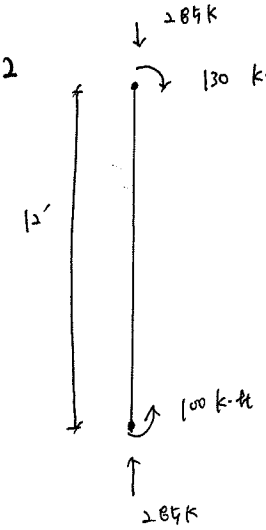
Lab # 13 Apr 30

6.7-2



40 % DL
60 % DL
A992 steel
Select lightest w10 shape

Solution

Find P_u

$P_u = 1.2(285\frac{1}{2}) + 1.6(285\frac{1}{2}) = 399$ k

Select a Trial section

Assume $B_1 = 1.0$, $C_b = 1.0$

$M_u = 1.2(130\frac{1}{2}) + 1.6(130\frac{1}{2}) = 182$ k-ft

$kL = L_b = 12'$

From table 6-1 try W 10 x 60

$p = 1.58 \times 10^{-3}$

$b_x = 3.31 \times 10^{-3}$

$pP_r = 1.58 \times 10^{-3}(399) = 0.63 > 0.2$

$pP_r + b_x M_{rx} = 0.63 + (3.31 \times 10^{-3})(182)$

$= 1.23 > 1.0$ NG

Try W 10 x 77, $p = 1.23 \times 10^{-3}$

$b = 2.5 \times 10^{-3}$

$pP_r = (1.23 \times 10^{-3})(399) = 0.49 > 0.2$

$pP_r + b_x M_{rx} = 0.49 + (2.5 \times 10^{-3})(182) = 0.95 < 1.0$ O.K

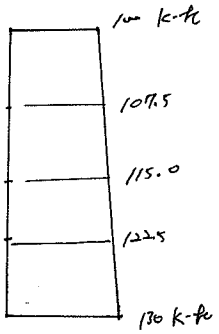
Find exact B_1, C_b

$$B_1 = \frac{C_m}{1 - \alpha P_r/P_{e1}} = \frac{0.907}{1 - (399/6280)} = 0.968 \leq 1.0 \rightarrow B_1 = 1.0$$

where $C_m = 0.6 - 0.4\left(\frac{-140}{182}\right) = 0.907$

$P_r = 399\ k$

$$P_{e1} = \frac{\pi^2 E I}{(KL)^2} = \frac{\pi^2 (29000\ ksi)(455\ in^4)}{(12 \cdot 12\ in)^2} = 6280\ k$$



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

$$= \frac{12.5\,(130)}{2.5(130) + 3(107.5) + 4(115) + 3(122.5)} = 1.1$$

Modify b_x

$$\phi_b M_{nx} = \frac{\beta}{9}\frac{1}{b_x} = 355.6\ k\text{-ft} \qquad (C_b = 1.0)$$

$$\phi_b M_{nx} = (1.1)(355.6\ k\text{-ft}) = 391.11\ k\text{-ft} \leq 366\ k\text{-ft} = \phi_b M_p$$

$\rightarrow \phi_b M_{nx} = 366\ k\text{-ft}$

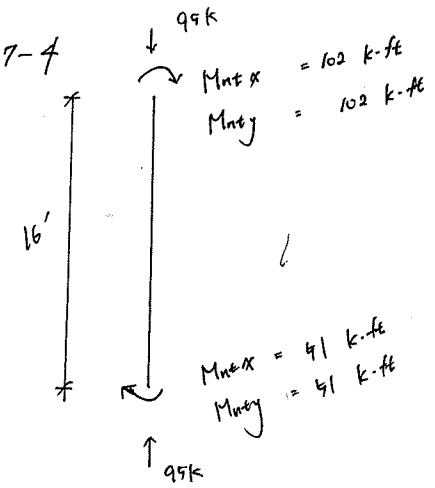
$$\text{Modified } b_x = \frac{\beta}{9}\frac{1}{366\ k\text{-ft}} = 2.429 \times 10^{-3}$$

Check Interaction equation

$$P_r + b_x M_{rx} = 0.49 + 2.429 \times 10^{-3}(182\ k\text{-ft}) = 0.932 \leq 1.0 \quad \text{o.k}$$

Use W10 x 77 for the member

6.7-4



$P_u = 1.2D + 1.6L = 1.2(0.33 \cdot 95) + 1.6(0.67 \cdot 95) = 139.5k$

$M_{ux\,top} = 1.2D + 1.6L = 1.2(0.33 \cdot 102) + 1.6(0.67 \cdot 102) = 149.74$ k-ft

$M_{uy\,top} = 149.74$ k-ft

$M_{ux\,bot} = 1.2D + 1.6L = 1.2(0.33 \cdot 51) + 1.6(0.67 \cdot 51) = 74.87$ k-ft

