control if $r_x/r_y < 2.5$. Since this is true for almost every shape in the column load tables, K_xL probably controls in this example.

Assume $r_x/r_y = 1.7$:

$$\frac{K_xL}{r_x/r_y} = \frac{20}{1.7} = 11.76 > K_yL$$

FIGURE 4.13