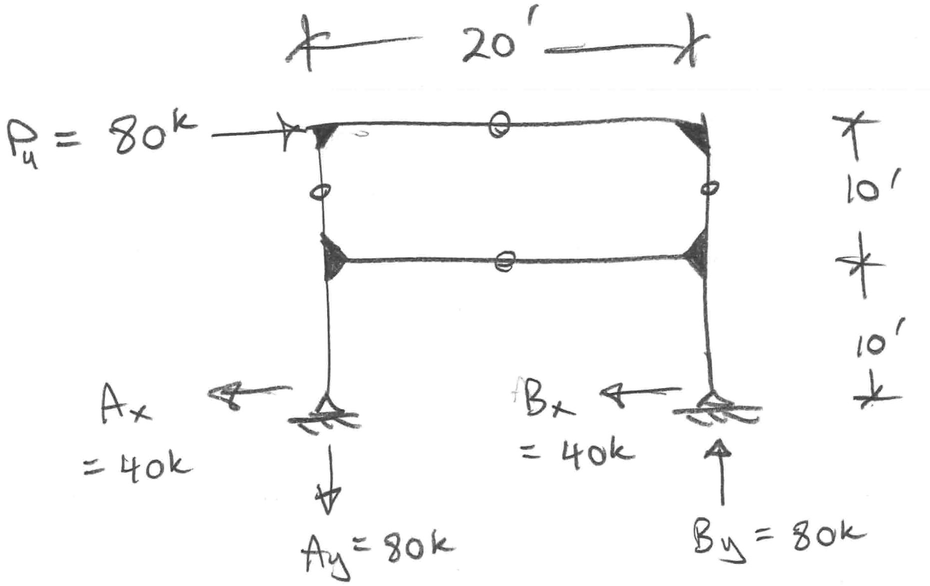
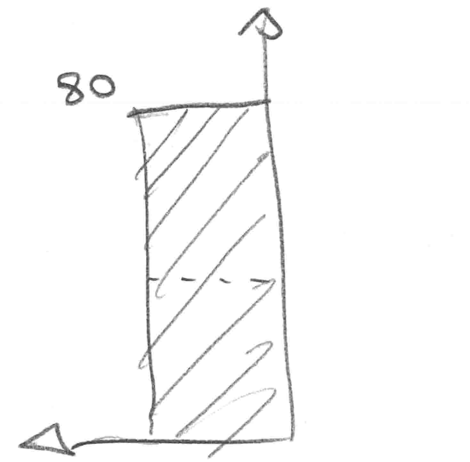
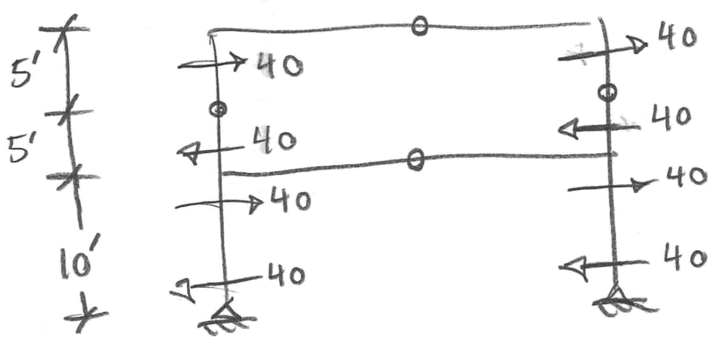
PORTAL FRAME METHOD



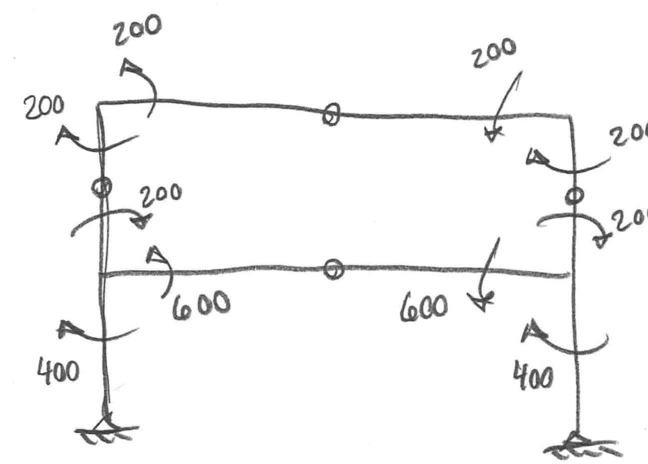
FBD



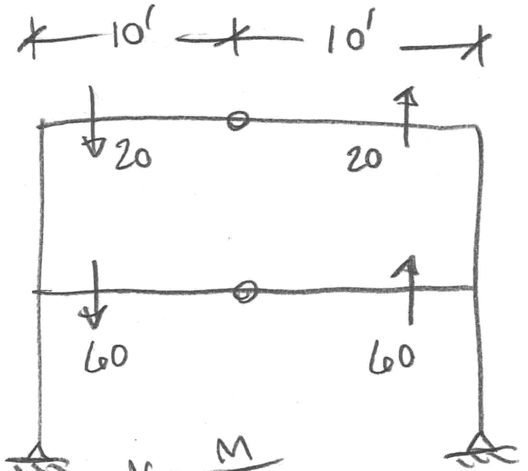
STORY SHEAR (k)



