4.3-1

(a)

$$\frac{KL}{r} = \frac{38(12)}{3.98} = 114.6 < 200 \quad \text{(OK)}$$

$$\lambda_c = \frac{KL}{r\pi}\sqrt{\frac{F_y}{E}} = \frac{114.6}{\pi}\sqrt{\frac{50}{29{,}000}} = 1.515 > 1.5 \quad \therefore \text{ use AISC Eq. E2-3:}$$

$$F_{cr} = \left[\frac{0.877}{\lambda_c^{\,2}}\right]F_y = \left[\frac{0.877}{(1.515)^2}\right](50) = 19.10 \text{ ksi}$$

$$\phi_c P_n = \phi_c A_g F_{cr} = 0.85(42.7)(19.10) = 693 \text{ kips}$$

Check width-thickness ratios:

$$\frac{b_f}{2t_f} = 7.1 < \frac{95}{\sqrt{F_y}} = \frac{95}{\sqrt{36}} = 15.8, \qquad \frac{h}{t_w} = 16.8 < \frac{253}{\sqrt{F_y}} = \frac{253}{\sqrt{36}} = 42.2 \quad \text{(OK)}$$

$$\underline{\phi_c P_n = 693 \text{ kips}}$$

(b)

$$\phi_c F_{cr} = 16.25 \text{ ksi by interpolation}$$

$$\phi_c P_n = \phi_c F_{cr} A_g = 16.25(42.7) = 694 \text{ kips}$$

$$\underline{\phi_c P_n = 694 \text{ kips}}$$

(c)

$$\frac{\phi_c F_{cr}}{F_y} = 0.325 \text{ by interpolation}$$

$$\phi_c P_n = \left(\frac{\phi_c F_{cr}}{F_y}\right) F_y A_g = 0.325(50)(42.7) = 694 \text{ kips}$$

$$\underline{\phi_c P_n = 694 \text{ kips}}$$

4.4-1

Possible choices:

W10 × 60 ($\phi_c P_n$ = 571 kips)
W12 × 65 ($\phi_c P_n$ = 668 kips)
W14 × 68 ($\phi_c P_n$ = 633 kips by interpolation)

Choose the lightest:

<u>Use W10 × 60</u>

4.5-1

$$\frac{K_x L}{r_x} = \frac{30(12)}{5.87} = 61.33, \qquad \frac{K_y L}{r_y} = \frac{10(12)}{1.55} = 77.42 \text{ (controls)}$$

$$\lambda_c = \frac{KL}{r\pi}\sqrt{\frac{F_y}{E}} = \frac{77.42}{\pi}\sqrt{\frac{36}{29{,}000}} = 0.8683 < 1.5 \quad \therefore \text{ use AISC Eq. E2-2:}$$

$$F_{cr} = (0.658)^{\lambda_c^2} F_y = (0.658)^{(0.8683)^2}(36) = 26.26 \text{ ksi}$$

$$\phi_c P_n = \phi_c A_g F_{cr} = 0.85(11.2)(26.26) = 250 \text{ kips}$$

Check width-thickness ratios:

$$\frac{b_f}{2t_f} = 6.6 < \frac{95}{\sqrt{F_y}} = \frac{95}{\sqrt{36}} = 15.8, \qquad \frac{h}{t_w} = 39.6 < \frac{253}{\sqrt{F_y}} = \frac{253}{\sqrt{36}} = 42.2 \text{ (OK)}$$

$$\underline{\phi_c P_n = 250 \text{ kips}}$$

4.5-7

(a) $$G_G = \frac{\sum I_c / L_c}{\sum I_g / L_g} = \frac{2(640)/15}{1330/30} = 1.92$$

$$G_F = \frac{\sum I_c / L_c}{\sum I_g / L_g} = \frac{2(640)/15}{2(1330)/30} = 0.962$$

From the alignment chart, $K_x \approx 1.45$.

$$\lambda_c = \frac{KL}{r\pi}\sqrt{\frac{F_y}{E}} = \frac{1.45(15 \times 12)}{5.98\pi}\sqrt{\frac{50}{29{,}000}} = 0.577 < 1.5 \quad \therefore \text{column is inelastic}$$

Since the column is inelastic, the stiffness reduction factor can be used:

$$\frac{P_u}{A} = \frac{350}{17.9} = 19.6 \text{ ksi}$$

From Manual Table 3-1, SRF = 0.974 by interpolation.

$$G_G = 0.974(1.92) = 1.87, \qquad G_F = 0.974(0.962) = 0.94$$

From the alignment chart, $K_x \approx 1.44$ $\underline{K_x = 1.44}$

(b) $K_y L = 15$ ft, $\dfrac{K_x L}{r_x / r_y} = \dfrac{1.44(15)}{2.44} = 8.85 \text{ ft} < K_y L = 15 \text{ ft}$

$K_y L$ controls. For $KL = 15$ ft, $\underline{\phi_c P_n = 512 \text{ kips}}$

(c) For case c, the effective length factor K is 1.2, as compared to the computed value of 1.44 (17% difference).

