Lab 11

P.1 The beam shown in Figure P5.5-11 has lateral support at a,b,c, and d. Compute Cb for segment b-c. Use factored loads.

Solution

$L := 35 \cdot ft$

$w_D := 0.5 \cdot \frac{kip}{ft}$ $\qquad p_D := 1.7 \cdot kip$

$w_L := 0.9 \cdot \frac{kip}{ft}$ $\qquad p_L := 5 \cdot kip$

Using Equations given in Table 3-23

$\frac{1}{4}$ point $\quad x := 13.75 \cdot ft \quad a := 25 \cdot ft \quad b := 10 \cdot ft$

$M_{wd} := \frac{w_D \cdot x}{2} \cdot (L - x)$ $\qquad M_{wd} = 73.047 \cdot kip \cdot ft$

$M_{wL} := \frac{w_L \cdot x}{2} \cdot (L - x)$ $\qquad M_{wL} = 131.484 \cdot kip \cdot ft$

$M_{pd} := \frac{p_D \cdot b \cdot x}{L}$ $\qquad M_{pd} = 6.679 \cdot kip \cdot ft$

$M_{pL} := \frac{p_L \cdot b \cdot x}{L}$ $\qquad M_{pL} = 19.643 \cdot kip \cdot ft$

$M_A := \max\left[1.4 \cdot \left(M_{wd} + M_{pd}\right), 1.2 \cdot \left(M_{wd} + M_{pd}\right) + 1.6 \cdot \left(M_{wL} + M_{pL}\right)\right]$ $\qquad M_A = 337.474 \cdot kip \cdot ft$

$\frac{2}{4}$ point $\quad x := 17.5 \cdot ft$

$M_{wd} := \frac{w_D \cdot x}{2} \cdot (L - x)$ $\qquad M_{wd} = 76.563 \cdot kip \cdot ft$

$M_{wL} := \frac{w_L \cdot x}{2} \cdot (L - x)$ $\qquad M_{wL} = 137.813 \cdot kip \cdot ft$

$M_{pd} := \frac{p_D \cdot b \cdot x}{L}$ $\qquad M_{pd} = 8.5 \cdot kip \cdot ft$

$M_{pL} := \frac{p_L \cdot b \cdot x}{L}$ $\qquad M_{pL} = 25 \cdot kip \cdot ft$

$M_B := \max\left[1.4 \cdot \left(M_{wd} + M_{pd}\right), 1.2 \cdot \left(M_{wd} + M_{pd}\right) + 1.6 \cdot \left(M_{wL} + M_{pL}\right)\right]$ $\qquad M_B = 362.575 \cdot kip \cdot ft$

$\frac{3}{4}$ point $\quad x := 21.25 \cdot ft$

$$M_{wd} := \frac{w_D \cdot x}{2} \cdot (L - x) \qquad M_{wd} = 73.047 \cdot kip \cdot ft$$

$$M_{wL} := \frac{w_L \cdot x}{2} \cdot (L - x) \qquad M_{wL} = 131.484 \cdot kip \cdot ft$$

$$M_{pd} := \frac{p_D \cdot b \cdot x}{L} \qquad M_{pd} = 10.321 \cdot kip \cdot ft$$

$$M_{pL} := \frac{p_L \cdot b \cdot x}{L} \qquad M_{pL} = 30.357 \cdot kip \cdot ft$$

$$M_C := \max\left[1.4 \cdot (M_{wd} + M_{pd}), 1.2 \cdot (M_{wd} + M_{pd}) + 1.6 \cdot (M_{wL} + M_{pL})\right] \qquad \underline{M_C = 358.988 \cdot kip \cdot ft}$$

$$M_{Max} := \max(M_A, M_B, M_C) \qquad \underline{M_{Max} = 362.575 \cdot kip \cdot ft}$$

Assume doubly symmetric member

$$C_b := \min\left(\frac{12.5 \cdot M_{Max}}{2.5 \cdot M_{Max} + 3 \cdot M_A + 4 \cdot M_B + 3 \cdot M_C}, 3.0\right) \qquad C_b = 1.019$$

P.2 The beam shown in Figure P5.10-6 has lateral support at the ends only. The concentrated loads are live loads. Use A992 steel and select a shape. Do not check deflections. Use Cb = 1.0. Use LRFD.

Solution

Assume 100ft/ft for the self weight.

$$w_D := 0.1 \cdot \frac{kip}{ft} \qquad L := 28 \cdot ft$$

$$P_L := 20 \cdot kip \qquad a := 5 \cdot ft \qquad b := 18 \cdot ft$$

at $x := 10 \cdot ft$

$$M_{wd} := \frac{w_D \cdot x}{2} \cdot (L - x) \qquad M_{wd} = 9 \cdot kip \cdot ft$$

$$M_{pL} := \frac{P_L \cdot (L - a) + P_L \cdot b}{L} \cdot x - P_L \cdot (x - a) \qquad M_{pL} = 192.857 \cdot kip \cdot ft$$

$$M_{10} := \max\left(1.4 \cdot M_{wd}, 1.2 \cdot M_{wd} + 1.6 \cdot M_{pL}\right) \qquad M_{10} = 319.371 \cdot kip \cdot ft$$

at $x := 14 \cdot ft$

$$M_{wd} := \frac{w_D \cdot x}{2} \cdot (L - x) \qquad M_{wd} = 9.8 \cdot kip \cdot ft$$

$$M_{pL} := \frac{P_L \cdot a + P_L \cdot (L - b)}{L} \cdot x \qquad M_{pL} = 150 \cdot kip \cdot ft$$

$$M_{14} := \max\left(1.4 \cdot M_{wd}, 1.2 \cdot M_{wd} + 1.6 \cdot M_{pL}\right) \qquad M_{14} = 251.76 \cdot kip \cdot ft$$

$$M_u := \max\left(M_{10}, M_{14}\right) \qquad \underline{M_u = 319.371 \cdot kip \cdot ft}$$

Find a trial section

$$L_b := 28 \cdot ft$$

$$C_b := 1.0$$

$$\frac{M_u}{C_b} = 319.371 \cdot kip \cdot ft$$

From table 3-10

Try W18 X 76

$$\phi M_n := 364 \cdot kip \cdot ft$$

$$\phi M_p := 611 \cdot kip \cdot ft$$

for the case with Cb = 1.0

$$\phi M_n := 1.0 \cdot 364 \cdot kip \cdot ft \qquad \phi M_n = 364 \cdot kip \cdot ft \; < \; \phi M_p = 611 \cdot kip \cdot ft \quad \text{OK}$$

Check for local buckling

$$\lambda := \frac{11}{2 \cdot 0.68} \qquad \lambda = 8.088$$

$$\lambda_p := 0.38 \cdot \left(\frac{29000}{50}\right)^{0.5} \qquad \lambda_p = 9.152$$

$\lambda < \lambda p$, Compact flange

$$\lambda := \frac{h}{tw} \qquad \lambda := 37.8$$

$$\lambda_p := 3.76 \cdot \left(\frac{29000}{50}\right)^{0.5} \qquad \lambda_p = 90.553$$

$\lambda < \lambda p$, Compact web

Compact Section , OK

Thus, W18 X 76 made from 50 ksi steel with moment capacity equal to 364kip*ft for a unsupported length of 28 ft is the design section.