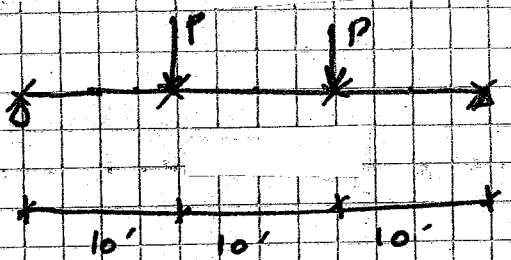
17. $P_D = 12$

$P_L = 18$



Assume $C_b = 1.0$

a/ LRFD: $P_u = 1.2(12) + 1.6(18) = 43.2\ K$

$\Rightarrow M_u = P_u \times 10 = 432\ ft.K$

try: W21x55:

$\phi M_n = 473$, $L_p = 6.11\ ft$ $\quad BF = 16.3$

$L_2 = 17.4\ ft$

$L_b = 10' > L_p \qquad L_b = 10 < L_2$

$\Rightarrow \phi M_n = \phi M_p - BF(L_b - L_p) \leq \phi M_p$

$= 473 - 16.3(10 - 6.11) < 473$

$= 409.6\ ft.K$

$M_u = 432\ ft > 409.6\ ft \Rightarrow$ W21x55 Not good

try W24x55

$\phi M_p = 503$, $L_p = 4.73 > L_b$ $\quad BF = 22.2$

$L_2 = 13.9 < L_b$

$\Rightarrow \phi M_n = \phi M_p - BF(L_b - L_p)$

$= 503 - 22.2(10 - 4.73) = 386.0\ ft.K < M_u = 409$

$\Rightarrow$ Not good

Try W 21×62 : $\phi M_p = 540$ $L_p = 6.25 < L_b$ $BF = 17.4$

$L_2 = 18.1 > L_b$

$\Rightarrow \phi M_n = \phi M_p - BF(L_b - L_p)$

$= 540 - 17.4(10 - 6.25) = 474.75$ ft.k > 432 ft.k

$\Rightarrow$ OK

b) ASD: $P_a = 12 + 18 = 30$ k

$M_a = 30 \times 10 = 300$ ft.k

Try: W 24×55 : $\frac{M_p}{\Omega} = 334$, $L_p = 4.73$ $BF = 14.8$

$L_2 = 13.9$

$\frac{M_a}{\Omega} = \frac{M_p}{\Omega} - BF(L_b - L_p)$

$= 334 - 14.8(10 - 4.73) = 256 < 300 \Rightarrow$ not good

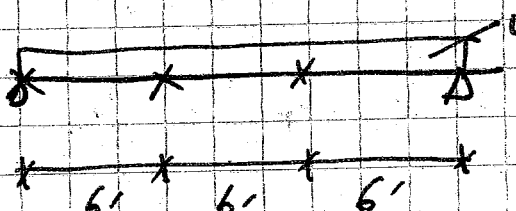
Try W 21×62 : $\frac{M_p}{\Omega} = 359$ $L_p = 6.25$ $BF = 11.6$

$L_2 = 18.1$

$\frac{M_a}{\Omega} = \frac{M_p}{\Omega} - BF(L_b - L_p)$

$= 359 - 11.6(10 - 6.25) = 315.5 > 300 \Rightarrow$ OK

18.



$w_D = 1.4$ k/ft

$w_L = 2.3$ k/ft

$C_b = 1.45$ 1.01 1.45 (TABLE 3-1)

a) LRFD: $w_u = 1.2(1.4) + 1.6(2.3) = 5.36$ K/ft

$\Rightarrow M_u = 5.36 \times \frac{18^2}{8} = 217.1$ ft.K

$L_b = 6'$

Try W18x35, $\phi M_p = 249$ $L_p = 4.31 < L_b$ $BF = 12.1$

$L_2 = 12.4 > L_b$

$\phi M_n = C_b \left[\phi M_p - BF(L_b - L_p) \right] \leq \phi M_p$

$= 1.01 \left[249 - 12.1 (6 - 4.31) \right] \leq 249$

$= 230.84$ ft-k

$\phi M_n > M_u = 217.1 \Rightarrow$ OK.

