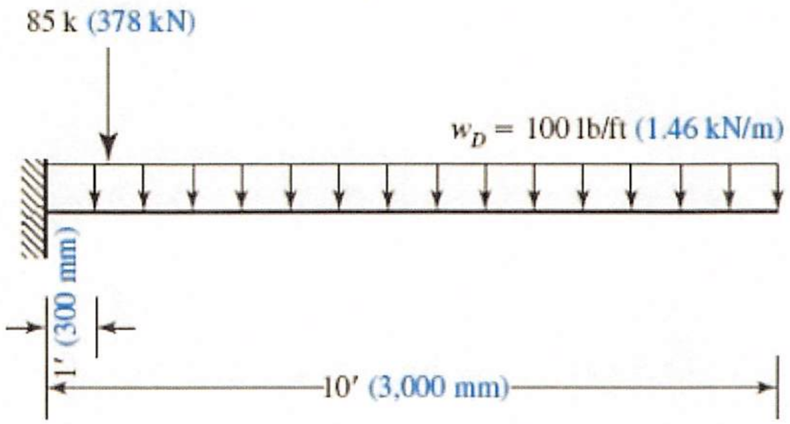
1/4

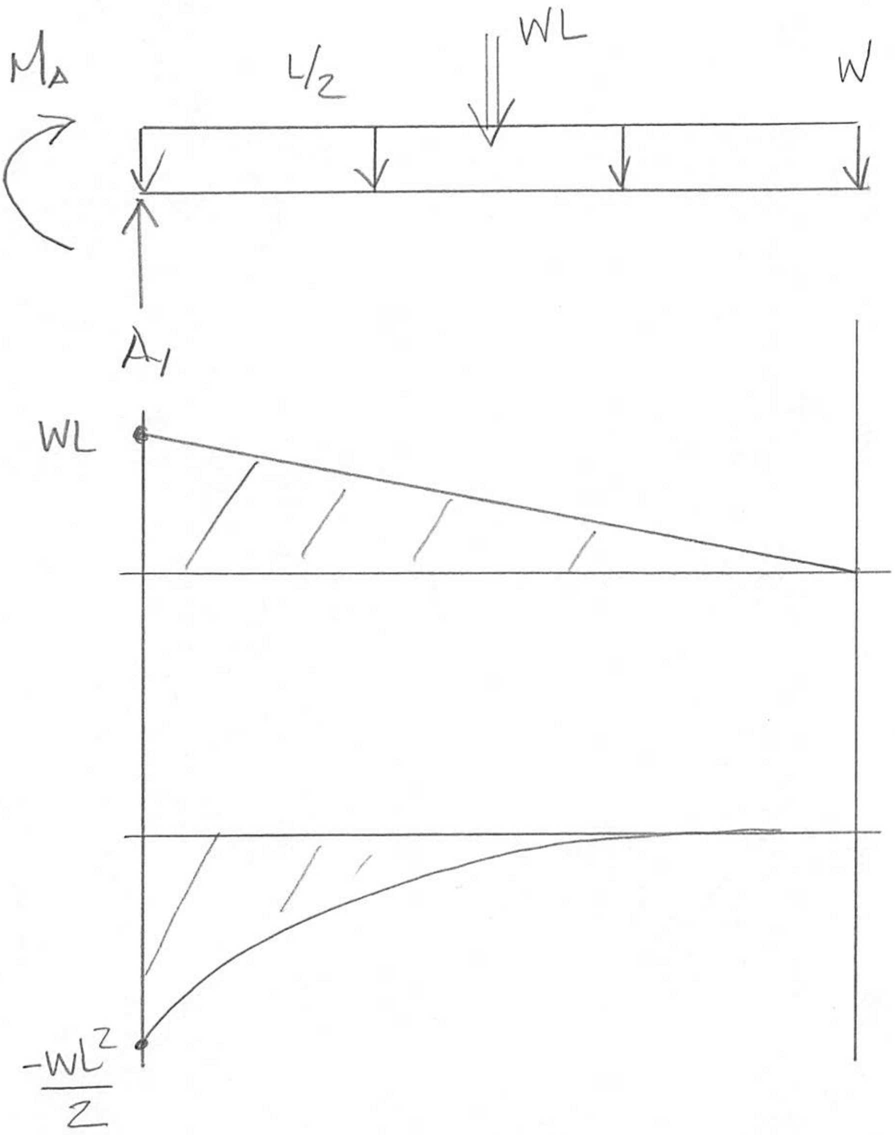
5.8-4 The cantilever beam shown in Figure P5.8-4 is a W16 × 45(W410 × 67) of A992 steel ($F_y = 50$ ksi(345 MPa)) . There is no lateral support other than at the fixed end. Use an unbraced length equal to the span length and determine whether the beam is adequate. The uniform load is a service dead load that includes the beam weight, and the concentrated load is a service live load.



