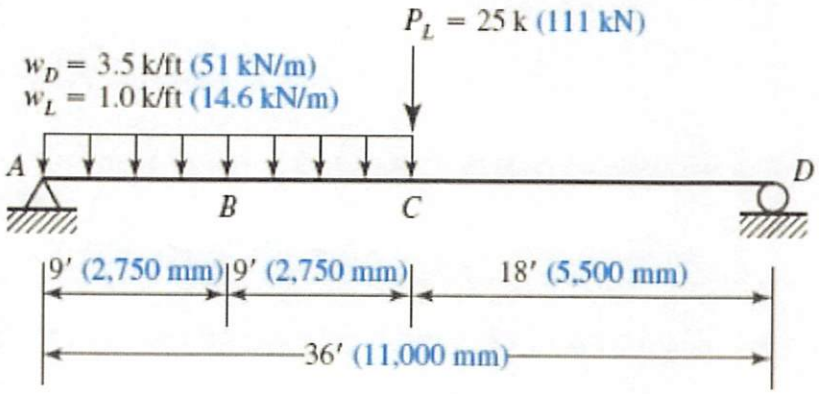
5.5-16 The beam shown in Figure P5.5-16 is laterally braced at A, B, C, and D. Is a W14 × 132(W360 × 196) adequate for $F_y = 50$ ksi(345 MPa)?



$WT_{BEAM} = 0.132$ k/ft

FROM TABLE 1-1 (1-24)

$d = 14.7$ in $\quad t_f = 1.03$ in $\quad \frac{b_f}{2t_f} = 7.15 \quad \frac{h}{t_w} = 17.7 \quad I_x = 1530$ in^4

$S_x = 209$ in^3 $\quad Z_x = 234$ in^3 $\quad I_y = 548$ in^4 $\quad r_y = 3.76$ in

$r_{ts} = 4.23$ in $\quad h_o = 13.7$ in $\quad J = 12.3$ in^4 $\quad C_w = 25{,}500$ in^6

$W_{AC} = 1.2(3.632) + 1.6(1\text{ k/ft}) = 5.958$ k/ft

$W_{CD} = 1.2(0.132\text{ k/ft}) = 0.158$ k/ft

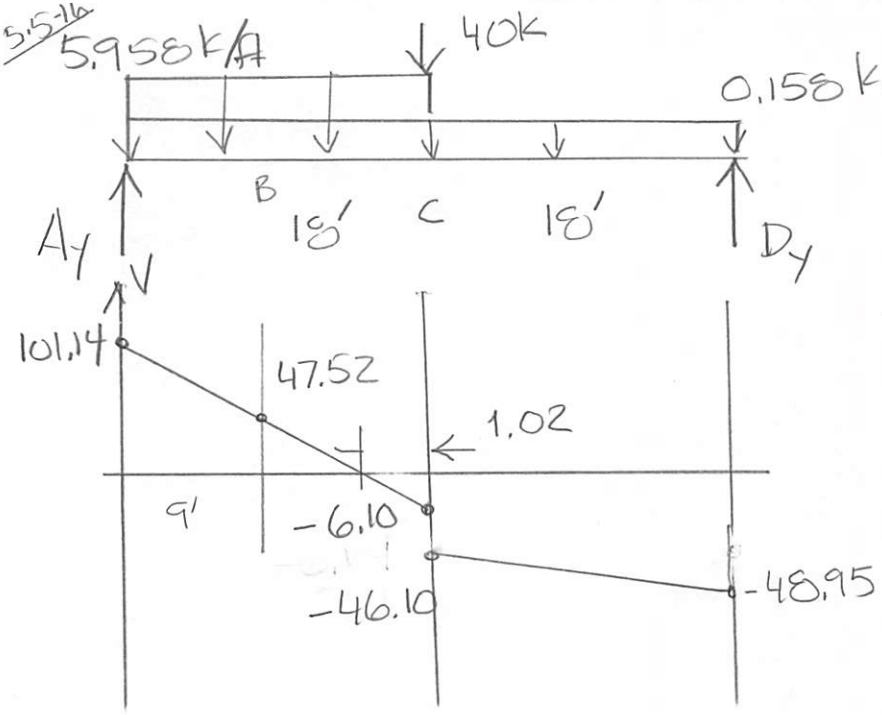
$P = 1.6(25\text{k}) = 40^{\text{k}}$

COMPACT?

