5-1

$S_{yt} = S_{yc} = 350$ mpa

c) $\sigma_x = -42$ mpa, $\sigma_y = -70$ mpa, $\tau_{xy} = -35$ mpa.

DET

Safety factor ; $\eta = \frac{S_y}{\sigma'}$

$$\sigma' = \sqrt{\sigma_x^2 + \sigma_y^2 - \sigma_x\sigma_y + 3\tau_{xy}^2}$$

$\sigma' = 86.02$ mpa.

$$\eta = \frac{S_y}{\sigma'} = \frac{350}{86.02} = 4.07$$

MSST

$$\sigma_A = \frac{\sigma_x + \sigma_y}{2} + \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$\sigma_A = \frac{-42 + (-70)}{2} + \sqrt{\left(\frac{-42+70}{2}\right)^2 + (-35)^2}$$

$\sigma_A = -56 + 37.7$

$\sigma_A = -18.3$ mpa.

$$\sigma_B = \frac{\sigma_x + \sigma_y}{2} - \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$= -56 - 37.7$

$= -93.7$ mpa.

$\because$ Case 3 : $0 \geq \sigma_A \geq \sigma_B$

$\sigma_1 = 0$, $\sigma_2 = -18.3 = \sigma_A$, $\sigma_3 = -93.7 = \sigma_B$.

$$\eta = \frac{-350}{-93.7} = 3.74.$$

- 1

1). $S_{yt} = S_{yc} = 350$ MPa.

$\sigma_x = 84$ mpa, $\sigma_y = 28$ mpa, $\tau_{xy} = 7$ mpa.

DET

$$\sigma_1 = \sqrt{\sigma_x^2 + \sigma_y^2 - \sigma_x \sigma_y + 3\tau_{xy}}$$

$$= 75.07 \text{ mpa.}$$

$$\eta = \frac{S_y}{\sigma_1} = \frac{350}{75.07} = 4.67$$

MSST

$$\sigma_1 = \frac{\sigma_x + \sigma_y}{2} + \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$\sigma_1 = 56 + 28.9$$

$$\sigma_1 = 84.9 \text{ mpa.}$$

$$\sigma_2 = \left(\frac{\sigma_x + \sigma_y}{2}\right) \mp \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$= 56 - 28.9$$

$$= 27.1 \text{ mpa.}$$

Case 1 : $\sigma_A \geq \sigma_B \geq 0$ $\sigma_1 = \sigma_A = 84.9$ $\sigma_3 = 0$

$\sigma_A \geq S_y$

$$\eta = \frac{350}{84.9} = 4.12.$$

-2

i) $S_y = 350$ mpa.

$\sigma_A = 84 \quad \sigma_B = 84$

DET

$\sigma' = (\sigma_A^2 - \sigma_A\sigma_B + \sigma_B^2)^{1/2}$

$\sigma' = 84$ mpa.

$n = \frac{S_y}{\sigma'} = \frac{350}{84} = 4.17$.

MSST

Case 1 : $\sigma_A \geq \sigma_B \geq 0$; $\sigma_1 = \sigma_A = 84$ mpa. $\sigma_3 = 0$

$\sigma_A \geq S_y$

$n = \frac{S_y}{\sigma_A} = \frac{350}{84} = 4.17$,

c) $\sigma_A = 84$mpa $\sigma_B = -84$mpa.

DET

$\sigma' = (\sigma_A^2 - \sigma_A\sigma_B + \sigma_B^2)^{1/2}$

$\sigma' = (84^2 - (84)(-84) + (-84)^2)^{1/2}$

$\sigma_1 = 145.49$ mpa.

$n = \frac{S_y}{\sigma'} = \frac{350}{145.49} = 2.41$

MSST

Case 2 : $\sigma_A \geq 0 \geq \sigma_B$; $\sigma_1 = \sigma_A = 84$ mpa

$\sigma_3 = \sigma_B = -84$.

$\sigma_A - \sigma_B \geq S_y$.

$n = \frac{S_y}{\sigma_A - \sigma_B} = \frac{350}{84 + 84}$

$= 2.08$

-3

From table A-18

For bar of AISI 1020 cold drawn steel yield strength, $S_y = 390$ mpa.

b) $\sigma_x = 180$ mpa $\tau_{xy} = 100$ mpa.