COLUMN SHEAR (k)



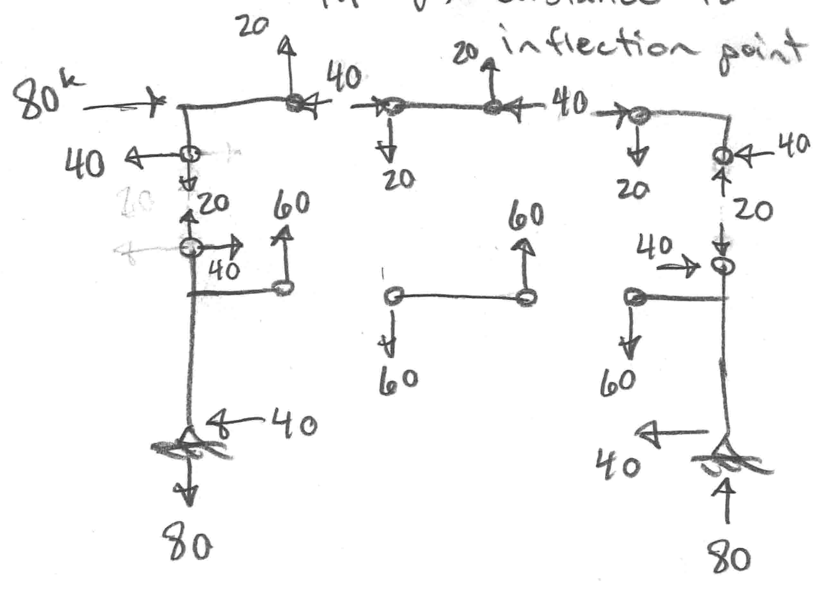
MOMENT (k·ft)



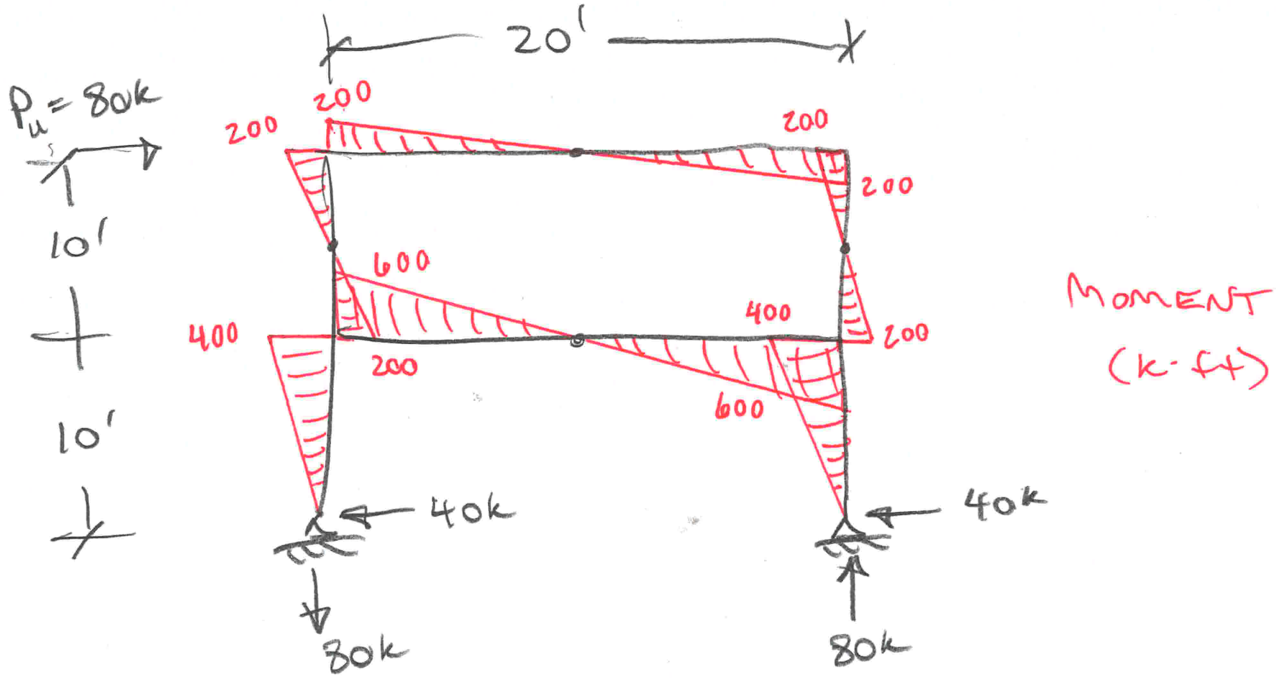
$$V = \frac{M}{\text{distance to inflection point}}$$

