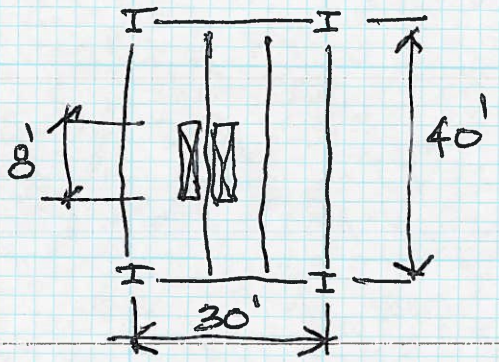
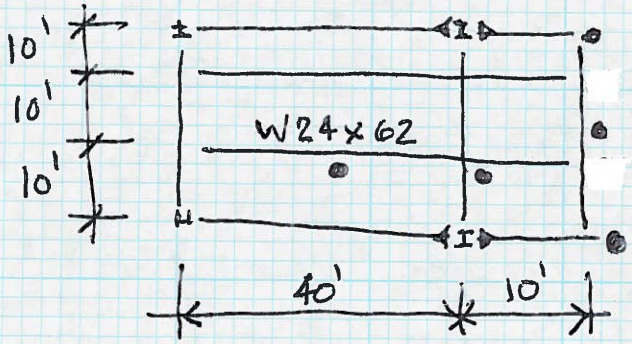
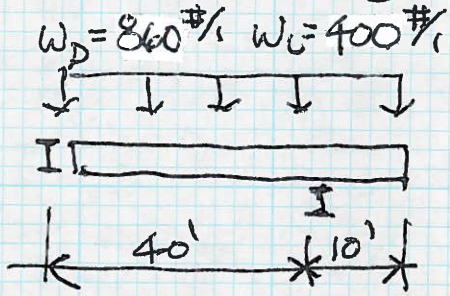
Assignment #2

(1) For the typical W24 x 55 floor beam, determine if the beam is adequate if it is unbraced for 8 feet at midspan. M_u was 334'k from Assignment #1. Show calculations and check you answer using AISC Table.



(2) At the edge of the building, the floor cantilevers as shown:





(A) Does the cantilever beam need to be braced more often than at the girder at at end?

(B) Design the girder, assuming braced at ends an at the beams.

(C) What camber is required at locations marked •

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① W 24 × 55 $L_b = 8' = 96''$ $S_x = 114$ $Z = 134$ $r_y = 1.34$

$J = 1.18$ $I_y = 29.1$

$A = 16.2$ $C_w = 3870$

$$L_p = \frac{300 r_y}{\sqrt{F_y}} = \frac{300 \times 1.34}{\sqrt{50}} = 56.9''$$

$$M_p = Z F_y = 134 \times 50 = 6700''^k = 558'^k$$

$$X_1 = \frac{\pi}{S_x}\sqrt{\frac{EGJA}{2}} = \frac{\pi}{114}\sqrt{\frac{29000(11{,}200)(1.18)(16.2)}{2}} = 1535$$

$$X_2 = 4\frac{C_w}{I_y}\left(\frac{S_x}{GJ}\right)^2 = 4\,\frac{3870}{29.1}\left(\frac{114}{11200 \times 1.18}\right)^2 = 0.0396$$

$$L_r = \frac{r_y X_1}{(F_y - F_r)}\sqrt{1 + \sqrt{1 + X_2 (F_y - F_r)^2}}$$

$$= \frac{1.34 \times 1535}{(50-10)}\sqrt{1 + \sqrt{1 + 0.0396(50-10)^2}} = 154''$$