DET

$$\sigma' = (\sigma_x^2 + \sigma_y^2 - \sigma_x\sigma_y + 3\tau_{xy}^2)^{1/2}$$

$$= 180^2 + 0 - 0 + 3(100)^2)^{1/2}$$

$$= 249.8 \text{ mpa.}$$

$$\eta = \frac{S_y}{\sigma'} = \frac{390}{249.8} = 1.56$$

MSST

$$\sigma_1 = \frac{\sigma_x + \sigma_y}{2} + \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$= \frac{180}{2} + \sqrt{\left(\frac{180}{2}\right)^2 + 100^2}$$

$$= 90 + 134.5$$

$$= 224.54 \text{ mpa.}$$

$$\sigma_2 = \frac{\sigma_x + \sigma_y}{2} - \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$= 90 - 134.5$$

$$= -44.5 \text{ mpa.}$$

Case 2: $\sigma_A \geq 0 \geq \sigma_B$; $\sigma_1 = \sigma_A = 224.54$

$\sigma_3 = \sigma_B = -44.5$

$\sigma_A - \sigma_B \geq S_y$

$$\eta = \frac{S_y}{\sigma_A - \sigma_B} = \frac{390}{224.54 - (-44.5)} = 1.45.$$

5-3

i) $\sigma_x = -160$ Mpa , $\tau_{xy} = 100$ Mpa.

DET. $\sigma' = (\sigma_x^2 + \sigma_y^2 - \sigma_x \sigma_y + 3(\tau_{xy})^2)^{1/2}$

$= 235.79$ Mpa.

$$n = \frac{S_y}{\sigma'} = \frac{390}{235.79} = 1.65.$$

MSST.

$$\sigma_1 = \frac{\sigma_x + \sigma_y}{2} + \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$= -80 + 128.06.$

$= 48.06$ Mpa.

$$\sigma_2 = \frac{\sigma_x + \sigma_y}{2} + \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$= -80 - 128.06.$

$= -208.06$ Mpa,

Case 2 : $\sigma_A \geq 0 \geq \sigma_B$; $\sigma_1 = \sigma_A = 48.06$ Mpa

$\sigma_3 = \sigma_B = -208.06$ Mpa.

$$n = \frac{S_y}{\sigma_A - \sigma_B} = \frac{390}{48.06 - (-208.06)}$$

$= 1.52$

5-4

From the table A-18

For AISI 1018 hot rolled steel

$S_y = 220$ Mpa.

a) $\sigma_A = 100$ Mpa , $\sigma_B = 80$ Mpa.

$\sigma' = (\sigma_A^2 - \sigma_A\sigma_B + \sigma_B^2)^{1/2}$

$\sigma' = 91.65$ Mpa.

$n = \frac{S_y}{\sigma'} = \frac{220}{91.65} = 2.4.$ For DET

MSST.

Case 1 : $\sigma_A \geq \sigma_B \geq 0$; $\sigma_1 = \sigma_A = 100$

$\sigma_A \geq \sigma_y$ @ S_y.

$n = \frac{S_y}{\sigma_A} = \frac{220}{100} = 2.2.$

d) $S_y = 220$ Mpa.

$\sigma_A = -180$ Mpa $\sigma_B = -100$ Mpa.

$\sigma' = (\sigma_A^2 - \sigma_A\sigma_B + \sigma_B^2)^{1/2}$

$= 91.65$ Mpa.

$n = \frac{S_y}{\sigma'} = \frac{220}{91.65} = 2.4$ For DET.

