6.5-6 $P_d = \frac{1}{4}\ 190\ k = 47.5\ k$

$P_l = \frac{3}{4}\ 190\ k = 142.5\ k$

$M_{d,\,Top} = \frac{1}{4}\ 80\ k\text{-}ft = 20\ k\text{-}ft$

$M_{l,\,Top} = \frac{3}{4}\ 80\ k\text{-}ft = 60\ k\text{-}ft$

$M_{d,\,Bot} = \frac{1}{4}\ 75\ k\text{-}ft = 18.75\ k\text{-}ft$

$M_{l,\,Bot} = \frac{3}{4}\ 75\ k\text{-}ft = 56.25\ k\text{-}ft$

$P_{nt} = 1.2D + 1.6L = 1.2\,(47.5) + 1.6\,(142.5) = 285\ k$

$M_{nt,\,Top} = 1.2D + 1.6L = 1.2\,(20) + 1.6\,(60) = 120\ k\text{-}ft$

$M_{nt,\,Bot} = 1.2D + 1.6L = 1.2\,(18.75) + 1.6\,(56.25) = 112.5\ k\text{-}ft$

Find B_1

$$B_1 = \frac{C_m}{1 - \alpha P_r / P_{e1}} = \frac{0.225}{1 - (1.0)\frac{285\,k}{3012.4\,k}} = 0.249 \le 1.0$$

Use $B_1 = 1.0$

where $C_m = 0.6 - 0.4\left(\frac{112.5}{120}\right) = 0.225$

$\alpha = (1.0)$

$P_r = P_{nt} = 285\ k$

$$P_{e1} = \frac{\pi^2 E I_x}{(K_1 L)^2} = \frac{\pi^2 (29000\ ksi)(341\ in^4)}{(15.12\ in)^2} = 3012.4\ k$$

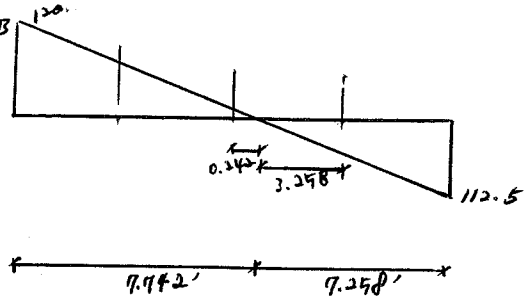
Find $\phi_c P_n$, $\phi_b M_n$

W 10 x 60

$\phi_c P_n = 555\ k$

$+\ \phi_b M_n = 257.25\ k\text{-}ft \rightarrow C_B = 1.0$

Find C_B



$M_{max} = 120\ k\text{-}ft$

$M_A = 120\ \frac{3.992}{7.742} = 61.89\ k\text{-}ft$

$M_B = 120\ \frac{0.242}{7.742} = 3.75\ k\text{-}ft$

$M_C = +112.5\ \frac{3.258}{7.258} = +50.5\ k\text{-}ft$

$$C_b = \frac{12.5\ M_{max}}{2.5\ M_{max} + 3M_A + 4M_B + 3M_C} = \frac{12.5\,(120)}{2.5\,(120) + 3(61.87) + 4(3.75) + 3(50.5)}$$

$$= \cancel{1.29}\ 2.3 \leq 3.0$$

$$\rightarrow C_b = \cancel{2.0}\ 2.3$$

Find $\phi_b M_n$

$$\phi_b M_n = C_b\,(\phi_b M_{n_{C_b=1.0}}) \leq \phi_b M_p$$

$$= (2.3)(257.25) = \cancel{592.1}\ \cancel{577.8}\ 591.7\ k\text{-}ft \leq 280\ k\text{-}ft$$

$$\rightarrow \phi_b M_n = 280\ k\text{-}ft$$

Check Interaction Equation

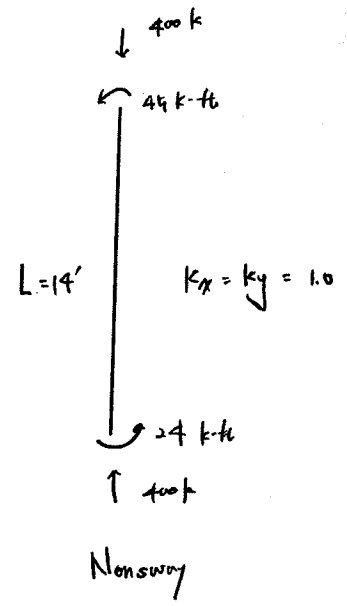
$$\frac{P_r}{P_c} = \frac{285\ k}{\cancel{555}\ k} = 0.5185 \geq 0.2 \quad \text{Use H1-1a}$$

$$\frac{P_r}{P_c} + \frac{8}{9}\left(\frac{M_{rx}}{M_{cx}} + \frac{M_{ry}}{M_{cy}}\right)$$

