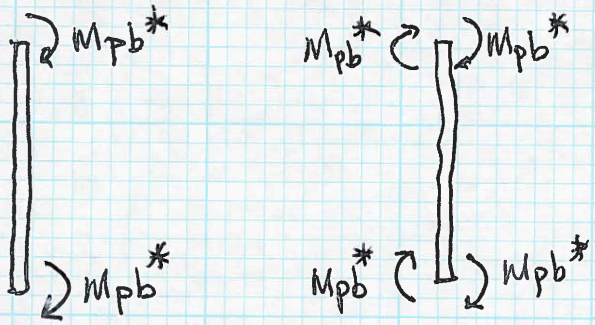
Assignment #9

(A) Make the 7 design checks for the "Revised SMF" at the 3rd Floor Beam W30x148 noting the column above is a W14x426 and below is W14x500.

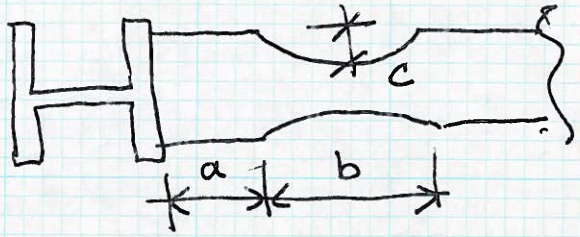
(B) Check the interior and exterior column at the 2nd Floor, noting that P_E is given and use $\Omega_o P_E$



Exterior Column

Assignment #9

W30x148 $Z_x = 500$ $b_f = 10.5"$ $t_{bf} = 1.18"$ $d = 30.7"$
$t_w = 0.65"$ $r_y = 2.28"$



(1)

$a = 6"$ $\quad 0.5 b_f = 5.25" \le a \le 0.75 b_f = 7.88"$

$b = 24"$ $\quad 0.65 d = 19.96" \le b \le 0.85 d = 26.1"$

$c = 2.5"$ $\quad 0.10 b_f = 1.05" \le c \le 0.25 b_f = 2.63"$

$$Z_{RBS} = Z_x - 2 c t_{bf} (d - t_{bf})$$
$$= 500 - 2(2.5)(1.18)(30.7 - 1.18) = \underline{326 \text{ in}^3}$$

$$C_{pr} = \frac{F_y + F_u}{2F_y} = \frac{50+65}{2(50)} = 1.15$$

$$M_{pr} = C_{pr} R_y F_y Z_{RBS} = (1.15)(1.1)(50)(326)/12 = 1718 \text{ k-ft.}$$

$$M_u = \frac{335.8 (15')}{2+3} = 840 \text{ k-ft} < M_{pr} \quad \underline{\text{OK}}$$

(2) Check $M_f < \phi M_{pe}$ $\quad L = 20'$ $\quad S_h = 6" + \frac{24}{2} = 18"$

$w_D = 1.958$ $\quad w_L = 0.836$ $\quad S_{DS} = 1.758$

$L_h = 20(12) - 2(18") - 19.6"$ $\quad \leftarrow$ W14x426 $d = 19.6"$
$= 184" = 15.4'$

$$V_b = \frac{2(1718)}{15.4'} + (1.2 + 0.2(1.758))(1.958)\left(\frac{15.4}{2}\right)$$
$$+ 0.5(0.836)(15.4/2) = 250^k$$

$$M_f = M_{pr} + V_b S_h = 1718 + 250\left(\frac{18}{12}\right) = 2093 \text{ k-ft.}$$