$L_p < L_b < L_r$

$$M_r = (F_y - F_r) S_x = (50-10)114 = 4560''^k = 380'^k$$

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

$$= \left[558 - (558-380)\left(\frac{96 - 56.9}{154 - 56.4}\right)\right] 1.0$$

$$= [558 - 178(0.40)]\,1.0 = 487'^k$$

$\phi M_n = 0.9 \times 487 = 438'^k$ ← Table $\phi M_n = 430'^k$

$\phi M_n > M_u = 334'^k$ from Assignment #1

② $w_u = 1.2(860) + 1.6(400) = 1672'^k$

$M_u = 1.672 \times 10^2/2 = 836'^k$

$L_b = 10'$ $\phi M_n = 387'^k \gg M_u$ OK

No bracing

FLOOR BEAM DESIGN

Girder supporting cantilever beams

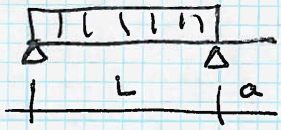
DL =	89	psf	
Lo =	50	psf	
Span =	30	ft	
TW =	32	ft	
At = Span * TW =	960	sq. ft.	
KLL =	2		
L =	29.61632992		Lo (0.25+ 15/Sqrt(KLL*At))
L =	30	psf	0.5 * Lo (min)
WD =DL*TW =	2848	plf	
WL=L*TW =	960	plf	
Wu = 1.2 WD + 1.6 WL =	4953.6	plf	
Mu = Wu *Span^2/8 =	557.3	ft-K	
Delta (D+L)< Span/240			
Req'd I =	1595.4	in^4	5*W(DL+LL)*Span^4/384/E * 240/Span
Delta (L)< Span/360			
Req'd I =	603.3	lin^4	5*W(LL)*Span^4/384/E * 360/Span
Choose Beam	W24x68		
Phi Mn =	663	ft-K	
I =	1830	in^4	
DL (Construction) =	59	psf	
Camber (calculated) =	0.648366309		5*(DL(const)*TW)*Span^4/384/E/I
Camber =	0.5	inch	

$L_b = 10'$ $C_b = 1.0$ $L_p = \frac{300 r_y}{\sqrt{F_y}} = \frac{300 \times 1.87}{\sqrt{50}} = 79'' < L_p$

$\phi M_n = 591 < \phi M_p$

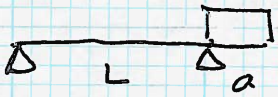
$> M_u$ OK

(2)(c) Const DL = 56 psf.



$$\Delta_{\text{¢}} = \frac{5(56\times10)40^4\times12^3}{384\times29000000\times1350} = 0.82''$$

$$\Delta_a = \frac{(56\times10)40^3\times10\times12^3}{24\times29000000\times1350} = 0.66'' \text{ up}$$



$$\Delta_{\text{¢}} = 0.0321\frac{(56\times10)10^2\times40^2\times12^3}{29000000\times1350} = 0.13 \text{ up}$$

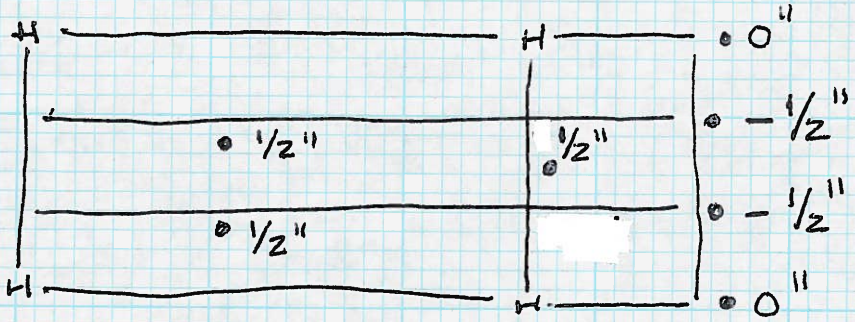
$$\Delta_a = \frac{(56\times10)10^3\times12^3}{24\times29000000\times1350}(4\times40+3\times10)$$

$$= 0.20''$$

$$\Delta_{\text{¢}} = 0.82'' - 0.13'' = 0.69'' \text{ down}$$

$$\Delta_a = 0.20'' - 0.66'' = -0.46'' \text{ up}$$

$$\Delta = \frac{(56\times10)10^4\times12^3}{8\times29000000\times1350} = 0.03''$$



Not part of solution —

If in problem ① the length of the unbraced beam is 15'. the $L_b = 15' = 180''$

If $L_b = 180''$ $= 15'$

$L_b > L_r$ $C_b = 1.0$ Cantilever Beam

$$M_n = \frac{C_b S_x X_1 \sqrt{2}}{L_b/r_y} \sqrt{1 + \frac{X_1^2 X_2}{2(L_b/r_y)^2}}$$

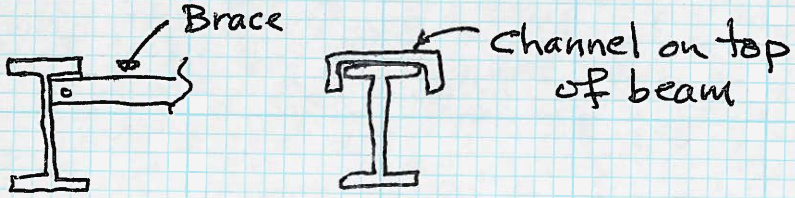
$$= \frac{1.0(114)(1535)\sqrt{2}}{(180/1.34)} \sqrt{1 + \frac{(1535)^2(0.0396)}{2(180/1.34)^2}}$$

$$= 3488 \text{ 'k}$$

$\phi M_n = 0.9 \times 3488 \text{'k} / 12 = 261 \text{ 'k}$ ← Table 26-3 'k

Since $\phi M_n = 261$ 'k $< M_u = 33$ 'k, your choices are

① Brace beam at middle of slot



② Use a larger beam

③ Reduce length of slot.