MSST

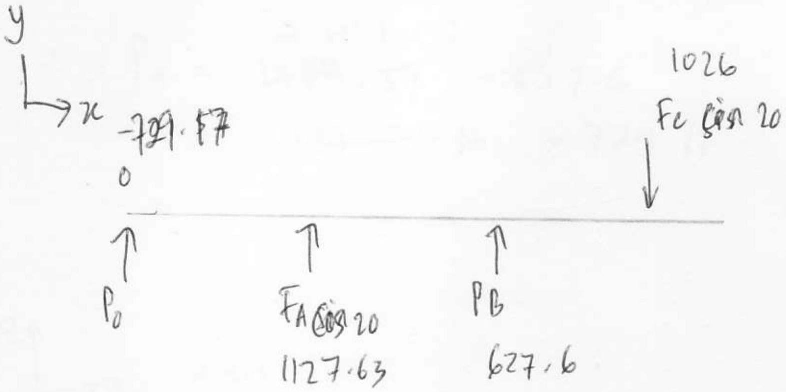
Case 3 : $0 \geq \sigma_A \geq \sigma_B$; $\sigma_1 = 0$ $\sigma_3 = \sigma_B = -100$ Mpa

$\sigma_B \leq -S_y$

$n = \frac{-S_y}{\sigma_B} = \frac{-220}{-100} = 2.2.$

5-25

$S_y = 42$ Mpa
$S.F = 3.5$
$F_A = 1.2$ kN.



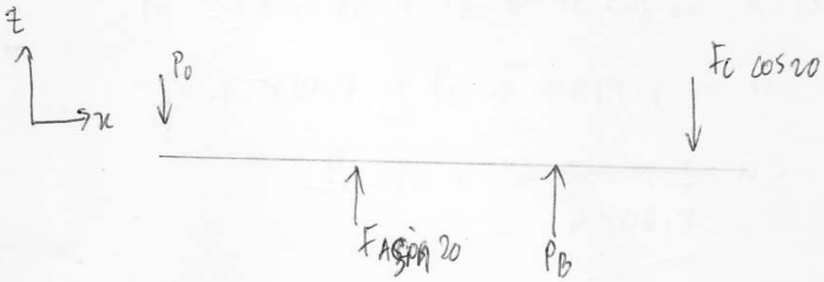
$F_A \sin 20 = 410.4$ ~~k~~pa.

$F_A \cos 20 = 1127.63$ pa.

Torque:

$F_A \cos 20 \left(d/2\right) = 563.82$ Nm.

$F_C \cos 20 \left(d/2\right) = F_A \cos 20 \left(d/2\right)$



$\Sigma T = 0$

$F_C \cancel{\cos 20} (0.12) = F_A \cancel{\cos 20} (0.3)$

$F_C = 3000$ N.

$\uparrow +)\ \Sigma F = 0$ for axis $y - x$.

$P_O + F_A \cos 20 + P_B - F_C \sin 20 = 0$.

$P_O + P_B = F_C \sin 20 - F_A \cos 20$.

$P_O + P_B = 3000^{\sin 20} - 1127.63$

$P_O + P_B = \cancel{1872.37} - 101.57$

$\Sigma M = 0.$

$$F_A \cos(20)(0.5) + P_B(0.9) - F_C \sin 20 (1.1) = 0.$$

$$563.82 + 0.9P_B - 1128.67 = 0.$$

$$P_B = 627.6 \text{ N}$$

$$\therefore P_0 = \overset{-101.57}{\cancel{1877.37}} - 627.6$$

$$= \cancel{1199.76 \text{ N}}.\quad -729.17.$$

z / x axis.

