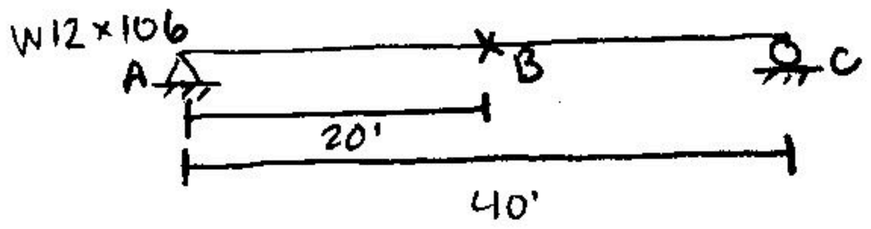
a) $W_d = 1\ k/ft \quad W_L = 1.5\ k/ft$



$$M_u = \frac{(3.6)(40)^2}{8} = 720\ kip\cdot ft$$

$W_u = 1.2W_D + 1.6W_L = 3.6\ k/ft$

$L_p = 1.76\, r_y \times \sqrt{E/F_y} = 1.76(3.11\ in)\sqrt{29000/50} = 131.8\ in = 11.0\ ft$ CHECKS w/ TABLE 3-6

$$L_r = 1.95 r_{ts} \frac{E}{0.7F_y}\sqrt{\frac{J_c}{S_x h_o}}\sqrt{1+\sqrt{1+6.76\left(\frac{0.7F_y}{E}\frac{S_x}{J}\frac{h_o}{c}\right)^2}}$$

$$= 1.95(3.52\ in)\frac{29000\ ksi}{0.7(50\ ksi)}\sqrt{\frac{9.13in^4(1)}{(145\ in^3)(11.9\ in)}}\sqrt{1+\sqrt{1+6.76\left(\frac{0.7(50\ ksi)}{29000\ ksi}\frac{(145in^3)}{9.13in^4}\frac{(11.9in)}{1}\right)^2}}$$

$L_r = 608.4\ in = 50.7\ ft$ CHECKS w/ TABLE 3-6

$L_p < L_b = 20\ ft \leq L_r \therefore M_n = C_b\left[M_p - (M_p - 0.7F_y S_x)\left(\frac{L_b - L_p}{L_r - L_p}\right)\right] \leq M_p$

$$C_b = \frac{12.5\,M_{max}}{2.5M_{max} + 3M_A + 4M_B + 3M_C}\,R_m \leq 3.0 \quad \text{where } R_m = 1.0$$

$M_{max} = 500\ kip\cdot ft$
$M(x) = 50x - 2.5x^2/2$
$M_A(x = 5ft) = 218.75\ kip\cdot ft$
$M_B(x = 10ft) = 375\ kip\cdot ft$
$M_C(x = 15ft) = 468.75\ kip\cdot ft$

$$C_b = \frac{12.5(500)}{2.5(500) + 3(218.75) + 4(375) + 3(468.75)}(1.0)$$

$C_b = 1.299$

$M_p = F_y Z_x = (50\ ksi)(164\ in^3) = 683.3\ kip\cdot ft$

$$M_n = 1.299\left[683.3 - (683.3 - 0.7(50\ ksi)(145in^3)(1ft/12in)\left(\frac{20ft - 11.0ft}{50.7ft - 11.0ft}\right)\right]$$

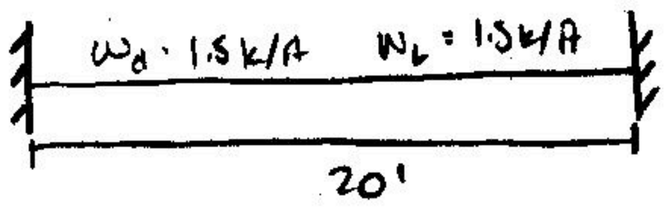
$M_n = 810.9\ kip\cdot ft \rightarrow \phi M_n = 0.9(810.9\ kip\cdot ft) = 730\ kip\cdot ft$

$\phi M_p = 0.9(683.3\ kip\cdot ft) = 615\ kip\cdot ft$ ← GOVERNS $\quad \phi M_n = \phi M_p$

$\phi M_n = 615\ kip\cdot ft < M_u = 720\ kip\cdot ft$

NOT ADEQUATE

b)



W14 x 45

$w_u = 1.2\,w_d + 1.6\,w_L = 4.2$ k/ft

$L_p = 1.76\,r_y\sqrt{E/F_y} = 1.76(1.57\text{ in})\sqrt{29000/50} = 66.5$ in $= 5.55$ ft

$$L_r = 1.95(1.88)\frac{29000}{0.7(50)}\sqrt{\frac{1.11(1)}{(72.7)(15.6)}}\sqrt{1+\sqrt{6.76\left(\frac{0.7(50)(72.7)(15.6)}{(29000)(1.11)}\right)^2}} = 198.4\text{ in} = 16.5\text{ ft}$$

$L_b > L_r > L_p \quad \therefore \quad M_n = F_{cr}S_x \le M_p$

$$F_{cr} = \frac{C_b\pi^2 E}{\left(\frac{L_b}{r_{ts}}\right)^2}\sqrt{1+0.078\frac{Jc}{S_x h_o}\left(\frac{L_b}{r_{ts}}\right)^2}$$

