HW #8 Solution

P.1

Problem 5.5-3 A simply supported beam is subjected to a uniform service dead load of 1.0 kips/ft, a uniform service live load of 2.0 kips/ft, and a concentrated dead load of 40 kips. The beam is 40 feet long, and the concentrated load is located 15 feet from the left end. The beam has continuous lateral support. and A572 grade 50 steel is used. Is a W30 X 108 adequate?

Solution

$L := 40 \cdot ft$

$a := 15 \cdot ft$

$b := 25 \cdot ft$

Find Mu

$w_D := 1.0 \cdot \frac{kip}{ft}$

$w_L := 2.0 \cdot \frac{kip}{ft}$

$p_D := 40 \cdot kip$

at $x := 15 \cdot ft$

$M15_{wD} := \frac{w_D \cdot x}{2} \cdot (L - x)$ $\quad M15_{wD} = 187.5 \cdot kip \cdot ft$

$M15_{wL} := \frac{w_L \cdot x}{2} \cdot (L - x)$ $\quad M15_{wL} = 375 \cdot kip \cdot ft$

$M15_{pD} := \frac{p_D \cdot a \cdot b}{L}$ $\quad M15_{pD} = 375 \cdot kip \cdot ft$

$Mu_{15} := \max\left[1.4 \cdot \left(M15_{wD} + M15_{pD}\right), 1.2 \cdot \left(M15_{wD} + M15_{pD}\right) + 1.6 \cdot M15_{wL}\right]$

$Mu_{15} = 1.275 \times 10^3 \cdot kip \cdot ft$

at $x := 20 \cdot ft$

$M20_{wD} := \frac{w_D \cdot x}{2} \cdot (L - x)$ $\quad M20_{wD} = 200 \cdot kip \cdot ft$

$M20_{wL} := \frac{w_L \cdot x}{2} \cdot (L - x)$ $\quad M20_{wL} = 400 \cdot kip \cdot ft$

$M20_{pD} := \frac{p_D \cdot a}{L} \cdot x$ $\quad M20_{pD} = 300 \cdot kip \cdot ft$

$Mu_{20} := \max\left[1.4 \cdot \left(M20_{wD} + M20_{pD}\right), 1.2 \cdot \left(M20_{wD} + M20_{pD}\right) + 1.6 \cdot M20_{wL}\right]$

$Mu_{20} = 1.24 \times 10^3 \cdot kip \cdot ft$

$M_u := \max\left(Mu_{15}, Mu_{20}\right)$ $\quad M_u = 1.275 \times 10^3 \cdot kip \cdot ft$

From Table 3-18

W30 X 108

$I_x := 4470 \cdot in^4$

$\phi M_p := 1300 \cdot kip \cdot ft$

$\phi M_p > M_u$ OK

Check for live load deflection

$$\Delta := \frac{5 \cdot w_L \cdot L^4}{384 \cdot 29000 \cdot ksi \cdot I_x} \qquad \Delta = 0.889 \cdot in$$

$$\Delta_{limit} := \frac{L}{360} \qquad \Delta_{limit} = 1.333 \cdot in$$

$\Delta < \Delta_{limit}$ OK

Check for local buckling

$$\lambda := \frac{10.5}{2 \cdot 0.76} \qquad \lambda = 6.908$$

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

$\lambda < \lambda p$, Compact flange

$$\lambda := \frac{h}{tw} \qquad \lambda := 49.6$$

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

$\lambda < \lambda p$, Compact web

Compact Section , OK

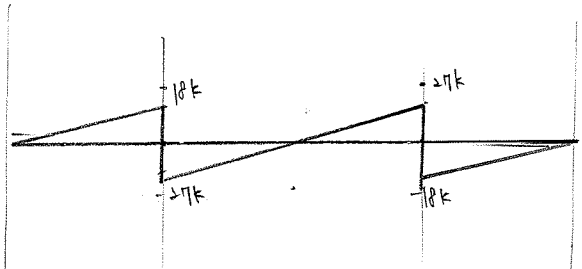
OK

P.2

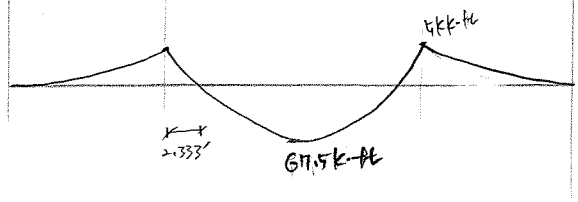
Problem 5.5-4 The beam shown in Figure P5.5-4 has continuous lasteral support of both flanges The uniform load is a service load consisting of 50% dead load and 50% live load. The dead loa includes the weight of the beam. If A992 steel is used, is a W12 X 35 adequate?

Solution

Shear by Dead and Live Load



Moment by Dead and Live Load



at $x := 15 \cdot ft$

$M_D := 67.5 \cdot kip \cdot ft$

$M_L := 67.5 \cdot kip \cdot ft$

$M_u := \max\left(1.4 \cdot M_D, 1.2 \cdot M_D + 1.6 \cdot M_L\right)$ $M_u = 189\ kip \cdot ft$