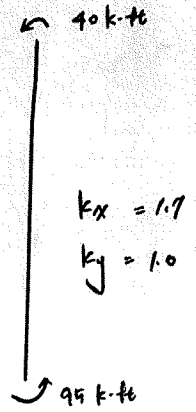
$$= 0.5185 + \frac{8}{9}\left(\frac{120\ k\text{-}ft}{280\ k\text{-}ft}\right) = 0.894 \leq 1.0 \quad \text{o.k}$$

$\rightarrow$ The member is adequate.

6.6-1



Nonsway



Sway

Determine the critical axis for axial compressive strength:

$K_y L = 14$ ft

$$\frac{K_x L}{r_x / r_y} = \frac{(1.7)(14')}{2.44} = 9.75' < 14 \text{ ft} \rightarrow kL = 14'$$

From the column load tables, $kL = 14'$, $\phi_c P_n = 1114$ kips

Find B_1

$$C_m = 0.6 - 0.4\left(\frac{M_1}{M_2}\right) = 0.6 - 0.4\left(\frac{24}{45}\right) = 0.387$$

$$P_{e1} = \frac{\pi^2 E I}{(kL)^2} = \frac{\pi^2 (29000 \text{ ksi})(881 \text{ in}^4)}{(14 \cdot 12)^2} = 8934.2 \text{ k}$$

$$B_1 = \frac{C_m}{1 - (P_r / P_{e1})} = \frac{0.387}{1 - (400 \text{ k} / 8934.2)} = 0.405 < 1.0$$

$\rightarrow B_1 = 1.0$

Find B_2

$$B_2 = \frac{1}{1 - \frac{\alpha \Sigma P_{nt}}{\Sigma P_{e2}}} = \frac{1}{1 - \frac{6000 \text{ k}}{40000 \text{ k}}} = 1.176$$

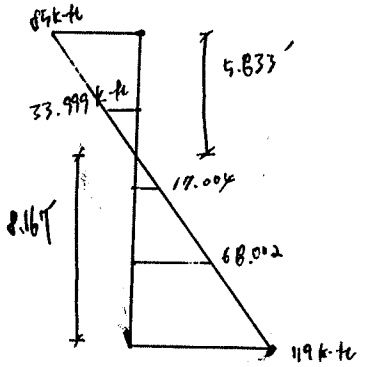
Find M_r

$$M_r = B_1 M_{nt} + B_2 M_{lt}$$

$$= (1.0)(24) + 1.176(95\ k\cdot ft) = 135.72\ k\cdot ft$$

Find $\phi_c M_n$

$$C_b = \frac{12.5\ M_{max}}{2.5M_{max} + 3M_A + 4M_B + 3M_C} = \frac{12.5(119)}{2.5(119)+3(33.999)+4(19.00^k)+3(68.00^2)} = 2.21$$