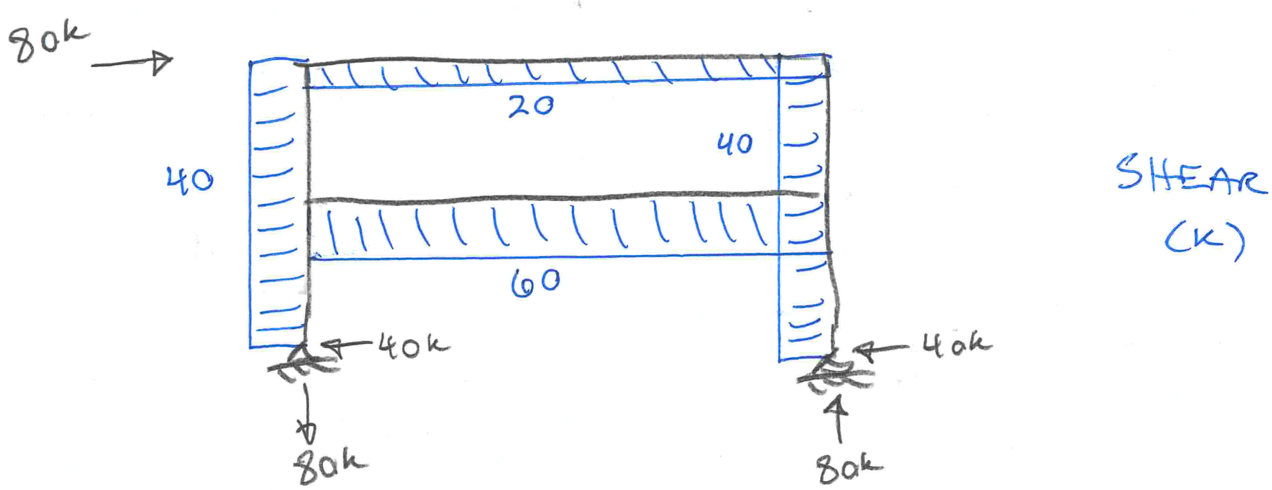
BEAM SHEAR (k)