$$M_{pe} = R_y F_y Z_x = 1.1(50)(500)/12 = 2292 \text{ k-ft}$$

$$\phi M_{pe} = 1.0(2293) = 2293 > M_f \quad \underline{\text{OK}}$$

(3) Check Strong Column/Weak Beam

Column $A_t = 20' \times (20+2) = 440^{0'}$

Ratio $P_D = \frac{440}{1200} \times 426 = 156^K$

$P_L = \frac{440}{1200} \times 204 = 75^K$

$P_u = (1.2 + 0.2(1.758))\,156 + 0.5(75) + 3.0(19)$

$= 337^K$

W14×426 $A = 125$ $Z = 869$ $d = 18.7$

W14×500 $A = 147$ $Z = 1050$ $d = 19.6$ $t_w = 2.19$ $b = 17$ $t = 3.50$

$$\Sigma M_{pc}^* = 869\left(50 - \frac{337}{125}\right) + 1050\left(50 - \frac{337}{147}\right)$$

$$= 91{,}200^{"K} = 7600^{'K}$$

$$\Sigma M_{pb}^* = 2\left(1718 \times 12 + 250\left(18 + {}^{19.6}/_{2}\right)\right)$$

$$= 55132^{"K} = 4594^{'K}$$

$$\frac{\Sigma M_{pc}^*}{\Sigma M_{pb}^*} = \frac{7600}{4594} = 1.65 \gg 1.0 \quad \underline{OK}$$

(4) Check Panel Zone

$$R_u = \frac{\Sigma M_f}{d - t_{bf}} - \frac{\Sigma M_f}{h}$$

$$= \frac{2 \times 2093}{30.7 - 1.18} - \frac{2 \times 2093}{15} = 1423^K$$

$$R_{vn} = 0.6 F_y d_c t_p \left[1 + 3 b_{cf} t_{cf}^2 / d_b d_c t_p\right]$$

$$= 0.6(50)(19.6)(2.19)\left[1 + \frac{3(17)(3.5)^2}{(30.7)(19.6)(2.19)}\right]$$

$$= 1898^K \qquad \times 1.474$$

$$R_u < \phi R_{vn} = 1.0 \times 1898 = 1898^K$$

No Doubler Plate Required

(5) Check if Continuity Plates are required?

$$t_{cf} \geq 0.4\sqrt{1.8\, b_{bf} t_{bf} \times \frac{R_{ybF_{yb}}}{R_{ycF_{yc}}}} \quad \& \quad t_{cf} \geq b_{bf}/6$$

$3.04 > 1.89$ & $3.04 > 10.5/6 = 1.75$ OK

No Continuity Plates required.

(6) Beam Bracing

$$\text{spacing} < 0.086 E r_y / F_y = 0.086(29000)(2.28")/50$$

$$< 114" \sim 9.5'$$

brace at midspan $L_b = \frac{20' - \frac{19.6}{12}}{2} = \frac{18.4'}{2} = 9.2'$

(7) Shear Connection

$$l_w = \frac{V_{RBS}}{\phi\, 0.6 F_y t_w C_v} = \frac{250}{1.0(0.6)(50)(0.65)(1.0)}$$

$$= 12.8" \ll d_{web} \simeq 30.7 - 6" = 24.7"$$

B. Columns

P_E @ Exterior = 209^k $\quad \Omega_o P_E$ = 627^k

P_E @ Interior = 19^k $\quad \Omega_o P_E$ = 57^k

P_u @ Exterior = $(1.2 + 0.2(1.758))\frac{156}{2} + 0.5 \times \frac{75}{2} + 627$

= 767^k

↑ Assume $\frac{1}{2} P_D$ & $\frac{1}{2} P_L$ at exterior.

P_u @ Interior = 337^k

↑ From Part (3)

From AISC Table 4-1 : W14×500 $\quad \phi P_n$ = 5860^k

Table 3-10 : W14×500 $\quad \phi M_n$ = 10300^{1k}

$\therefore P_u/\phi P_n << 0.2$

Exterior

$$\frac{P_u}{2\phi P_n} + \frac{M_u}{\phi M_n} = \frac{767}{2 \times 5860} + \frac{4594/2}{10300} =$$

$$= 0.065 + 0.223 = 0.288 < 1.0$$

OK

Interior

$$= \frac{337}{2 \times 5860} + \frac{4594}{10300}$$

$$= 0.029 + 0.446 = 0.475 < 1.0$$

OK