From table 3-10 $\phi_b M_{n\ C_b=1} = 477\ k\cdot ft$

3-6 $\phi_b M_p = 521\ k\cdot ft$

$$\phi_b M_n = (\phi_b M_{n\ C_b=1})\ C_b \leq \phi_b M_p$$

$$= (477)(2.215) = 1056.6\ k\cdot ft \leq 521\ k\cdot ft$$

$$\phi_b M_n = 521\ k\cdot ft$$

Check Interaction equation

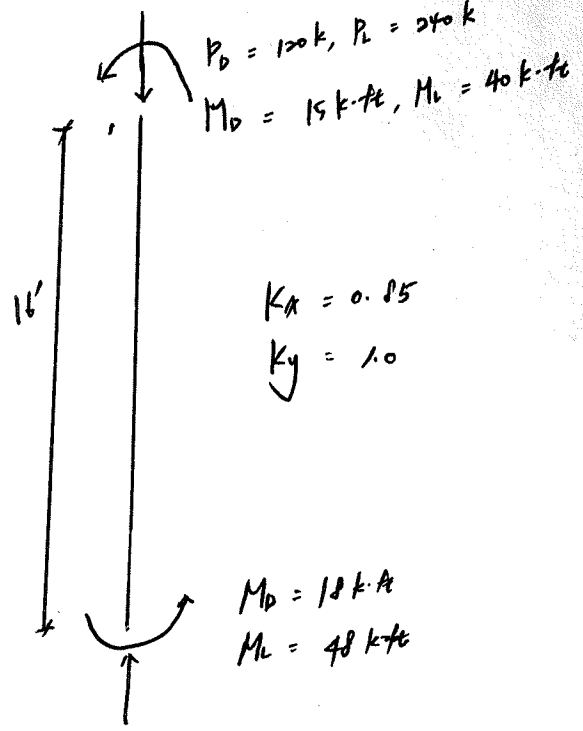
$$\frac{P_r}{P_c} = \frac{400\ k}{774\ k} = 0.516 > 0.2 \quad \text{Use H1-1a}$$

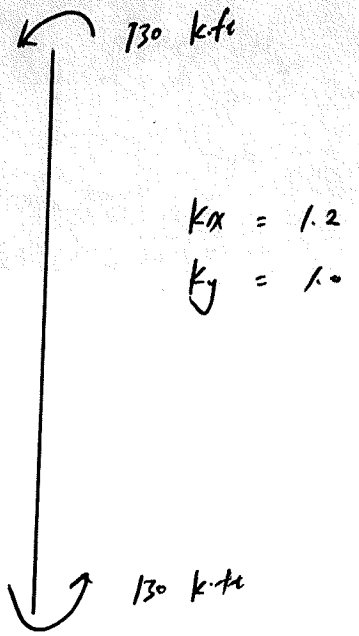
$$\frac{P_r}{P_c} + \frac{8}{9}\left(\frac{M_{rx}}{M_{cx}}\right) = 0.516 + \frac{8}{9}\left(\frac{135.72\ k\cdot ft}{521\ k\cdot ft}\right)$$

$$= 0.748 \leq 1.0 \quad \text{o.k}$$

Thus, the member satisfies the provisions of the AISC.

6.6-2





Load Case 1 : 1.2D + 1.6L

The critical axis for axial compressive strength

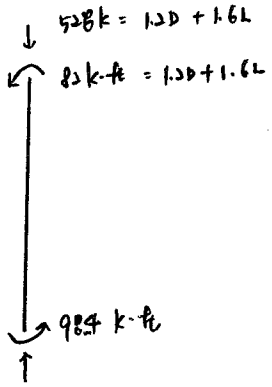
$K_y L = 16'$

$$\frac{K_x L}{r_x / r_y} = \frac{(0.85)16'}{2.44} = 5.57'$$

$$= \frac{(1.2)(16')}{2.44} = 7.86' \quad \rightarrow \quad KL = 16'$$

$\phi_c P_n$

From table $\phi_c P_n$ = 698 kips, KL = 16'



$$C_m = 0.6 - 0.4\left(\frac{82}{984}\right) = 0.267$$

Find B_1

$$B_1 = \frac{C_m}{1-(P_r/P_{e1})} = \frac{0.267}{1-(528k/9467k)} = 0.27 \leq 1.0 \rightarrow B_1 = 1.0$$

$$P_{e1} = \frac{\pi^2 E I}{(KL)^2} = \frac{\pi^2 (29000\ ksi)(881\ in^4)}{(0.85 \times 16 \times 12)^2} = 9467\ k$$