$M(x) = \frac{w}{12}(6Lx - L^2 - 6x^2)$

$M_{max}(x=0) = \frac{(3)}{12}[6(20)(0) - (20)^2 - 6(0)^2] = 100$ ft·kip

$M_A(x=5) = \frac{(3)}{12}[6(20)(5) - (20)^2 - 6(5)^2] = 12.5$ ft·kip

$M_B(x=10) = \frac{3}{12}[6(20)(10) - (20)^2 - 6(10)^2] = 50$ ft·kip

$M_C(x=15) = M(x=5)$ due to symmetry $= 12.5$ ft·kip

$M(x=20) = M(x=0)$ due to symmetry $= 100$ ft·kip

$$C_b = \frac{12.5(100\text{ ft·kip})}{2.5(100) + 3(12.5) + 4(50) + 3(12.5)} = 2.38$$

$$F_{cr} = \frac{2.38\pi^2(29000\text{ ksi})}{\left(\frac{20\cdot 12}{1.88}\right)^2}\sqrt{1+0.078\frac{(1.11)(1)}{(72.7)(15.6)}\left(\frac{20\cdot 12}{1.88}\right)^2} = 62.6\text{ ksi}$$

$M_n = (62.6\text{ ksi})(72.7\text{ in}^3) = 4551$ kip·in $= 379$ kip·ft

$M_p = F_y Z_x = (50\text{ ksi})(82.3\text{ in}^3) = 4115$ kip·in $= 343$ kip·ft ← GOVERNS

$M_p = M_n$

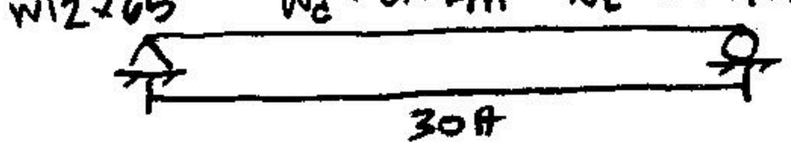
$\phi M_n = (0.90)(343\text{ kip·ft}) = 309$ kip·ft

$M_u = \frac{(41.2)(20)^2}{12} = 140$ kip·ft

$\phi M_n = 309$ kip·ft $> M_u = 140$ kip·ft

ADEQUATE

C]



I TRIED TO USE DESIGN TABLES FOR THIS PART, BUT I DON'T THINK I QUITE GET THE HANG OF IT.

$W_u = 1.2W_d + 1.6W_L = 2.24$ k/ft

$L_p = 11.9$ ft
$L_r = 35.1$ ft
$L_p < L_b = 30$ ft $\leq L_r$ $\therefore M_n = C_b[M_p - (M_p - 0.7F_yS_x)\left(\frac{L_b - L_p}{L_r - L_p}\right)] \leq M_p$

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

$M_{max} = \frac{wl^2}{8} = \frac{(1.6\text{ k/ft})(30\text{ ft})^2}{8} = 180$ k·ft

$M_A(x = 7.5) = \frac{wx}{2}(l - x) = \frac{(1.6)(7.5)}{2}(30 - 7.5) = 135$ k·ft

$M_B(x = 15) = M_{max} = 180$ k·ft
$M_C(x = 22.5) = M(x = 7.5)$ due to symmetry $= 135$ k·ft

$$C_b = \frac{12.5(180)}{2.5(180) + 3(135) + 4(180) + 3(135)} = 1.14$$

C

$M_p = \frac{356}{0.9} = 395.6$ kip·ft

$M_n = 1.14\left[395.6 - (395.6 - 0.7(50)(87.9)(1/12))\left(\frac{30 - 11.9}{35.1 - 11.9}\right)\right] = 327.2$ kip·ft

BECAUSE SHAPE IS NONCOMPACT FOR FLEXURE WE NEED TO CHECK EQN. F3-1

$M_n = [M_p - (M_p - 0.7F_yS_x)\left(\frac{\lambda - \lambda_{pf}}{\lambda_{rf} - \lambda_{pf}}\right)]$

$\lambda = \frac{b_f}{2t_f} = \frac{12\text{ in}}{2(0.605\text{ in})} = 9.917$ $\lambda_{pf} = 0.38\sqrt{E/F_y} = 9.152$ $\lambda_{rf} = 1.0\sqrt{E/F_y} = 24.083$

$M_n = [395.6 - (395.6 - 0.7(50)(87.9)(1/12))\left(\frac{9.917 - 9.152}{24.083 - 9.152}\right)] = 388.5$ kip·ft

M_n FOR LATERAL TORSIONAL BUCKLING CONTROLS

$\phi M_n = 0.9(327.2\text{ kip·ft}) = 294.5$ kip·ft ← GOVERNS

$\phi M_p = 356$ kip·ft

$M_u = \frac{(2.24)(30)^2}{8} = 252$ kip·ft

$\phi M_n = 294.5$ kip·ft $> M_u = 252$ kip·ft ADEQUATE

a) M_u : 850 ft·kip L_b = 20 ft

W24×104

b) M_u : 1700 k·ft L_b = 24 ft

W30×173

c) M_u = 600 k·ft L_b = 12 ft

W21×76

d) M_u = 2700 k·ft L_b = 50 ft

W30×326

USED TABLE 3-10 TO FIND MOST EFFICIENT W SECTION