4. W14x109, A992, L = 36' (about both axes).

$\frac{KL}{r}$, use r_y $\Rightarrow$ $\frac{KL}{r_y} = \frac{1 \times 36 \times 12}{3.73} = 115.82$

K = 1 pin-ended

$4.71\sqrt{\frac{E}{F_y}} = 4.71\sqrt{\frac{29000}{50}} = 113.43$

$\Rightarrow \frac{KL}{r_y} > 4.71\sqrt{\frac{E}{F_y}} \Rightarrow F_{cr} = 0.877\, F_e$

$F_e = \frac{\pi^2 E}{\left(\frac{KL}{r}\right)^2} = \frac{\pi^2\, 29000}{(115.82)^2} = 21.34$ Ksi

$\Rightarrow F_{CR} = 0.877 \times 21.34 = 18.72$ Ksi

$\Rightarrow P_n = F_{CR} \cdot A = 18.72 \times 32 = 599.04$ K

$\left(\frac{KL}{r} > 4.71\sqrt{\frac{E}{F_y}} \Rightarrow \text{Elastic buckling}\right)$.

LRFD . ⇒ $\phi P_n = 0.9 \times 599.04 = 539.14\ K$

ASD , ⇒ $\frac{P_n}{\Omega} = \frac{599.04}{1.67} = 358.71\ K$

using λ_c, the problem is solved as follows:

$$\lambda_c = \frac{KL}{\pi r}\sqrt{\frac{F_y}{E}} = \frac{36 \times 12}{\pi \times 3.73}\sqrt{\frac{50}{29000}} = 1.531 > 1.5$$

⇒ elastic

$$\Rightarrow F_{CR} = \frac{0.877}{\lambda_c^2} \cdot F_y = \frac{0.877}{(1.531)^2} \times 50 = 18.71\ Ksi$$

$$\Rightarrow P_n = F_{CR} \cdot A = 18.71 \times 32 = 598.72\ K$$

6. W12x45, A992, $KL_y = 20'$, $KL_x = 40'$

$r_x = 5.15$, $r_y = 1.95$, $A = 13.1$

$\Rightarrow \frac{KL_y}{r_y} = \frac{20 \times 12}{1.95} = \underline{123.08}$ ← controls

$\frac{KL_x}{r_x} = \frac{40 \times 12}{5.15} = 93.20$

$4.71\sqrt{\frac{E}{F_y}} = 113.43 \Rightarrow \frac{KL_y}{r_y} > 4.71\sqrt{\frac{E}{F_y}} \Rightarrow$ Elastic

$\Rightarrow F_{CR} = 0.877\, F_e$

$F_e = \frac{\pi^2 E}{\left(\frac{KL_y}{r_y}\right)^2} = \frac{\pi^2 \times 29000}{(123.08)^2} = 18.89$ Ksi

$\Rightarrow F_{CR} = 0.877 \times F_e = 16.57$ Ksi

$\Rightarrow P_n = F_{cr} \cdot A = 16.57 \times 13.1 = 217.07$ K

LRFD: $\phi P_n = 0.9 \times 217.07 = 195.36$ K

ASD: $\frac{P_n}{\Omega} = \frac{217.07}{1.67} = 129.98$ K

7. W8x24, A992, $KL_y = 12.5'$, $KL_x = 28'$

$r_x = 3.42$, $r_y = 1.61$, $A = 7.08$

$$\frac{KL_y}{r_y} = \frac{12.5 \times 12}{1.61} = 93.17$$

$$\frac{KL_x}{r_x} = \frac{28 \times 12}{3.42} = \underline{98.25} \quad \leftarrow \text{controls}$$

$$\frac{KL_x}{r_x} < 4.71\sqrt{\frac{E}{F_y}} = 113.43 \quad \Rightarrow \text{Inelastic}$$

$$\Rightarrow F_{cr} = \left(0.658^{F_y/F_e}\right) F_y$$

$$F_e = \frac{\pi^2 E}{\left(\frac{KL_x}{r_x}\right)^2} = \frac{\pi^2\, 29000}{(98.25)^2} = 29.65 \text{ Ksi}$$