(we can go in table 3-10, with $L_b = 6'$

$\Rightarrow$ W18x35 is good)

b) ASD: $w_a = 1.4 + 2.3 = 3.7$ K/ft

$M_a = 3.7 \times \frac{18^2}{8} = 149.85$ ft.K

Try W18x35, $\frac{M_p}{\Omega} = 166$ $L_p = 4.31 < L_b$ $BF = 8.07$

$L_2 = 12.4 > L_b$

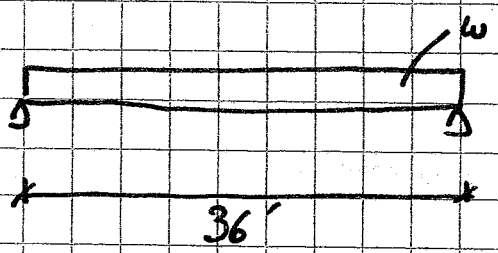
$\frac{M_n}{\Omega} = C_b \left[\frac{M_p}{\Omega} - BF (L_b - L_p) \right] \leq \frac{M_p}{\Omega}$

$= 1.01 \left[166 - 8.07 (6 - 4.31) \right] \leq 166$

$= 153.89$ ft.K > 149.85 ft.K $\Rightarrow$ OK

from table 3-10, W18x35 is OK.

19. W18x60, A992,



When to put lateral supports to sustain

$M_u = 435$ ft.k

$M_a = 290$ ft.k ?

a) LRFD. $M_u = 435$ ft.k.

W18x60 : $\phi M_p = 461$ ft.k $L_p = 5.93'$ $BF = 14.5$

$\phi M_2 = 284$ ft.k $L_2 = 18.2'$

$M_u < \phi M_p$ but $M_u > \phi M_2$

$\Rightarrow M_u \geq \phi M_n = C_b \left[\phi M_p - BF (L_b - L_p) \right] \leq \phi M_p$

Let's assum $C_b = 1.0$

$\Rightarrow M_u = \phi M_n = \phi M_p - BF (L_b - L_p)$

$\Rightarrow 435 = 461 - 14.5 (L_b - 5.93)$

$\Rightarrow 14.5 (L_b - 5.93) = 461 - 435 = 26$

$\Rightarrow L_b = \frac{26}{14.5} + 5.93 = 7.72'$

$\Rightarrow$ lateral support @ fifth of the length $\Rightarrow L_b = 7.2'$

& $C_b = 1.0$.

$\Rightarrow \phi M_n = 461 - 14.5 (7.2 - 5.93) = 442.6 > 435$ ft.k

$\Rightarrow$ OK

b/ ASD: $M_a = 290$ ft.k

W18x60: $\frac{M_p}{\Omega} = 307$ ft.k ; $\frac{M_2}{\Omega} = 189$ ft.k

$\Rightarrow \frac{M_2}{\Omega} < M_a < \frac{M_p}{\Omega} \Rightarrow L_p < L_b < L_2$

$L_p = 5.93$, $L_2 = 18.2$, $BF = 9.64$

Let's assume $C_b = 1.0$

$\Rightarrow M_a \leq \frac{M_n}{\Omega} = C_b \left[\frac{M_p}{\Omega} - BF(L_b - L_p) \right]$

$\Rightarrow 290 = 307 - 9.64(L_b - 5.93)$

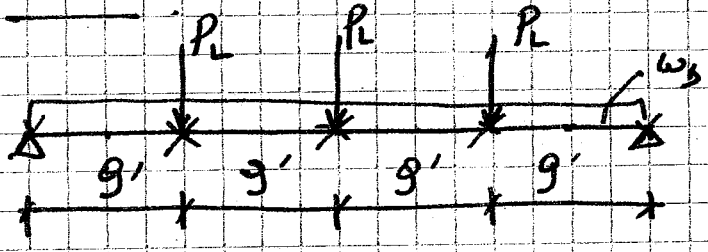
$\Rightarrow L_b = 7.7'$

$\Rightarrow$ Lateral support @ fifth L, $L_b = 7.2'$, $C_b = 1.0$

$\Rightarrow M_a \leq \frac{M_n}{\Omega} = 1.0 \left[307 - 9.64(7.2 - 5.93) \right]$

$\Rightarrow 290 < 294.76$ ft.k $\Rightarrow$ OK

20.



