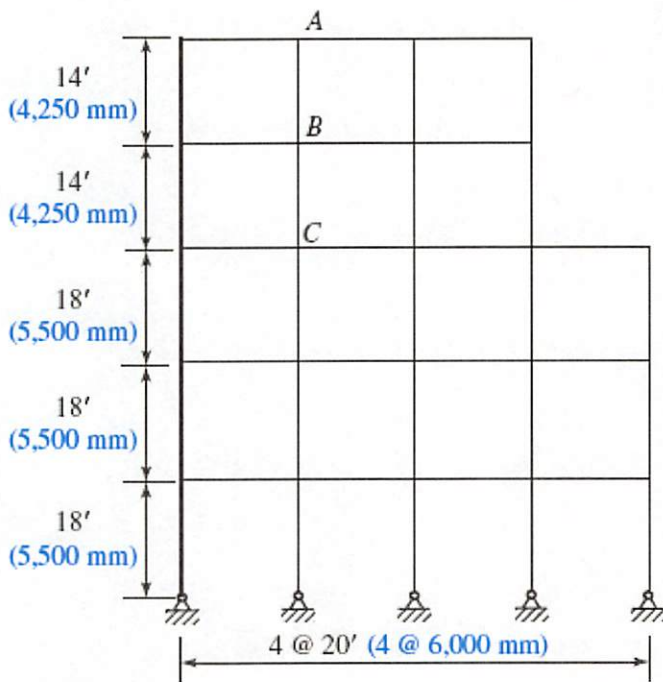


4.7-14 The rigid frame shown in [Figure P4.7-14](#) is unbraced in the plane of the frame. In the direction perpendicular to the frame, the frame is braced at the joints. The connections at these points of bracing are simple (moment-free) connections. Roof girders are W14 x 30 (W360 x 44), and floor girders are W16 x 36 (W410 x 53). Member BC is a W10 x 45 (W250 x 67). Use A992 steel ($F_y = 50$ ksi (345 MPa)) and select a W-shape for AB. Assume that the controlling load combination causes no moment in AB. The service dead load is 25 kips (110 kN) and the service live load is 75 kips (330 kN).

a. Use LRFD.

b. Use ASD.



ROOF BEAM - $\frac{W14 \times 30}{I_x = 291 \text{ IN}^4}$
 $I_y = 19.6 \text{ IN}^4$

FLOOR BEAM - $\frac{W16 \times 36}{I_x = 448 \text{ IN}^4}$
 $I_y = 24.5 \text{ IN}^4$

COLUMN BC $\frac{W10 \times 45}{I_x = 248 \text{ IN}^4}$
 $I_y = 53.4 \text{ IN}^4$
 $A = 13.3 \text{ IN}^2$
 $r_x = 4.32 \text{ IN}$
 $r_y = 2.01 \text{ IN}$

a) LRFD $P_u = 1.2D + 1.6L = 1.2(25k) + 1.6(75k) = 150k$

* ASSUME Y-AXIS CONTROLS FOR COLUMN AB

$L_{cy} = K_y L = 1.0(14') = 14 \text{ ft}$

FROM TABLE 4-16 FOR $L_c = 14 \text{ ft}$ $\phi_c P_n = 150k$

SELECT W8 x 31 $\phi_c P_n = 248k$

4.7-14 | W8 x 31 $I_x = 110 \text{ in}^4$ $r_x = 3.47 \text{ in}$ 2/2
 $I_y = 37.1 \text{ in}^4$ $r_y = 2.02 \text{ in}$ $A = 9.13 \text{ in}^2$

JOINT A

$$\left. \begin{aligned} G_A &= \frac{110 \text{ in}^4 / 14'}{2(291 \text{ in}^2 / 20')} = 0.27 \\ G_B &= \frac{110 \text{ in}^4 / 14' + 248 / 14'}{2(448 \text{ in}^4 / 20')} = 0.57 \end{aligned} \right\} \text{FROM TC-A-7.2}$$

$$\underline{k_x = 1.13}$$

$$\frac{L_{c_x}}{r_x} = \frac{k_x L}{r_x} = \frac{1.13(14')(12 \text{ in/ft})}{3.47 \text{ in}} = 54.71$$

$$\frac{L_{c_y}}{r_y} = \frac{1.0L}{r_y} = \frac{14 \text{ ft}(12 \text{ in/ft})}{2.02 \text{ in}} = 83.17 \quad * \text{ CONTROLS}$$

$$4.71 \sqrt{E/F_y} = 4.71 \sqrt{\frac{29,000 \text{ ksi}}{50 \text{ ksi}}} = 113.43$$

$$\frac{L_{c_y}}{r_y} < 4.71 \sqrt{E/F_y} \Rightarrow \text{COLUMN Y-AXIS CONTROLS}$$

\Rightarrow USE A W8 x 31

b) ASD $P_u = D + L = 25 \text{ k} + 75 \text{ k} = 100 \text{ k}$

* ASSUME Y-AXIS CONTROLS, WITH $L_c = 14'$ & $\frac{P_u}{\Omega_c} = 100 \text{ k}$

FROM TABLE 4-19 SELECT W8 x 31

WITH $\frac{P_u}{\Omega_c} = 165 \text{ k}$

* AS WITH LRFD $\underline{k_x = 1.13}$

* $\frac{L_{c_y}}{r_y} < 4.71 \sqrt{E/F_y}$ & $\frac{L_{c_y}}{r_y} > \frac{L_{c_x}}{r_x} \Rightarrow$ USE W8 x 31