$$\Rightarrow F_{cr} = \left(0.658^{50/29.65}\right) 50 = 24.69 \text{ Ksi}$$

$$\Rightarrow P_n = F_{cr} A = 24.69 \times 7.08 = 174.81 \text{ K}$$

<u>LRFD</u>: $\phi P_n = 0.9 \times 174.81 = 157.33 \text{ K}$

<u>ASD</u>: $\frac{P_n}{\Omega} = \frac{174.81}{1.67} = 104.68 \text{ K}$

8. W 8x40 col

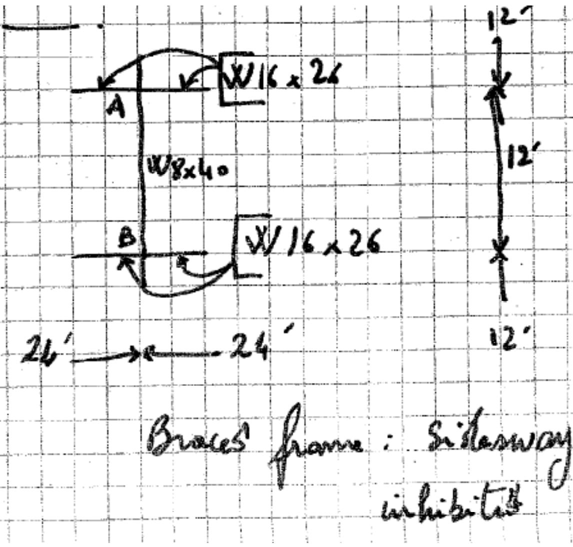
W 16 x 26 beams

Beam: $I_x = 301$

Col: $I_x = 146$

$I_y = 49.1$

$r_x/r_y = 1.73$



i) weak axis col:

$$G_A = \frac{\Sigma(I/L)_c}{\Sigma(I/L)_B} = \frac{2\left(\frac{49.1}{12}\right)}{2\left(\frac{301}{24}\right)} = 0.326$$

$G_B = G_A = 0.326$

$\Rightarrow K \simeq 0.64$

$\Rightarrow KL = 0.64 \times 12 = 7.68'$

(using the eqn to find K, with $G_A = G_B$

$$K = \frac{G+0.4}{G+0.8} = \frac{0.326+0.4}{0.326+0.8} = 0.645$$

We used $K = 0.64$)

From table 4-1 in the manual,

LRFD:

$KL = 7' \longrightarrow \phi P_n = 467K$

$KL = 8' \longrightarrow \phi P_n = 449K$

$\Rightarrow KL = 7.68' \longrightarrow \phi P_n = 467 - (0.68 \times [467 - 449])$

$= 454.76K$

ASD: $KL = 7' \longrightarrow \frac{P_n}{\Omega} = 310$

$KL = 8' \longrightarrow \frac{P}{\Omega} = 299$

$KL = 7.68 = 310 - (0.68 \times [310 - 299])$

$= 302.52\ K$

ii) STRONG AXIS

$$G_A = G_B = \frac{\Sigma (I/L)_c}{\Sigma (I/L)_B} = \frac{2\left(\frac{146}{12}\right)}{2\left(\frac{301}{24}\right)} = 0.97$$

From Alignment chart $K = 0.77$

From EQUATION $\left(\frac{G+0.4}{G+0.8}\right) = 0.774$

$KL = 12(0.77) = 9.24'$

Since column is buckling about strong axis, MUST ACCOUNT for r_x

$$KL_{eff} = \frac{KL_x}{r_x/r_y} = \frac{9.24}{1.73} = 5.34\,ft$$

LRFD

$KL = 0 \quad \phi P_n = 528^k$

$KL = 6ft \quad \phi P_n = 482^k$

for $KL = 5.34\,ft \quad \phi P_n = 487^k$

ASD

$KL = 0 \quad P_n/\Omega = 351^k$

$KL = 6ft \quad P_n/\Omega = 321^k$

for $KL = 5.34\,ft \quad \frac{P_n}{\Omega} = 324^k$