FLANGE $\lambda_p = 0.38\sqrt{\frac{29{,}000}{50}} = 9.15 > \frac{b_f}{2t_f}$ COMPACT!

WEB $\lambda_p = 3.76\sqrt{\frac{29{,}000}{50}} = 90.55 > \frac{h}{t_w}$ COMPACT!

5.5-16



$$\curvearrowleft \sum M_D = 0 = 0.158\,k/ft(36')(18') + 5.8\,k/ft(18')(27') + 40^k(18') - A_1(36')$$

$$A_y = 101.14^k$$

$$+\uparrow \sum F_y = 0 = A_y + D_y - 40^k - 0.158(36) - 5.8(18')$$

$$D_y = 48.95^k$$

$M(x=9) = 668.96\,k\text{-}ft$

$M_{MAX}(x=16.98) = 858\,k\text{-}ft$

$M(x=18) = 855.45\,k\text{-}ft$

* CHECK SEGMENT BC

$$L_b = 9\,ft(12\,in/ft) = 108\,in$$

$$L_p = 1.76 r_y \sqrt{E/F_y} = 1.76(3.76in)\sqrt{\frac{29{,}000}{50}} = 159.37 > L_b$$

$$L_r = 1.95(4.23)\frac{29{,}000}{0.7(50)}\sqrt{\left(\frac{J_c}{S_x h_o}\right) + \sqrt{\left(\frac{J_c}{S_x h_o}\right)^2 + 6.76\left(\frac{0.7F_y}{E}\right)^2}}$$

$$= 670.20\,in$$

$L_b < L_p$ * $M_n = M_p$

$= F_y Z_x = 50ksi(234in^3) = 11{,}700\,k\text{-}in$

$\phi_b M_n = 0.9(11{,}700\,k\cdot in) = 10{,}530\,k\text{-}in$

$= 877.5\,k\cdot ft > M_{MAX}$ ✓ O.K.

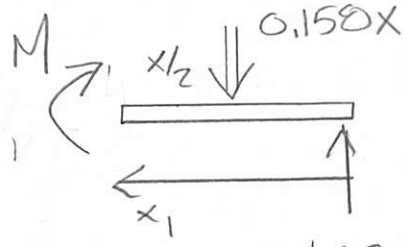
5.5-16

* CHECK SEGMENT CD $\quad L_b = 18\text{ft}\,(12\text{in/ft}) = 216\text{in}$

$L_b > L_p \Longrightarrow$ USE EQN F2-2

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

COMPUTE C_b



$M_A\,(x = 22.5) = 646.4\text{ kft}$

$M_B\,(x = 27) = 434.2\text{kft}$

$M_C\,(x = 31.5) = 220.1\text{kft}$

$M = -\dfrac{0.150x_1^2}{2} + 48.95x_1$

$M_{MAX}\,(x = 18) = 855.5\text{kft}$

$$C_b = \frac{12.5(855.5)}{2.5(855.5) + 3(646.4) + 4(434.2) + 3(220.1)} = 1.652$$

$$M_n = 1.652\left[11{,}700 - (11{,}700 - 0.7(50)(209)\left(\frac{216 - 159.4}{670.2 - 159.4}\right)\right]$$

$= 18{,}525.7\text{ kin} = 1{,}543\text{kft} > M_p \;\therefore\; M_n = M_p = 975\text{kft}$