4.5-10

For purposes of determining G, assume that column AB is a W10 × 45.

$$G_A = \frac{\sum I_c/L_c}{\sum I_g/L_g} = \frac{248/14}{2(291/20)} = 0.6087$$

$$G_B = \frac{\sum I_c/L_c}{\sum I_g/L_g} = \frac{2(248/14)}{2(448/20)} = 0.7908$$

From the alignment chart, $K_x \approx 1.22$.

$$\lambda_c = \frac{KL}{r\pi}\sqrt{\frac{F_y}{E}} = \frac{1.22(14 \times 12)}{4.32\pi}\sqrt{\frac{36}{29{,}000}} = 0.5321 < 1.5 \quad \therefore \text{column is inelastic}$$

Since the column is inelastic, the stiffness reduction factor can be used:

$$\frac{P_u}{A} = \frac{150}{13.3} = 11.28 \text{ ksi}$$

From Manual Table 3-1, SRF = 1.0, so there is no change in K_x.

From the Column Load Tables, $r_x/r_y = 2.15$ for a W10 × 45.

$$\frac{K_x L}{r_x/r_y} = \frac{1.22(14)}{2.15} = 7.94 \text{ ft}$$

Assuming that $K_y = 1.0$, $\quad K_y L = 1.0(14) = 14$ ft (controls)

From the column load tables with $KL = K_yL = 14$ ft,

$$\phi_c P_n = 282 \text{ kips} >> P_u = 150 \text{ kips}$$

Try a W8 × 31.

$$G_A = \frac{\sum I_c/L_c}{\sum I_g/L_g} = \frac{110/14}{2(291/20)} = 0.2700$$

$$G_B = \frac{\sum I_c/L_c}{\sum I_g/L_g} = \frac{110/14 + 248/14}{2(448/20)} = 0.5708$$

From the alignment chart, $K_x \approx 1.14$.

$$\lambda_c = \frac{KL}{r\pi}\sqrt{\frac{F_y}{E}} = \frac{1.14(14 \times 12)}{3.47\pi}\sqrt{\frac{36}{29{,}000}} = 0.6190 < 1.5 \quad \therefore \text{ column is inelastic}$$

Since the column is inelastic, the stiffness reduction factor can be used:

$$\frac{P_u}{A} = \frac{150}{9.13} = 16.43 \text{ ksi}$$

From Manual Table 3-1, SRF = 0.908

$$G_A \text{ (inelastic)} = \text{SRF} \times G_A \text{ (elastic)} = 0.908(0.2700) = 0.245$$
$$G_B \text{ (inelastic)} = \text{SRF} \times G_B \text{ (elastic)} = 0.908(0.5708) = 0.518$$

From the alignment chart, $K_x \approx 1.12$. Since

$$\frac{K_x L}{r_x/r_y} = \frac{1.12(14)}{1.72} = 9.128 \text{ ft} < K_y L = 14 \text{ ft},$$

use $KL = 14$ ft in the Column Load Tables. For A W8 × 31 with $KL = 14$ ft,

$$\phi_c P_n = 194 \text{ kips} > P_u = 150 \text{ kips} \quad \text{(OK)}$$

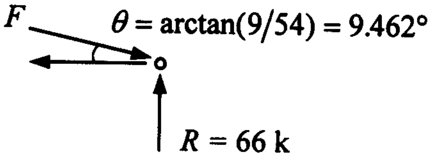
<u>Use a W8 × 31</u>

4.6-1

4.7-12

Reaction = $\Sigma P/2 = 11(12)/2 = 66$ kips

Consider the joint at the right support:



$$\sum F_y = 66 - F\sin(9.462°) = 0 \quad \Rightarrow \quad F = 401 \text{ kips}$$

(This is the maximum force in the top chord.)

$$K_xL = K_yL = \frac{9}{\cos(9.462°)} = 9.124 \text{ ft}$$

From the Column Load Tables,

Try 2L 6 × 6 × ¾:

$$\phi_c P_n = 427 \text{ kips (x axis controls), weight} = 57.4 \text{ lb/ft}$$

Number of intermediate connectors:

To obtain the tabulated strength for the y axis, 2 connectors must be used. For the x axis, from AISC E4,

$$\frac{Ka}{r_i} \le \frac{3}{4}\frac{KL}{r}$$

where KL/r is the controlling slenderness ratio.

$$a = \text{spacing} = \frac{9.124(12)}{n+1}$$

$$r_i = r_z = 1.17 \text{ in.}, \qquad \frac{Ka}{r_i} = \frac{1.0(9.124)(12)}{(n+1)(1.17)}$$

Since the x axis controls, the governing slenderness ratio for the member is

$$\frac{K_xL}{r_x} = \frac{1.0(9.124 \times 12)}{1.83} = 59.83$$

For $\frac{Ka}{r_i} \le \frac{3}{4}\frac{KL}{r}$,

$$\frac{1.0(9.124)(12)}{(n+1)(1.17)} \le \frac{3}{4}(59.83) \quad \Rightarrow \quad n \ge 1.1 \quad \text{Use 2.}$$

<u>Use 2L 6 × 6 × ¾ with 2 intermediate connectors</u>