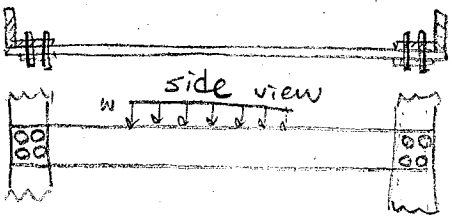
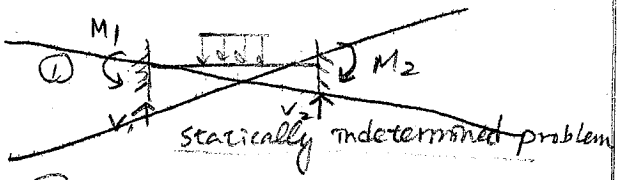
• Shear of Bolts and Rivets Dut to Eccentric loading

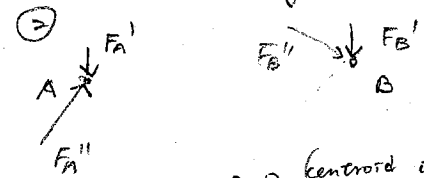
ex.

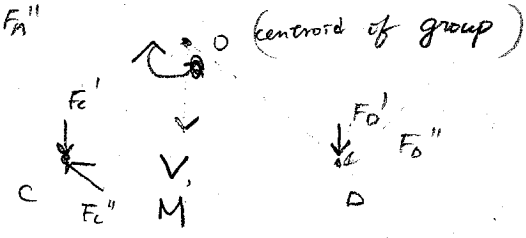


Top view



statically indetermined problem





Step 1

$F' = \frac{V}{n} = \frac{V}{4}$ direct load (primary shear)

F'' = moment load (secondary shear)

$M = F_A'' \cdot R_A + F_B'' \cdot R_B + \cdots$ ——— ①

The force on each bolt due to the moment is assumed proportional to its distance from the centroid.

$\rightarrow \frac{F_A''}{R_A} = \frac{F_B''}{R_B} = \cdots$ ——— ②

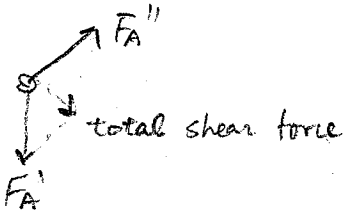
solving ① & ②

Step 2

$$F_n'' = \frac{M R_n}{R_A^2 + R_B^2 + \cdots}$$

Step 3

Result force



why ?

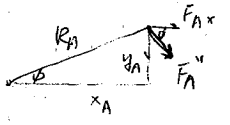
Because F_A'', F_B'' ---- must have force ballance (no extral force in either x or y direction)

in X direction

left to centroid ⇒ $F_{Ax}'' \cdot \cos\phi + F_{Bx}'' + \cdots = F_{Dx}'' + \cdots$ (right to centroid)

$F_A'' \cdot \cos\phi + \cdots = \cdots$

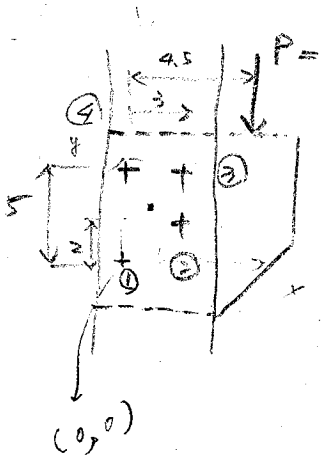
$F_A'' \cdot \frac{x_A}{R_A} + \cdots = \cdots$



solution $\frac{F_A''}{R_A} = \frac{F_B''}{R_B} = \cdots$

read example 8.4

example on eccentric loading



- If bolts have equal area $A_t = 0.0775\ in^2$ (tensile stress area)
  ($\frac{3}{8}$-16 UNF Bolt)

Find maximum shear ~~stress~~ load on which bolt ?

5 mins.

Sol:

① primary shear $\frac{2500}{4} = 1875$ lb

② secondary shear ?

centroid

$\bar{x} = \frac{0+3+3+0}{4} = 1.5$

$\bar{y} = \frac{0+2+5+3}{4} = 3$

$M = 7.5 \times 3 (4.5 - 1.5) = 22500$

$R_i = \frac{M R_i}{\sum R_i^2}$

$R_1 = \sqrt{(0-1.5)^2 + (0-3)^2} = 3.35$

$R_2 = \sqrt{(3-1.5)^2 + (2-3)^2} = 1.80$

$R_3 = \sqrt{(3-1.5)^2 + (5-3)^2} = 2.5$

$R_4 = \sqrt{(0-1.5)^2 + (5-3)^2} = 2.5$

$R_1^2 + R_2^2 + R_3^2 + R_4^2 = 26.9625$

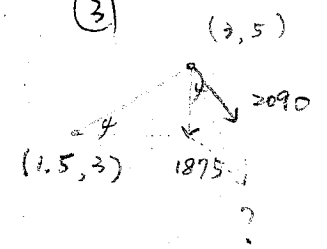
$F_1'' = \frac{22500(3.35)}{26.9625} \cong 2800$

$F_2'' = \frac{22500(1.8)}{26.9625} \cong 1500$

$F_3'' = \frac{22500(2.5)}{26.9625} \cong 2090$

$F_4'' = \frac{22500(2.5)}{26.9625} \cong 2090$

It turns out ③ is the biggest F,



$\tan\gamma = \frac{5-3}{3-1.5} \Rightarrow \gamma = 53.1°$

$2090 \cdot \cos 53.1° = 1254$

$2090 \cdot \sin 53.1° = 1672$

$\rightarrow F_③ = -(1875+1254)\,j + 1672\,i$

$F_③ = \sqrt{(1875+1254)^2 + 1672^2}$

$\cong 3550$ lb

~~= 4500~~