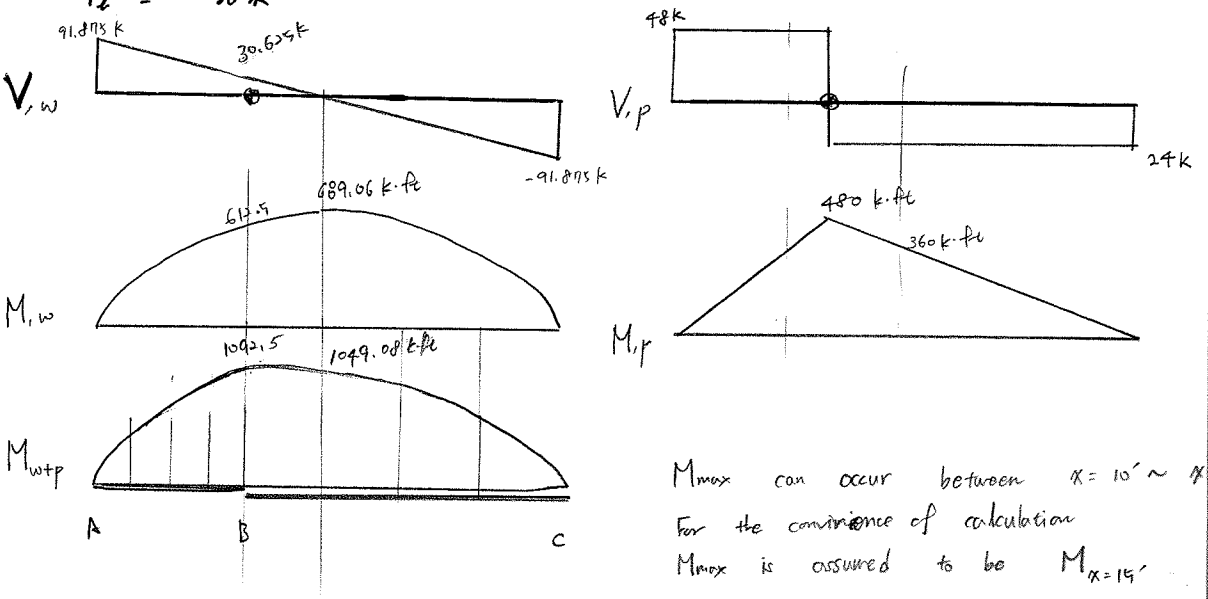
5.5 -15

W_d = 1 klf + 104 lb/ft = 1.104 klf → $W_u = 1.2D + 1.6L$ = 6.125 klf

W_l = 3 klf

P_d = 12 k

P_l = 36 k → $P_u = 1.2D + 1.6L$ = 72 k



M_{max} can occur between $x = 10' \sim x = 14'$

For the convinience of calculation

M_{max} is assumed to be $M_{x=14'}$

Span AB

M_{max} = 1092.5 k·ft

M_A = 330.94 k·ft

M_B = 622.8 k·ft

M_C = 876.78 k·ft

$$C_b = \frac{12.5(1092.5)}{2.5(1092.5) + 3(330.94) + 4(622.8) + 3(876.78)} = 1.544$$

Span BC

M_{max} = 1092.5 k·ft

M_A = 1049.08 k·ft

M_B = 852.48 k·ft

M_C = 502.8 k·ft

$$C_b = \frac{12.5(1092.5)}{2.5(1092.5) + 3(1049.08) + 4(852.48) + 3(502.8)} = 1.265$$