$M_{2t} = 0 \rightarrow B_2 = 0$

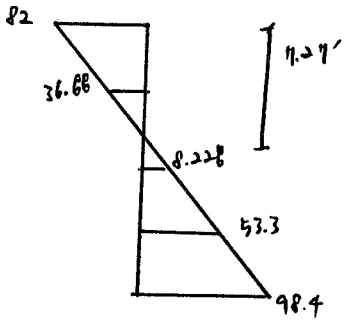
Find M_r

$$M_r = B_1 M_{nt} + B_2 M_{lt}$$

$$= (1.0)(98.4) + 0$$

$$= 98.4\ k\cdot ft$$

Find C_b



$$C_b = \frac{125\ M_{max}}{2.5\ M_{max} + 3M_A + 4M_B + 3M_C}$$

$$= \frac{125\ (98.4)}{2.5(98.4) + 3(36.88) + 4(8.228) + 3(53.3)}$$

$$= 2.27$$

Find $\phi_b M_n$

$\phi_b M_{n,\ C_b=1.0}$ from table 3-10 462 k·ft

$\phi_b M_p$ from table 3-6 521 k·ft

$\phi_b M_{n,\ C_b=2.27} = (2.27)(462\ k\cdot ft) \leq 521\ k\cdot ft$

$= 1034\ k\cdot ft \leq 521\ k\cdot ft$

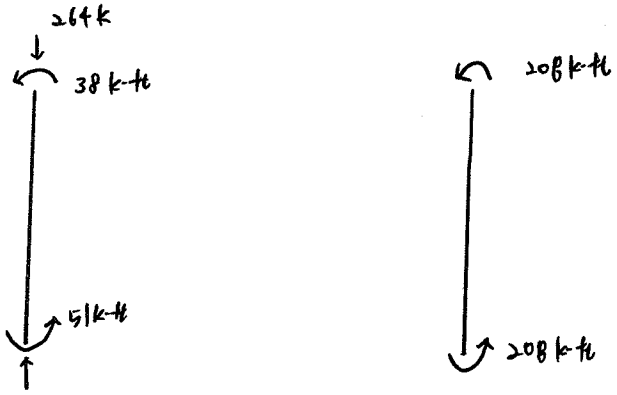
$\phi_b M_n = 521\ k\cdot ft$

Check Interaction equation

$\frac{P_r}{P_c} = \frac{528k}{698k} = 0.756 \geq 0.2$ Use H1-1a

$$\frac{P_r}{P_c} + \frac{8}{9}\left(\frac{M_{rx}}{M_{cx}}\right) = \frac{0.756}{\cancel{0.38}} + \frac{8}{9}\left(\frac{98.4}{521}\right) = \cancel{0.945} \quad 0.92 < 1.0 \quad \text{o.k}$$

Load Case 2 : 1.2D + 0.5L + 1.6W



$$C_m = 0.6 - 0.4\left(\frac{38}{51}\right) = 0.302$$

$$P_{e1} = 9467\ k$$

$$\beta_1 = \frac{C_m}{1 - P_r/P_{e1}} = \frac{0.302}{1 - 264/9467} = 0.31 < 1.0 \rightarrow \beta_1 = 1.0$$

$$\beta_2 \approx \frac{1}{1 - (P_u/P_{e2})} = \frac{1}{1 - \left(\frac{264}{4750.17}\right)} = 1.06$$

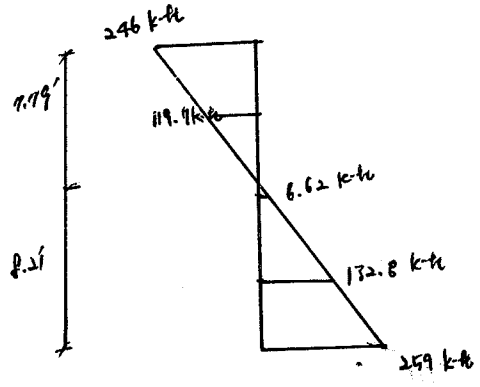
where $P_u = 264\ k$

$$P_{e2} = \frac{\pi^2 E I}{(K_x L_x)^2} = \frac{\pi^2 (29000\ ksi)(88\ in^4)}{(1.2 \cdot 16 \cdot 12)^2} = 4750.17\ k$$

$$M_r = \beta_1 M_{nt} + \beta_2 M_{lt}$$

$$= (1.0)(51\ k\text{-}ft) + 1.06(208\ k\text{-}ft) = 271.5\ k\text{-}ft$$

Find C_b



$$C_b = \frac{12.5\ M_{max}}{2.5\ M_{max} + 3M_A + 4M_B + 3M_C}$$

$$= \frac{12.5(259)}{2.5(259) + 3(119.9) + 4(6.62) + 3(132.8)} = 2.26$$

Find $\phi_b M_n$

$$C_{b_{1.2D+1.6L}} \approx C_{b_{1.2D+0.5L+1.6W}}$$

$$\rightarrow \phi_b M_n = 521 \text{ k-ft}$$

Check Interaction equation

$$\frac{P_r}{P_c} = \frac{264^k}{698^k} = 0.38 \geq 0.2 \quad \text{Use H1-1a}$$

$$\frac{P_r}{P_c} + \frac{8}{9}\left(\frac{M_{rx}}{M_{cx}}\right) = 0.38 + \frac{8}{9}\left(\frac{271.5}{521}\right) = 0.841 \leq 1.0 \quad \text{o.k}$$

$\rightarrow$ The member is in compliance with the AISC spec.