$M_{uy\,bot} = 74.87$ k-ft

Find a trial section

$kL = Lb = 16'$

$P_u = 139.5$ k

$M_u = 149.74$ k-ft

From table 3-10 W10 x 68 $\phi_b M_n = 293$ k-ft

From table 4-1 W 10 x 68 $\phi_c P_n = 602$ kips

Find p, b_x, b_y from table 6-1

$p = 1.66 \times 10^{-3}$

$b_x = 3.03 \times 10^{-3}$

$b_y = 5.91 \times 10^{-3}$

$pP_r = (1.66 \times 10^{-3})(139.5k) = 0.2315 > 0.2$

$pP_r + b_x M_{rx} + b_y M_{ry} = 0.2315 + (3.03 \times 10^{-3})(149.74) + (5.91 \times 10^{-3})(149.74)$

$= 1.57 > 1.0$ NG

Try W 10 x 112

$p = 0.982 \times 10^{-3}$

$b_x = 1.69 \times 10^{-3}$

$b_y = 3.43 \times 10^{-3}$

$pP_r = (0.982 \times 10^{-3})(139.5k) = 0.137 < 0.2$

$0.5pP_r + \frac{9}{8}(b_x M_{rx} + b_y M_{ry}) = \frac{0.137}{2} + \frac{9}{8}\left(149.74\left[(1.69 + 3.43) \times 10^{-3}\right]\right)$

$= 0.931 \leq 1.0$ O.K

Find exact β_1, C_b

$$\beta_1 = \frac{C_m}{1 - \alpha \, P_r/P_{e1}} = \frac{0.4}{1 - \left(139.5/5559\right)} = 0.41 \leq 1.0$$

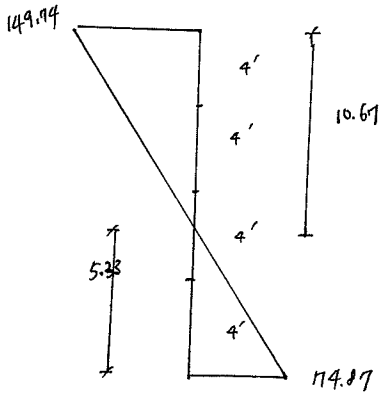
$$\rightarrow \beta_1 = 1.0$$

where $C_m = 0.6 - 0.4\left(\frac{74.87}{149.74}\right) = 0.4$

$P_r = 139.5$ k

$$P_{e1} = \frac{\pi^2 E I}{(kL)^2} = \frac{\pi^2 (29000 \text{ ksi})(716 \text{ in}^4)}{(16 \cdot 12 \text{ in})^2} = 5559 \text{ k}$$

$$C_b = \frac{12.5 M_{max}}{2.5 M_{max} + 3M_A + 4M_B + 3M_C} = \frac{12.5(149.74)}{2.5(149.74) + 3(93.6) + 4(37.47) + 3(18.68)} = 2.17$$



$M_{max} = 149.74$ k-ft

$M_A = 149.74\left(\frac{6.67'}{10.67'}\right) = 93.6$ k-ft

$M_B = 149.74\left(\frac{2.67'}{10.67'}\right) = 37.47$ k-ft

$M_C = 74.87\left(\frac{1.33'}{5.33'}\right) = 18.68$ k-ft

Modify b_{nx}, b_{ny}

$\phi_b M_{nx} = \frac{\phi}{9}\frac{1}{b_{nx}} = 529.97$ k-ft $\rightarrow C_b = 1.0$

$\phi_b M_{nx} = C_b(529.97 \text{ k-ft}) = 1150.0$ k-ft ≥ 551 k-ft

$\rightarrow \phi_b M_{nx} = 551$ k-ft

Modified $b_{nx} = \frac{\phi}{9}\frac{1}{551} = 1.613 \times 10^{-3}$

$\phi_b M_{ny} = \frac{\phi}{9}\frac{1}{b_{ny}} = 150.4$ k-ft

$\phi_b M_{ny} = C_b(150.4 \text{ k-ft}) = 326.4$ k-ft ≥ 259.5 k-ft $= \phi_b M_{py}$

$\rightarrow \phi_b M_{ny} = 259.5$ k-ft

Modified $b_{ny} = \frac{\phi}{9}\frac{1}{259.5} = 3.425 \times 10^{-3}$

Check Interaction equation

$$\frac{1}{2}\phi P_r + \frac{9}{8}\left(b_x M_{rx} + b_y M_{ry}\right)$$

$$= \frac{0.139}{2} + \frac{9}{8}\left(1.613 \times 10^{-3} \cdot (149.74) + 3.435 \times 10^{-3} \cdot (149.74)\right)$$

$$= 0.917 \leq 1.0 \qquad \text{o.k}$$

Thus, Use W 10 X 112 for the member.