Check Flexural Resistance

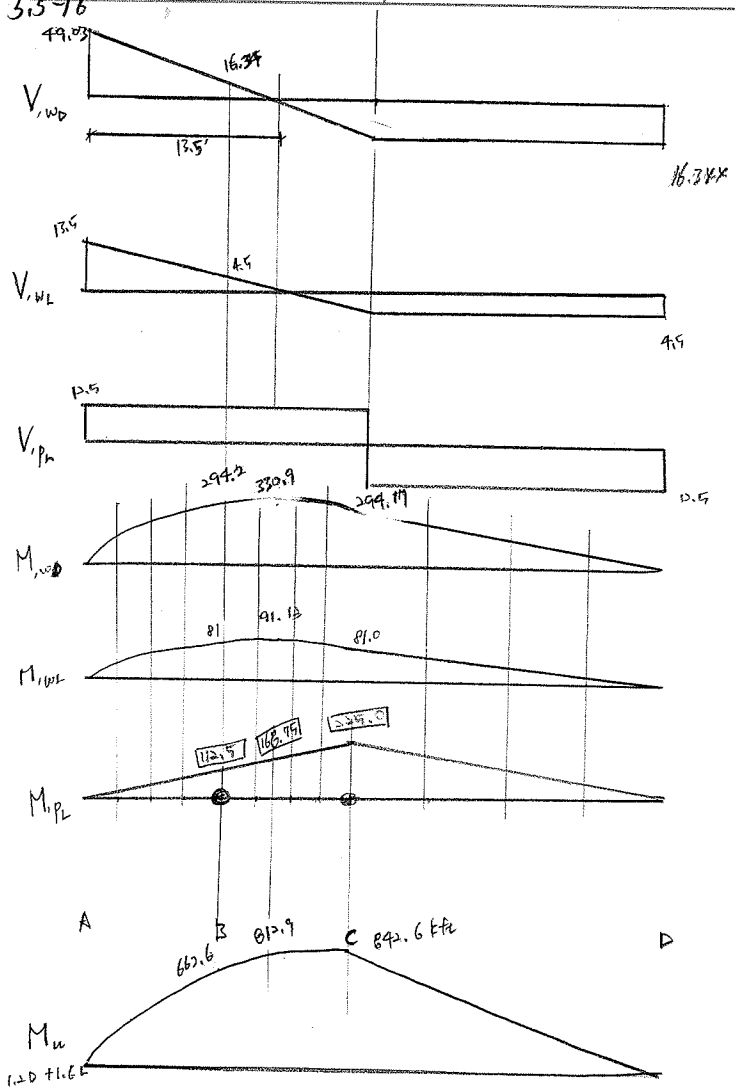
Span	L_b	$\phi_b M_n$	C_b	$\phi_b M_n C_b$	$\phi_b M_p$	M_u
AB	10'	1084 k-ft	1.544	1673.7 k-ft	1080 k-ft	1092.5 k-ft
BC	20'	864 k-ft	1.265	1092.96 k-ft	1080 k-ft	1092.5 k-ft

→

Span	$\phi_b M_n$		M_u	
AB	1080 k-ft	<	1092.5 k-ft	NG
BC	1080 k-ft	<	1092.5 k-ft	NG

Thus, the member is not adequate.

5.5-16



Span AB

M_{max} = 662.6 k-ft

M_A = 210.89 k-ft

M_B = 391.63 k-ft

M_C = 842.2 k-ft

$$C_b = \frac{12.5\,(662.60)}{2.5\,(662.60) + 3\,(210.89) + 4\,(391.63) + 3\,(842.2)} = 1.51$$

Span BC

M_{max} = 846.49 k-ft (x = 16.9 ft)

M_A = 752.85 k-ft

M_B = 812.9 k-ft

M_C = 842.8 k-ft

$$C_b = \frac{12.5\,(846.49)}{}$$ = 1.04

Span CD

M_{max} = 842.6 k-ft

M_A = 631.95 k-ft

M_B = 421.3 k-ft

M_C = 210.6 k-ft

$$C_b = \frac{12.5(842.6)}{2.5(842.6)+3(631.95)+4(421.3)+3(210.6)} = 1.67$$

Check $\phi_b M_n$

Span	Lb	$\phi_b M_{n, C_b=1}$	C_b	$\phi_b M_n C_b$		$\phi_b M_p$	$\phi_b M_n$	$M_u (=M_{max})$	
AB	9'	878	1.51	1325.8	>	878	878	662.6	Ok
BC	9'	878	1.04	913.12	>	878	878	846.5	Ok
CD	18'	841	1.67	1404.5	>	878	878	842.5	Ok

Check Local Buckling

Flange $\lambda = b_f/2t_f = \frac{14.9}{2(1.03)} = 7.14$

$\lambda_p = 0.38\sqrt{E/F_y} = 0.38\sqrt{29000/50} = 9.15$ → Compact

Web $\lambda = h/t_w = 10/0.645 = 15.9$

$\lambda_p = 3.76\sqrt{E/F_y} = 3.76\sqrt{29000/50} = 90.55$ → Compact

Check live load Deflection

Δ by w_L

at $x = 16.9' = 202.8$ in

$$\Delta_x = \frac{wx}{24EIl}\left(a^2(2l-a)^2 - 2ax^2(2l-a) + lx^3\right)$$

$$= \frac{(1/12)(202.8)}{24(29000)(1530)(432)}\left(216^2(2\cdot432-216)^2 - 2\cdot216\cdot202.8^2(2\cdot432-216) + 432\cdot202.8^3\right)$$

$$= 0.43 \text{ in}$$

Δ by P_L

at $x = 16.9'$

$$\Delta_x = \frac{Pbx}{6EIl}\left(l^2 - b^2 - x^2\right)$$

$$= \frac{(25\,k)(216)(202.8)}{6(29000)(1530)(432)}\left(432^2 - 216^2 - 202.8^2\right)$$

$$\Delta = \Delta_{x,w_L} + \Delta_{x,P_L} = 0.43 \text{ in} + 0.941 \text{ in}$$

$$= 1.371 \text{ in}$$

$$\Delta_{max} = \frac{L}{360} = \frac{36 \cdot 12}{360} = 1.2 < \Delta \quad \text{N.G}$$