$w_D = 1.7$ K/ft

$P_L = 15$ K

$C_b = 1.11$ (for concentrated loads, approximately for actual case)

a) LRFD: $w_u = 1.2\ (1.7) = 2.04$ K/ft

$P_u = 1.6\ (15) = 24$ K

$$\Rightarrow M_u = w_u \frac{L^2}{8} + P_u \cdot 9 + P_u \frac{L}{4} \quad \text{k}$$

$$= 2.04 \times \frac{36^2}{8} + 24 \times 9 + 24 \times \frac{36}{4}$$

$$= 330.48 + 216 + 216$$

$$= 762.48 \text{ ft.k}$$

$L_b = 9'$

from table 3-10, try W24×84

$$\Rightarrow M_g = \frac{84}{1000} \times \frac{36^2}{8} = 13.61 \text{ ft.k}$$

$$\Rightarrow M_u = 762.48 + 1.2\,(13.61) = 778.81 \text{ ft.k}$$

$$\phi M_n = C_b \left[\phi M_p - BF (L_b - L_p) \right] \leq \phi M_p$$

$$= 1.11 \left[840 - 24.3 (9 - 6.89) \right] \leq 840$$

$$= 875.49 \not< 840$$

$$\phi M_n = 840 \text{ ft.k} \Rightarrow \underline{\text{OK}}$$

THIS CHECK NOT NECESSARY SINCE W24×84 WORKS WITHOUT C_b

Check deflection under live load:

$$\delta = \frac{Pl^3}{48EI} + \frac{Pa}{24EI}\left(3l^2 - 4a^2\right) \leq \frac{36 \times 12}{360} = 1.2"$$

$I = 2370 \text{ in}^4$, $E = 29000 \text{ ksi}$

$$\Rightarrow \delta = \frac{15 \times (36 \times 12)^3}{48 \times 29000 \times 2370} + \frac{15 \times 9 \times 12}{24 \times 29000 \times 2370}\left(3 \times (36 \times 12)^2 - 4 \times (9 \times 12)^2\right)$$

$$= 0.367 + 0.504 = 0.871" < 1.2" \quad \therefore \text{ OK}$$

b) ASD

$w_a = 1.7$ K/Ft

$P_a = 15$ K

$M_a = 1.7 \times \frac{36^2}{8} + 15 \times 9 + 15 \times \frac{36}{4} = 545.4$ Ft-K

TABLE 3-10 $L_b = 9'$, W27×84

Self weight

$$M = \frac{84}{1000} \times \frac{36^2}{8} = 13.6 \text{ ft-K}$$

$M_a = 545.4 + 13.6 = 559$ ft-K

W27×84 STIL GOOD $I = 2850$ in^4

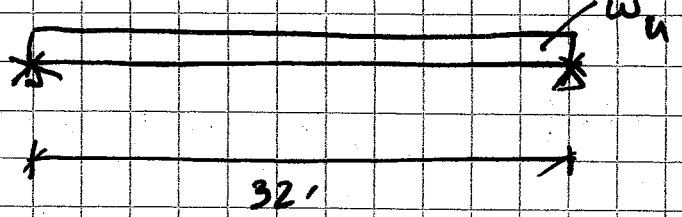
$$\delta = \frac{15 \times (36 \times 12)^3}{48 \times 29000 \times 2850} + \frac{15 \times 9 \times 12}{24 \times 29000 \times 2850}\left(3 \times (36 \times 12)^3 - 4 \times (9 \times 12)^3\right)$$

$= 0.305 + 0.419 = 0.724'' < 1.2''$ ∴ OK

21.

$w_D = 2.3$ K/ft

$w_L = 3.1$ K/ft



a) LRFD:

$C_b = 1.14$

$w_u = 1.2(2.3) + 1.6(3.1) = 7.72$ K/ft

$M_u = 7.72 \times \frac{32^2}{8} = 988.16$ ft.K

$L_b = 32'$

Enter table 3-10 with $\frac{M_u}{C_b} = \frac{988.16}{1.14} = 867$ ft.K

try W 24 x 146

$M_g = \frac{146}{1000} \times \frac{32^2}{8} = 18.69$ ft.K

$\Rightarrow M_u = 988.16 + 1.2 \times (18.69) = 1010.6$ ft.K

W24x146 : $\phi M_p = 1570$, $L_p = 10.6$ $L_b = 32$

$L_r = 33.7$ $BF = 25.8$

$$\phi M_n = C_b \left[\phi M_p - BF(L_b - L_p)\right] \leq \phi M_p$$

$$= 1.14 \left[1570 - 25.8(32 - 10.6)\right] \leq 1570$$

$$= 1.14 \times 1017.88 = 1160.38 < 1570$$

$\Rightarrow M_u < \phi M_n \Rightarrow$ OK.