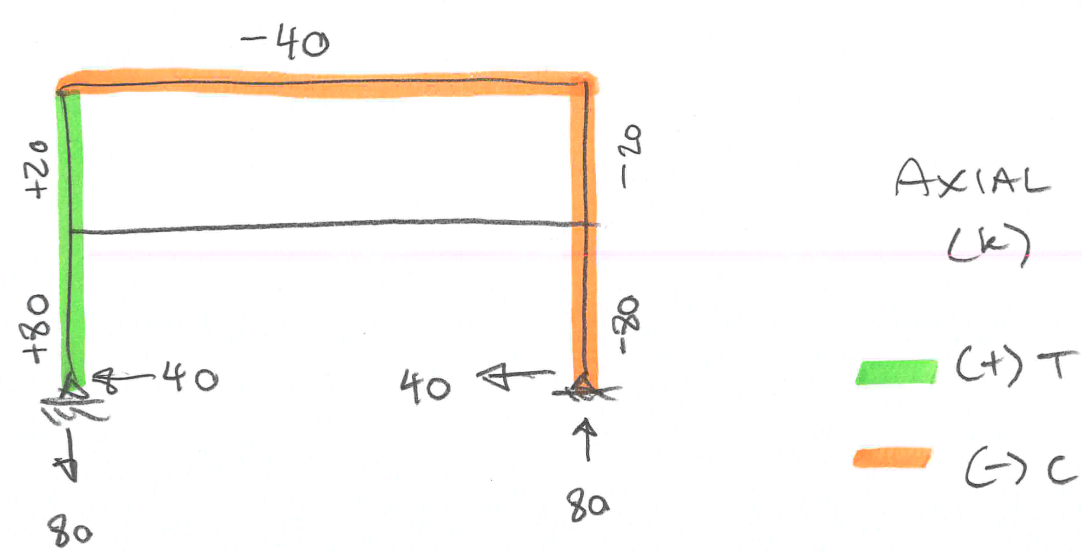
M = V * distance to inflection point



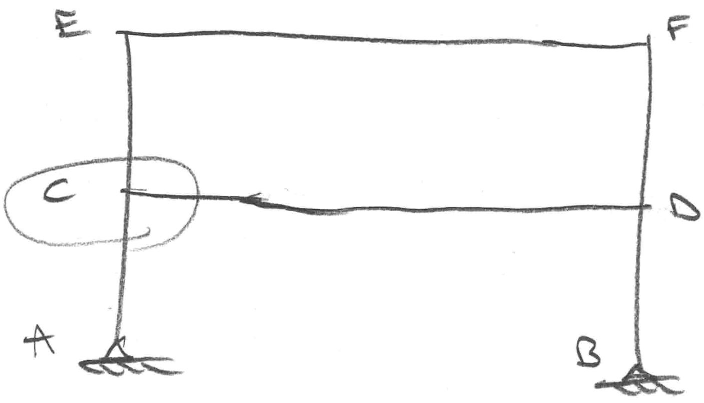
PORTAL FRAME



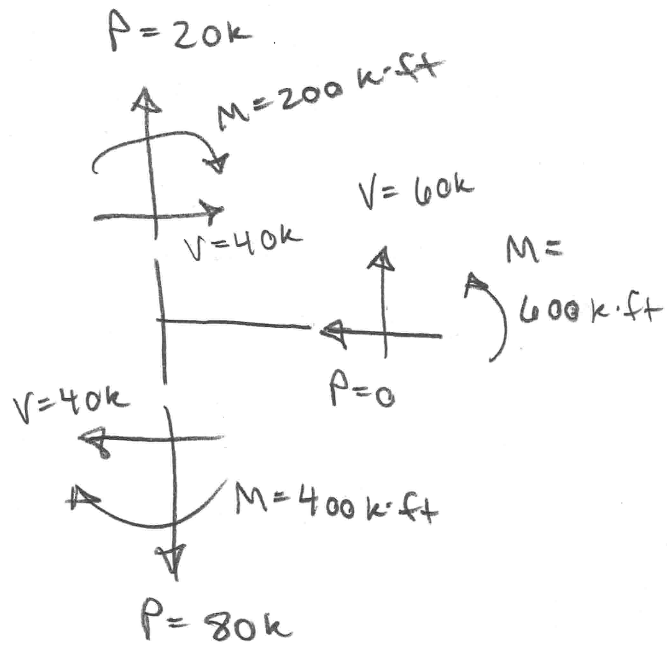




MOMENT CONNECTION