Thus, the member is not adequate.

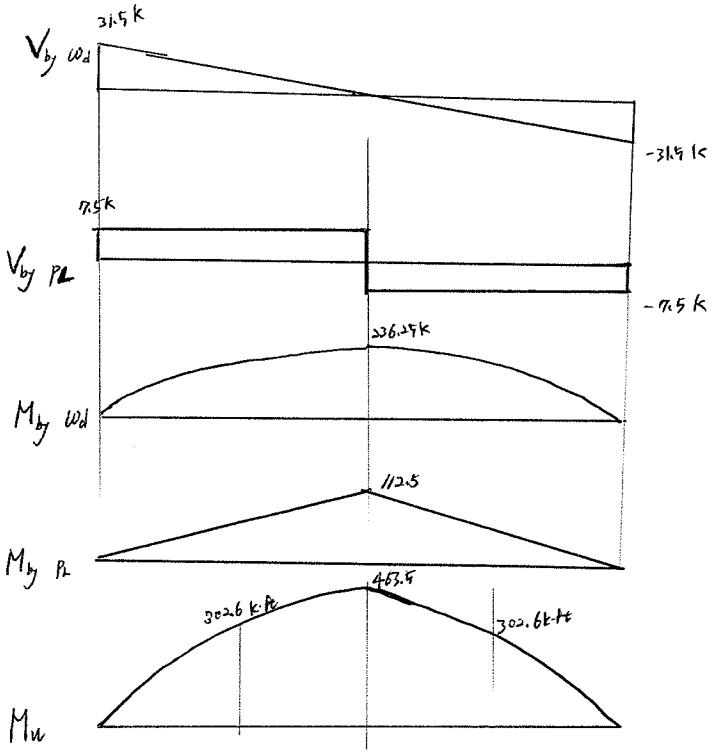
5.10-4

$\Delta_{req'd} = \frac{30 \cdot 12}{360} = 1 \text{ in}$

$\Delta = \frac{(15k)(30 \cdot 12)^3}{48(29000)(I_{req'd})} = 1 \text{ in}$

$\rightarrow I_{req'd} = 502.7 \text{ in}$

Find C_b



100 lb/ft assumed for self wt.

$C_b = \frac{12.5(463.5)}{2.5(463.5) + 3(302.6) + 4(463.5) + 3(302.6)} = 1.2$

Trial Section

Req'd $\phi_b M_n = M_u / C_b = 463.5 / 1.2 = 386.2 \text{ k-ft}$

From Table 3-10

Try W 18 X 86

$\phi_b M_n = 405 \text{ k-ft} \quad C_b = 1.0$

$\phi_b M_n C_b = 405(1.2) = 486 \text{ k-ft} \leq 698 = \phi_b M_p$

$\rightarrow \phi_b M_n = 486 \text{ k-ft}$

Find Δ

$$\Delta_{center} = \frac{(15\,k)(30\cdot 12)^3}{48\,(29000)(1530)} = 0.33\ in$$

$$\Delta_{max} = \frac{30\cdot 12}{360} = 1\ in \quad > \Delta_{center} \quad o.k$$