From Table 3-6

W12 X 35

$I_x := 285 \cdot in^4$

$\phi M_p := 192 \cdot kip \cdot ft$

$\phi M_p > M_u$ OK

Check for live load deflection

$\Delta := 0.3847 \cdot in$ From SAP2000 $\Delta = 0.385 \cdot in$

$\Delta_{limit} := \frac{18 \cdot ft}{360}$ $\Delta_{limit} = 0.6 \cdot in$

$\Delta < \Delta_{limit}$ OK

Check for local buckling

$$\lambda := \frac{6.56}{2 \cdot 0.52} \qquad \lambda = 6.308$$

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

$\lambda < \lambda p$, Compact flange

$$\lambda := \frac{h}{tw} \qquad \lambda := 36.2$$

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

$\lambda < \lambda p$, Compact web

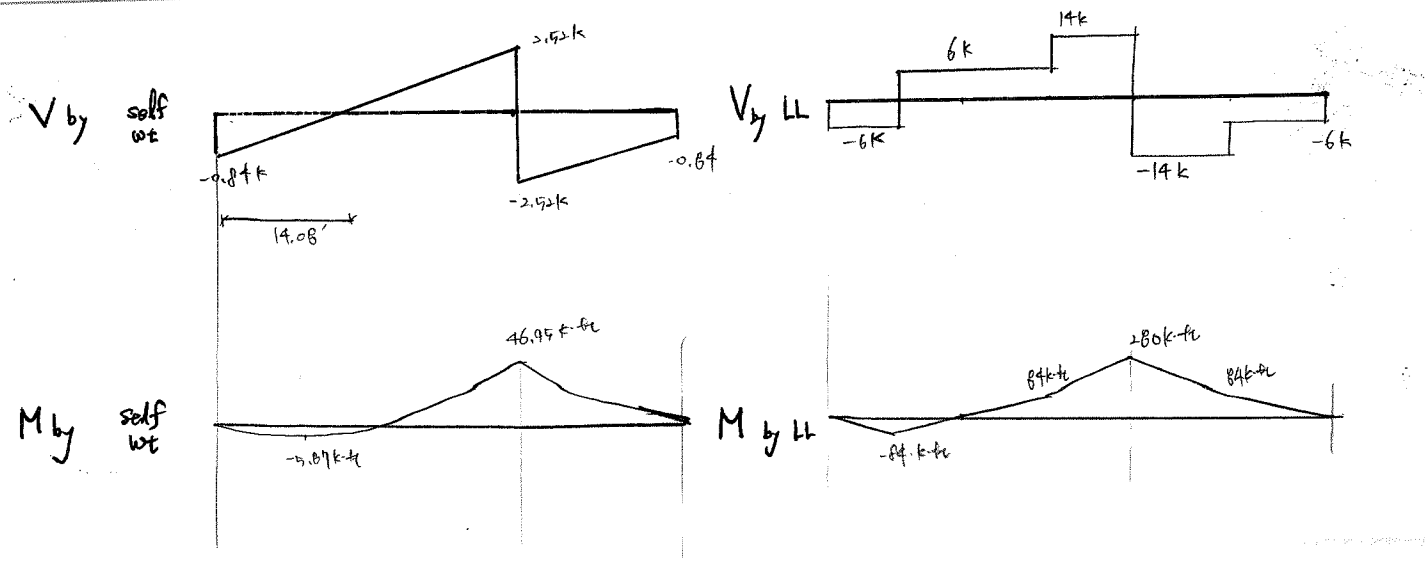
Compact Section , OK

Thus, the section is adequate

P.3

Problem 5.5-5 The beam shown in Figure P5.5-5 is a two-span beam with a pin(hinge) in the center of the left span, making the beam statically determinate. There is continuous lateral support. The concentrated loads are service loads. Determine whether a W18 X 60 of A992 stee is adequate?

Solution



at $x := 14 \cdot ft$

$M_D := 5.87 \cdot kip \cdot ft$

$M_L := 84 \cdot kip \cdot ft$

$M_{u14} := \max\left(1.4 \cdot M_D, 1.2 \cdot M_D + 1.6 \cdot M_L\right)$ $\quad M_{u14} = 141.444\ kip \cdot ft$

at $x := 28 \cdot ft$

$M_D := 0 \cdot kip \cdot ft$

$M_L := 0 \cdot kip \cdot ft$

$M_{u28} := \max\left(1.4 \cdot M_D, 1.2 \cdot M_D + 1.6 \cdot M_L\right)$ $\quad M_{u28} = 0\ kip \cdot ft$

at $x := 42 \cdot ft$

$M_D := -17.61 \cdot kip \cdot ft$

$M_L := -84 \cdot kip \cdot ft$

$M_{u42} := \min\left(1.4 \cdot M_D, 1.2 \cdot M_D + 1.6 \cdot M_L\right)$ $\quad M_{u42} = -155.532\ kip \cdot ft$

at $x := 56 \cdot ft$

$M_D := -46.95 \cdot kip \cdot ft$

$M_L := -280 \cdot kip \cdot ft$

$M_{u56} := \min\left(1.4 \cdot M_D, 1.2 \cdot M_D + 1.6 \cdot M_L\right)$ $\quad M_{u56} = -504.34\ kip \cdot ft$

at $x := 70 \cdot ft$

$M_D := -17.61 \cdot kip \cdot ft$

$M_L := -84 \cdot kip \cdot ft$

$M_{u70} := \min\left(1.4 \cdot M_D, 1.2 \cdot M_D + 1.6 \cdot M_L\right)$ $\quad M_{u70} = -155.532\ kip \cdot ft$

$M_u := \max\left(\left|M_{u14}\right|, \left|M_{u28}\right|, \left|M_{u42}\right|, \left|M_{u56}\right|, \left|M_{u70}\right|\right)$ $\quad M_u = 504.34\ kip \cdot ft$

From Table 3-6

W18 X 60

$I_x := 285 \cdot in^4$

$\phi M_p := 461 \cdot kip \cdot ft$

$\phi M_p < M_u$ NG