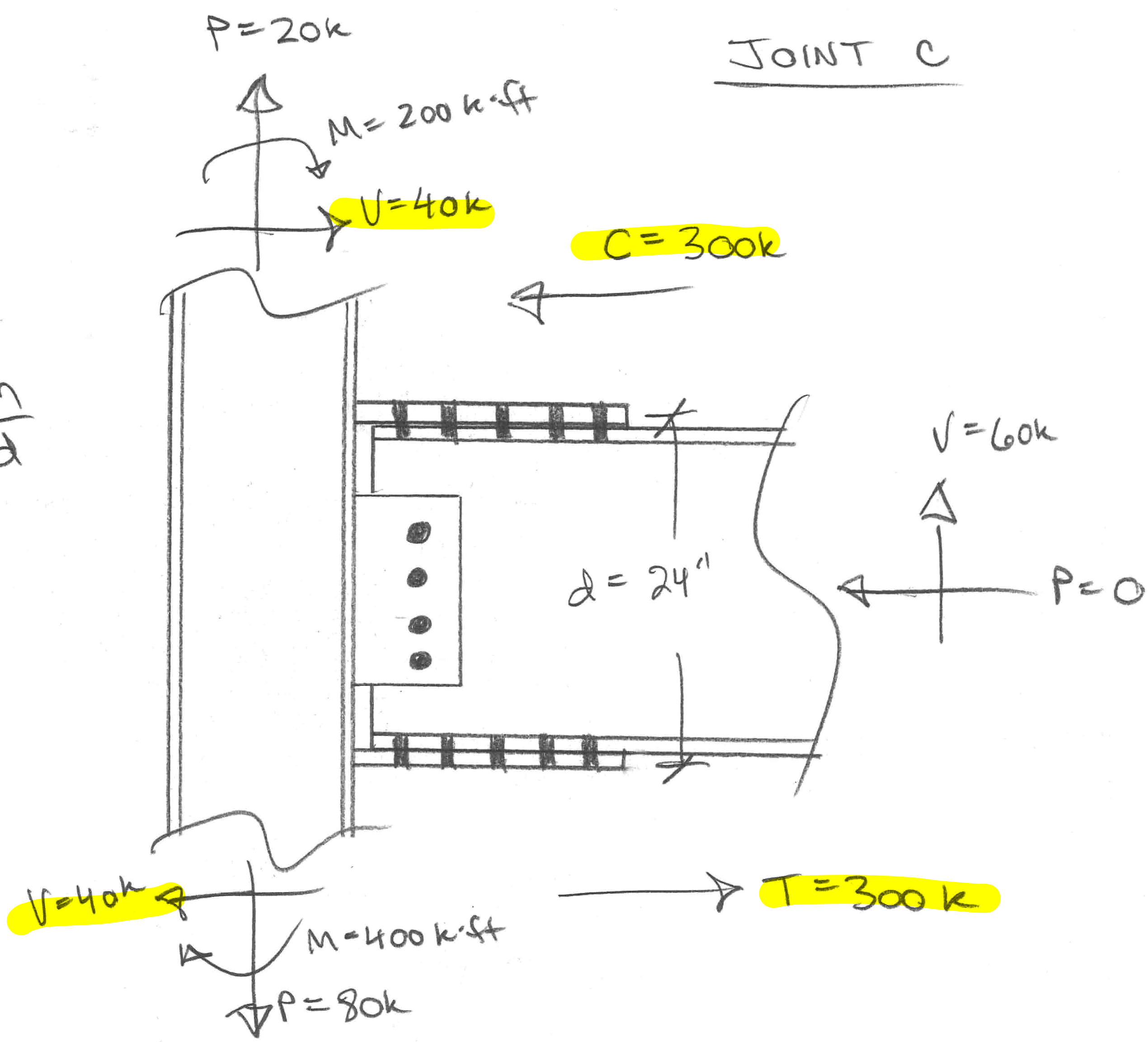


FRAME



JOINT C

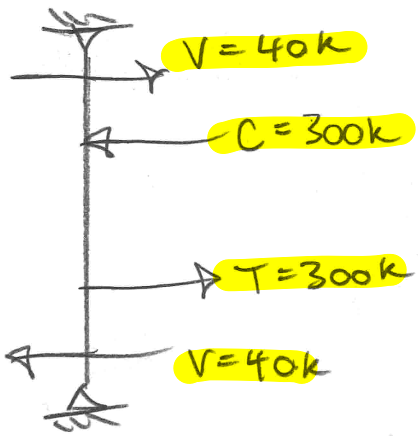
$$C = T = \frac{M}{d}$$

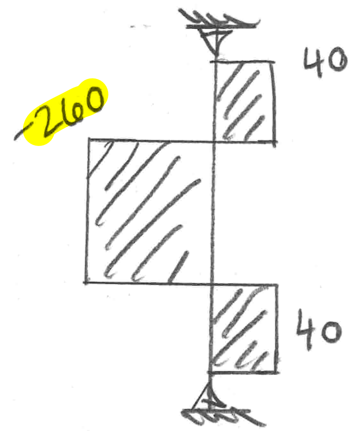


CONNECTION DETAIL: JOINT C