CANTILEVER $C_b = 1.0$

AISC F-1 (16.1-52)

NOTE (c)



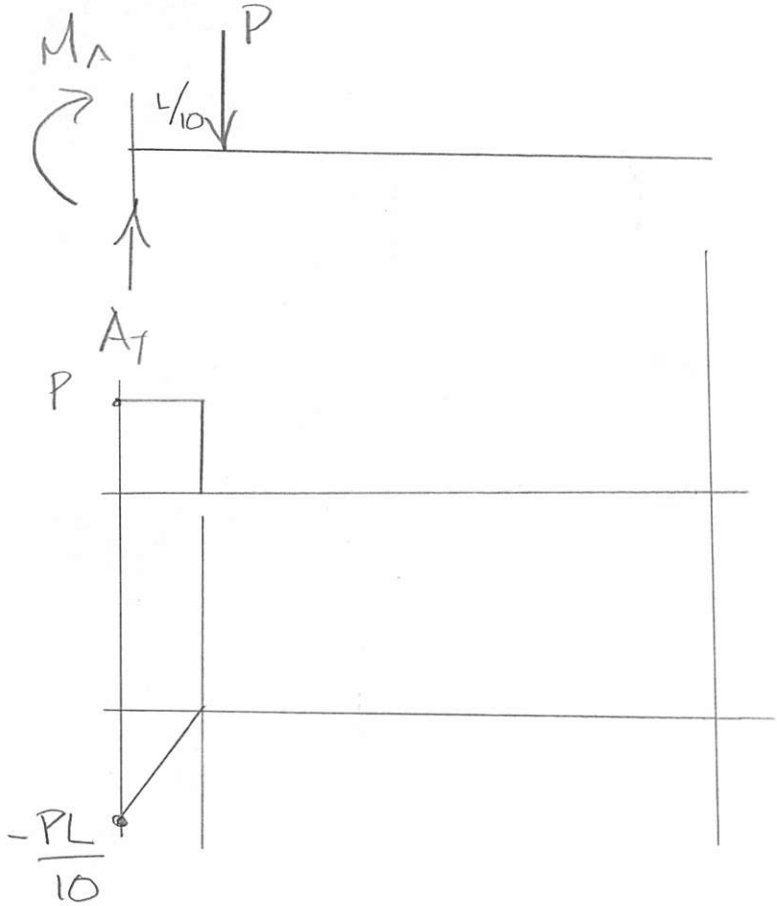
$\circlearrowleft + \sum M_A = 0 = +WL\left(\frac{L}{2}\right) + M$

$M = \frac{-WL^2}{2}$

$+\uparrow \sum F_y = 0 = A_y - WL$

$A_y = WL$

5.8-4



$M_A = -\frac{PL}{10}$ $A_Y = P$

W16X45
* FROM TABLE 1-1 (1-22)
$Z_x = 82.3\,IN^3$ $S_x = 72.7\,IN^3$
$h/t_w = 41.1$ $d = 16.1$
$t_w = 0.345\,IN$

FROM "Z TABLE" TABLE 3-2 (3-25)

$M_p/\Omega_b = 205\,kft$ $\phi_b M_p = 309\,kft$

$L_p = 5.55\,ft$ $L_r = 16.5\,ft$ $L_b = 10\,ft > L_p$

* $L_p < L_b < L_r$

$$M_n = C_b\left[M_p - (M_p - 0.7S_x F_y)\left[\frac{L_b - L_p}{L_r - L_p}\right]\right] \le M_p$$

$M_p = F_y Z_x = 50ksi(82.3\,IN^3) = 4{,}115\,k\cdot in = 342.92\,kft$

$0.7F_y S_x = 0.7(50ksi)(72.7\,IN^3) = 2{,}544.5\,k\cdot IN$

5.8-4

$$M_n = \left[4115 - (4115 - 2544.5)\left[\frac{10 - 5.55}{16.5 - 5.55}\right]\right] = 3{,}476.76\ k\cdot in$$

$$= \underline{289.73\ kft}$$

LRFD $W = 1.2W_D = 1.2(0.1\ k/ft) = 0.12\ k/ft$

$P = 1.6P_L = 1.6(85k) = 136^k$

$$M_U = M_{MAX} = \frac{WL^2}{2} + \frac{PL}{10} = \frac{(0.12\ k/ft)(10ft)^2}{2} + \frac{136^k(10ft)}{10}$$

$$= \underline{142\ kft}$$

$\phi_b M_n = 0.9(289.73\ kft) = 260.75\ kft > M_U$ **o.k.**

ASD $W = W_D \quad P = P_L$

$$M_U = M_{MAX} = \frac{(0.1k/ft)(10ft)^2}{2} + \frac{85^k(10ft)}{10} = 90^k$$

$$\frac{M_n}{\Omega_b} = \frac{289.73\ kft}{1.67} = 173.84\ kft > 90^k$$ **o.k.**

CHECK SHEAR

$$\frac{h}{t_w} = 41.1 < 2.24\sqrt{E/F_Y} = 53.95$$

$C_{v1} = 1.0$

$\phi_v = 1.0$

$\Omega_v = 1.5$

$$V_n = 0.6 F_y A_W C_{v1} = 0.6(50\text{ksi})(16.1\text{IN})(0.345\text{IN})(1.0)$$
$$= 166.6\text{K}$$

<u>LRFD</u>

$$\phi_v V_n = V_n = 166.6\text{K}$$

$$V_u = WL + P = (1.2 W_D \text{K/ft})(10\text{ft}) + 1.6 P_L$$
$$= (0.12\text{K/ft})(10\text{ft}) + 1.6(85\text{K}) = 137.2^k$$

$$\phi_v V_n > V_u \qquad \text{o.k.}$$

<u>ASD</u>

$$\frac{V_n}{\Omega_v} = \frac{166.6\text{k}}{1.5} = 111.1\text{k}$$

$$V_u = 0.1\text{K/ft}(10\text{ft}) + 85^k = 86^k$$

$$V_u < \frac{V_n}{\Omega_v} \qquad \text{o.k.}$$