Check Shear:

$$V_u = 7.72 \times \frac{32}{2} + \frac{146}{1000} \times \frac{32}{2} \times 1.2 = 126.32\ K$$

$$\phi V_n = 482\ K > V_u \Rightarrow \underline{OK}$$

Check deflection:

$$\delta_L = \frac{5}{384} \frac{w_L L^4}{EI} \leq \frac{1}{360} \times L = 1.07''$$

$$= \frac{5}{384} \times \frac{3.1 \times 32^4 \times 12^3}{29000 \times 4580} = 0.55'' < 1.07'' \Rightarrow \underline{OK}$$

b) ASD:

$$w_a = 2.3 + 3.1 = 5.4\ k/ft$$

$$M_a = 5.4 \times \frac{32^2}{8} = 691.2\ ft.k$$

Enter table 3-10 with $\frac{M_a}{C_b} = \frac{691.2}{1.14} = 606.32\ ft.k$

$L_b = 32' \Rightarrow W24 \times 146$

Try W24×146

$M_g = 18.63\ ft.k$

$\Rightarrow M_a = 691.2 + 18.63 = 709.9\ ft.k$

$$\frac{M_n}{\Omega} = 1.14 \left[\frac{M_p}{\Omega} - BF(L_b - L_p) \right] \leq \frac{M_p}{\Omega}$$

$$= 1.14 \left[1040 - 17.1(32 - 10.6) \right] = 768.43 \leq 1040$$

$M_a = 709.9 \text{ ft.K} < \frac{M_n}{\Omega} = 768.43 \text{ ft.K} \Rightarrow OK$

Check Shear:

$$V_a = 5.4 \times \frac{32}{2} + \frac{146}{1000} \times \frac{32}{2} = 88.74 \text{ K}$$

$$\frac{V_n}{\Omega} = 322 \text{K} \Rightarrow V_a < \frac{V_n}{\Omega} \Rightarrow OK$$

Deflection OK SAME AS FOR LRFD.

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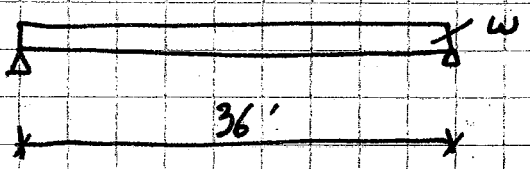
22. $w_D = 3.4$ K/ft

$w_L = 2.4$ K/ft



$C_b = 1.0$

$L_b = 0$

a) LRFD:

$$w_u = 1.2(3.4) + 1.6(2.4) = 7.92 \text{ K/ft}$$

$$\Rightarrow M_u = 7.92 \times \frac{36^2}{8} = 1283.04 \text{ ft.K}$$

Table 3-2 $\Rightarrow$ W 30 x 108

Try W 30 x 108 $\Rightarrow \phi M_p = 1300$ ft.K, $\phi V_n = 488$ K

$$M_g = \frac{108}{1000} \times \frac{36^2}{8} = 17.5 \text{ ft.K}$$

$$V_g = \frac{108}{1000} \times \frac{36}{2} = 1.94 \text{ K}$$

$$\Rightarrow M_u = 1283.04 + 1.2(17.5) = 1304.04 \text{ ft.K} > 1300 \text{ ft.K}$$

$\Rightarrow$ NOT good

$\Rightarrow$ try W 30×116

$$M_g = \frac{116}{1000} \times \frac{36^2}{8} = 18.79 \text{ ft.K}$$

$$V_g = \frac{116}{1000} \times \frac{36}{2} = 2.09 \text{ K}$$

$$\Rightarrow M_u = 1283.04 + 1.2(18.79) = 1305.53 \text{ ft.K} < 1420 \Rightarrow \text{OK}$$

$$V_u = 7.92 \times \frac{36}{2} + 1.2(2.09) = 145.07 \text{ K} < 503\text{K} \Rightarrow \text{OK}$$

Check deflection:

$$\delta_{max} = \frac{L}{360} = \frac{36 \times 12}{360} = 1.2''$$

$$\delta_L = \frac{5}{384} \times \frac{2.4 \times 36^4 \times 12^3}{29000 \times 4930} = 0.63'' < 1.2'' \Rightarrow \underline{\text{OK}}$$

b) #80 :

$$M_a = (3.4 + 2.4)\frac{36^2}{8} = 939.6 \text{ ft.K}$$

$$V_a = (3.4 + 2.4)\frac{36}{2} = 104.4 \text{ K}$$

table 3-2 , $\Rightarrow$ W 30×116

try W 30×116

$$M_a = 939.6 + 18.79 = 958.4 \text{ ft.K} > \frac{M_p}{\Omega} = 943 \text{ ft.K}$$