WEB PANEL ZONE SHEAR

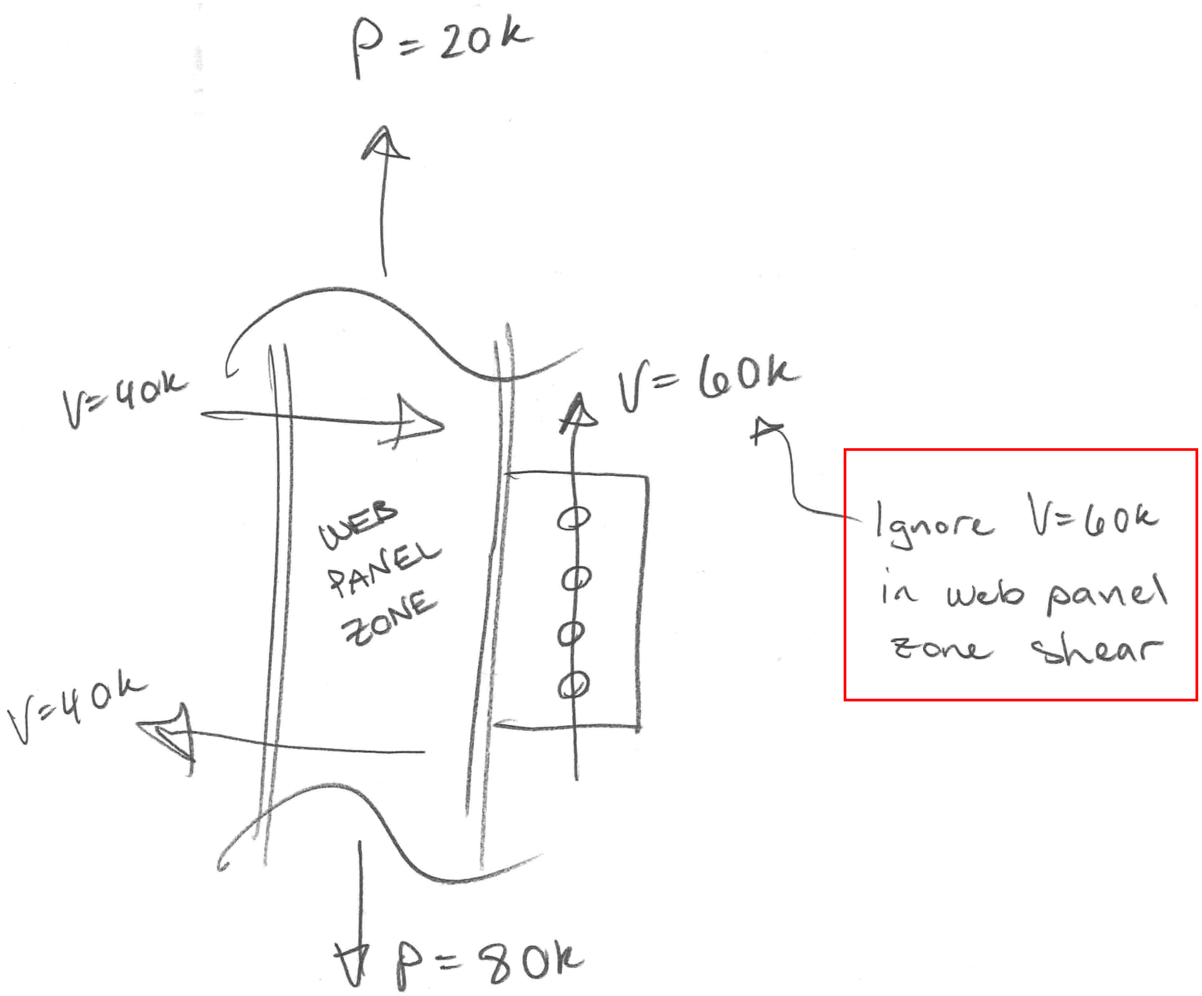
COLUMN TRANSVERSE SHEAR:





SHEAR (K)

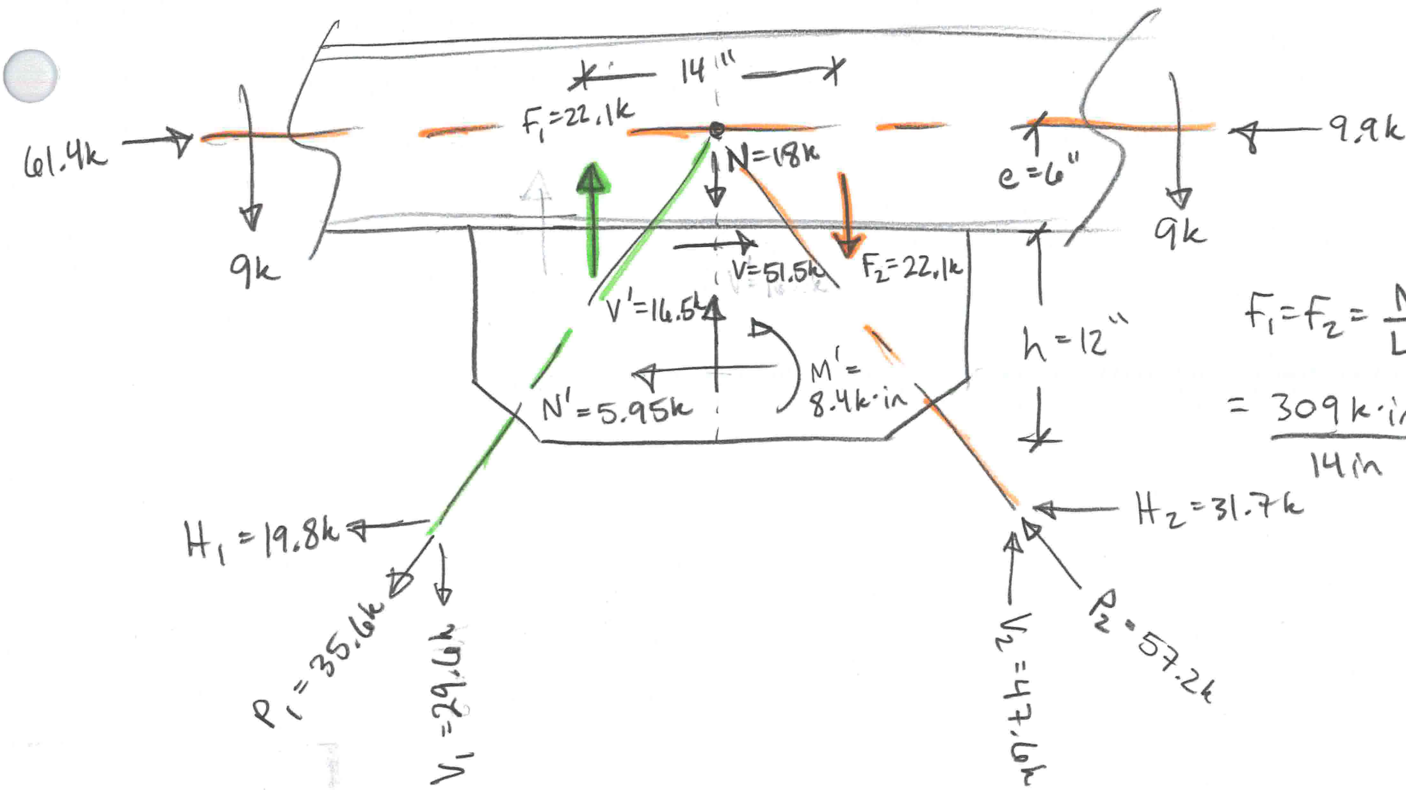
WEB PANEL ZONE SHEAR DEMAND, $R_u = 260k$