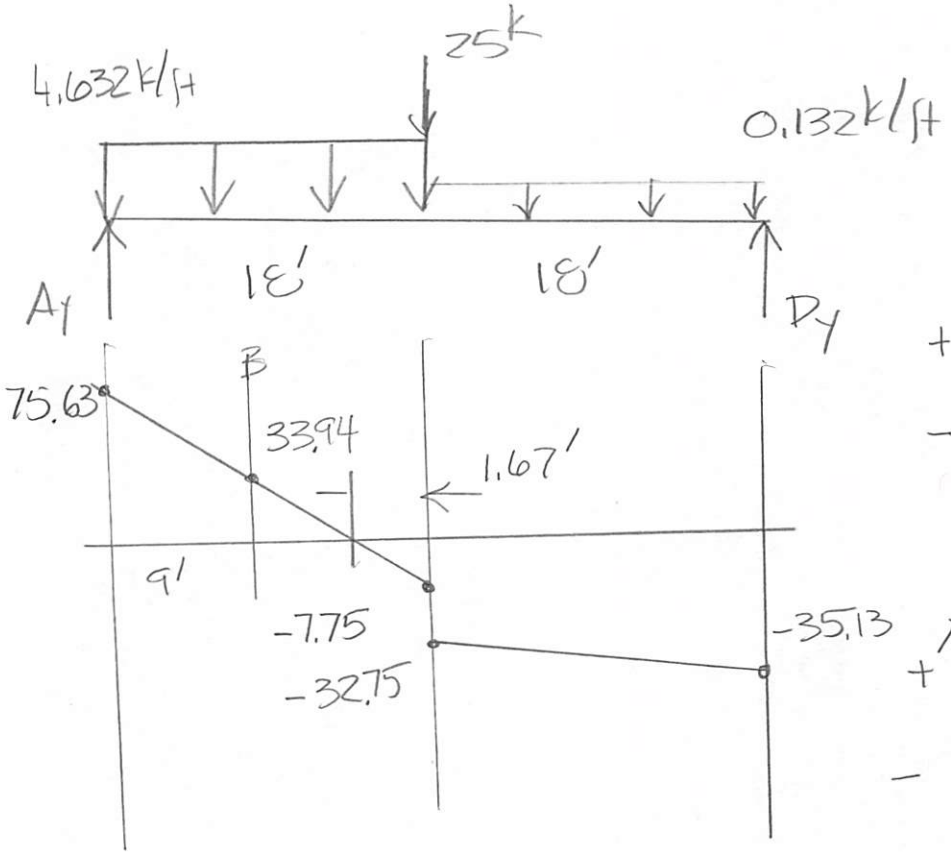
$\phi_b M_n = 0.9(975\text{k·ft}) = 877.5\text{kft} > 855.5\text{kft}$ o.k.

b) ASD

$W_{AC} = D+L = 3.5\,k/ft + 1\,k/ft + 0.132\,k/ft = 4.632\,k/ft$

$W_{CD} = D = 0.132\,k/ft$

$P = D+L = 25^k$



$+\circlearrowleft \sum M_D = 0 = 25^k(18') + 0.132(18)(9) + 4.632(18)(27) - A_y(36)$

$A_y = 75.63^k$

$+\uparrow \sum F_y = 0 = A_y + D_y - 25k - 4.632(18) - 0.132(18)$

$D_y = 35.13^k$

SECTION BC

$M_{MAX}\,(x = 16.33') = 617.5\,k\text{-}ft$

$L_b = 9\,ft = 9\,ft\,(12\,in/ft) = 108\,IN$

$L_p = 159.37\,in > L_b \Longrightarrow M_n = M_p = F_y Z_x$

$= (50\,ksi)(234\,IN^3)$

$= 11{,}700\,k\text{-}in$

$= 975\,k\text{-}ft$

5.5-16

$$\frac{M_n}{\Omega_b} = \frac{975\,k\text{-}ft}{1.67} = 583.8\,k\text{-}ft < 617.5\,k\text{-}ft \quad \underline{\text{N.G.}}$$