Check Local Buckling

Flange $\lambda = \frac{b_f}{2t_f} = \frac{11.1}{2(0.99)} = 7.2$

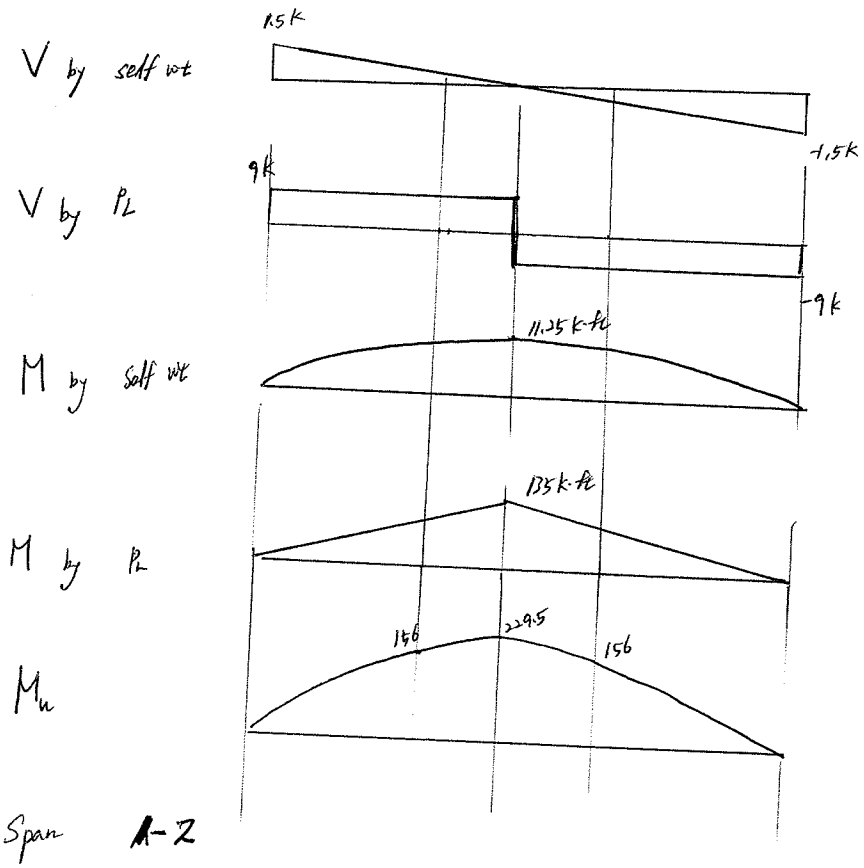
$\lambda_p = 0.38\sqrt{E/F_y} = 9.15 > \lambda \rightarrow$ Compact

Web $\lambda = \frac{h}{t_w} = 33.4$

$\lambda_p = 3.76\sqrt{E/F_y} = 90.6 > \lambda \rightarrow$ Compact

Thus, use W 18 x 86 for the member.

5.10-5



Span 1-2

M_{max} = 156 k-ft

M_A = 40.125 k-ft

M_B = 79.5 k-ft

M_C = 118.125 k-ft

$$C_b = \frac{12.5\,(156)}{2.5\,(156) + 3(40.125) + 4(79.5) + 3(118.125)} = 1.65$$

Spa 2-3

M_{max} = 229.5 k-ft

M_A = 193.125 k-ft

M_B = 229.5 k-ft

M_C = 193.125 k-ft

$$C_b = \frac{12.5\,(229.5)}{2.5(229.5) + 3(193.125) + 4(229.5) + 3(193.125)} = 1.08$$

Span 3-4

$M_{max} = 156$ k-ft

$M_A = 118.125$ k-ft

$M_B = 79.5$ k-ft

$M_C = 40.125$ k-ft

$$C_b = \frac{12.5(156)}{2.5(156) + 3(118.125) + 4(79.5) + 3(40.125)} = 1.65$$

Req'd $\phi_b M_n$ -

$$\phi_b M_{n,\,req'd} = \frac{M_u}{C_b} = \frac{156}{1.65} = 94.54 \text{ k-ft} \quad \text{span 1-2}$$

$$= \frac{229.5}{1.08} = 212.5 \text{ k-ft} \quad \text{span 2-3}$$

$$= \frac{156}{1.65} = 94.54 \text{ k-ft} \quad \text{span 3-4}$$

From Table 3-10

Try W18 x 40

$\phi_b M_n = 220.5$ $C_b = 1.0$

$\phi_b M_n = (220.5)(1.65) = 363.8$ k-ft > 294 k-ft $= \phi_b M_p$

$(220.5)(1.08) = 238.1$ k-ft < 294 k-ft $= \phi_b M_p$

$(220.5)(1.65) = 363.8$ k-ft > 294 k-ft $= \phi_b M_p$

$\phi_b M_n = 294$ k-ft > 156 k-ft o.k

238.1 k-ft > 229.5 k-ft o.k

294.1 k-ft > 156 k-ft o.k

Check Local Buckling

Flange $\lambda = b_f/2t_f = 7.2$

$\lambda_p = 0.38\sqrt{E/F_y} = 9.15 > \lambda \rightarrow$ Compact

Web $\lambda = h/t_w = 33.4$

$\lambda_p = 3.76\sqrt{E/F_y} = 90.6 > \lambda \rightarrow$ Compact

Thus, Use W18X40 for the member.