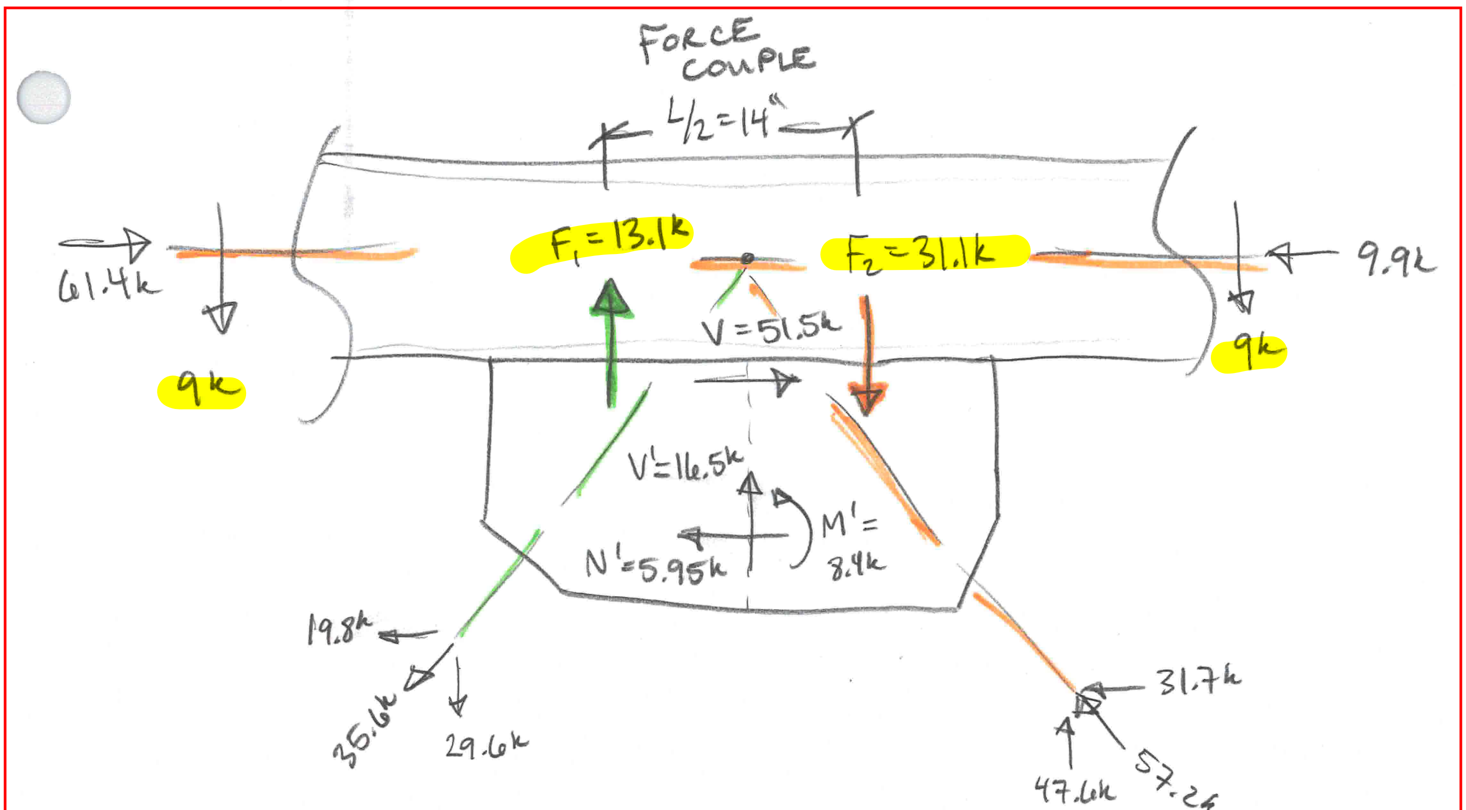
GUSSET PLATE DESIGN: AISC 360-16 LRFD

Chevron brace example

JOINT E:



$$F_1 = F_2 = \frac{M}{L/2} = \frac{309\ k\cdot in}{14\ in} = \underline{22.1k}$$



$$F_1 + \frac{N}{2} = 22.1k + \left(\frac{-18k}{2}\right) = 13.1k \uparrow$$

$$F_2 + \frac{N}{2} = -22.1k + \left(\frac{-18k}{2}\right) = 31.1k \downarrow$$

DESIGN FOR CONCENTRATED FORCES, F_1 & F_2, ACTING OVER DISTANCE $L/2 = 14"$

GUSSET PLATE DESIGN: AISC 360-16 LRFD

BEAM CHECKS: CONCENTRATED FORCES

WEB SIDESWAY BUCKLING: (J10.4) $\phi = 0.85$

BEAM IS UNRESTRAINED. $L_b = 20\text{ft} = 240\text{ in}$ $h/t_w = 33.6$

$$\frac{h/t_w}{L_b/b_f} = \frac{33.6}{240''/8.01''} = \underline{1.12} \leq 1.7$$

$\therefore$ (Eq. J10-7):

$$R_n = \left(\frac{C_r t_w t_f}{(h/t_w)^2}\right)\left[0.4\left(\frac{h/t_w}{L_b/b_f}\right)^3\right]$$

$M_u = 17.6\text{ k}\cdot\text{ft} < M_y = 214.6\text{ k}\cdot\text{ft}$

$\therefore$ $C_r = 960{,}000$ ksi $\underline{M_u = 17.6\text{ k}\cdot\text{ft}}$

$M_y = F_y S_x = 50\text{ksi}(51.5\text{ in}^3)$
$= 2575\text{ k}\cdot\text{in} = \underline{214.6\text{ k}\cdot\text{ft}}$

$$R_n = \left(\frac{(960{,}000\text{ ksi})(0.295'')(0.515'')}{(33.6)^2}\right)\left[0.4(1.12)^3\right] = 129.2\text{k}(0.56) = \underline{72.4\text{k}}$$

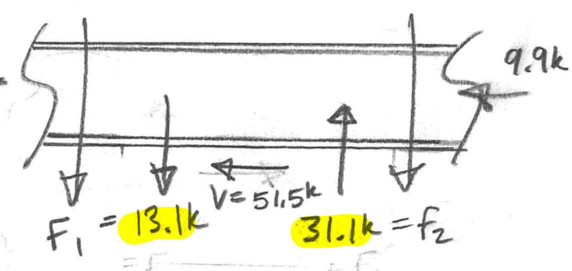
$\phi R_n = 0.85(72.4\text{k}) =$ **$\phi R_n = 61.5\text{k} > R_u = 31.1\text{ k}$ OK**

WEB PANEL-ZONE SHEAR: (J10.6) $\phi = 0.9$

$\alpha P_r = 1.0(61.4\text{k}) = \underline{61.4\text{k}}$

$0.4P_y = 0.4F_yA_g = 0.4(50\text{ksi})(11.7\text{ in}^2) = \underline{234\text{k}}$

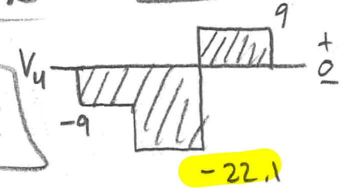
$\alpha P_r = 61.4\text{k} < 0.4P_y = 234\text{k}$



$\therefore R_n = 0.6F_y d t_w = 0.6(50\text{ksi})(11.9\text{in})(0.295\text{in}) = \underline{105.3\text{k}}$

$\phi R_n = 0.9(105.3\text{k}) =$ **$\phi R_n = 94.8\text{k} > V_u = 22.1\text{k}$ OK**

Shear Diagram



BEAM SHEAR STRENGTH: (G2)

$h/t_w = \underline{33.6}$

$2.24\sqrt{\frac{E}{F_y}} = 2.24\sqrt{\frac{29{,}000}{50}} = \underline{53.9}$

$\therefore \phi = 1.0,\ C_{v1} = 1.0$

$V_n = 0.6F_y A_w C_{v1} = 0.6F_y d t_w C_{v1}$

$= 0.6(50\text{ksi})(11.9\text{in})(0.295\text{in})(1) = \underline{105\text{ k}}$ **$\phi V_n = 105\text{k} > V_u = 22.1\text{k}$ OK**