$\Sigma F = 0.$

$$-P_0 + F_A \sin 20 + P_B - F_C \cos 20 = 0.$$

$$-P_0 + 410.4 + P_B - 2819.1 = 0.$$

$$P_B - P_0 = \underset{2408.7}{\cancel{3229.5}} \text{ N}.$$

$\Sigma M = 0.$

$$F_A \sin 20 (0.5) + P_B(0.9) - F_C \cos 20 (1.1) = 0.$$

$$410.4(0.5) + 0.9P_B - 3101.01 = 0.$$

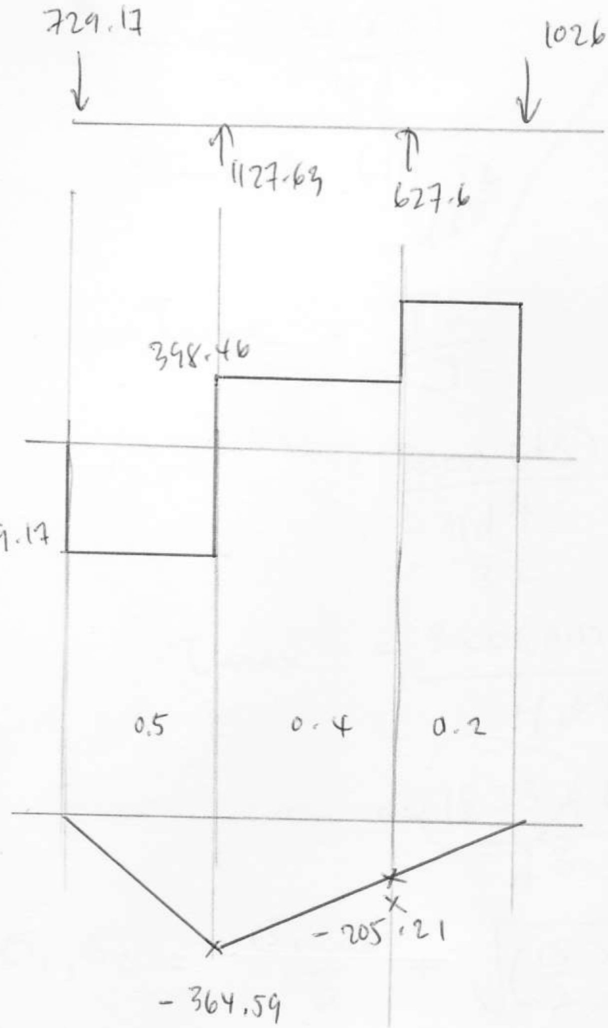
$$P_B = \underset{3217.67.}{\cancel{2690.61}/0.9.}$$

$$\therefore P_B - P_0 = 2408.7.$$

$$-P_0 = 2408.7(-3217.67.)$$

$$P_0 = 808.97 \text{ N}.$$

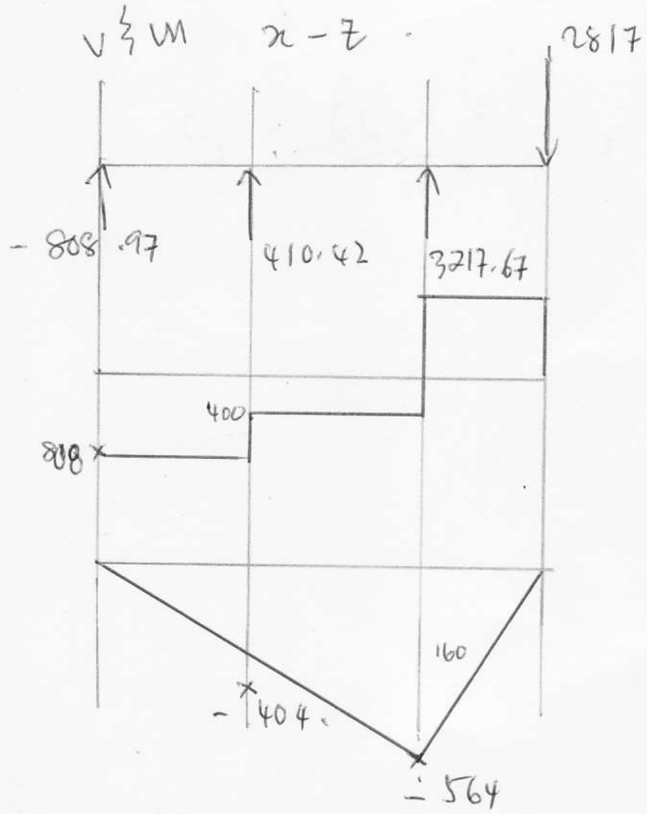
glrajah V & M - axis x - y.



Resultant $M_A = \sqrt{(-364^2 + (-404^2)}$

$M_A = 543.79.$

V & M x - z.



Resultant $M_B = \sqrt{-205^2 + (-564^2}$

$M_B = 600$

$$\sigma_{max} = \frac{32M}{\pi d^3}$$

$$\sigma_{max} = \frac{32(600)}{\pi d^3}$$

$$\sigma_{max} = \frac{6111.52}{d^3}$$

$$\tau_{max} = \frac{Tr}{J}$$

$$= \frac{3000(d/2)}{\frac{\pi d^4}{32}}$$

$$\tau_{max} = \frac{3000(0.12)\cancel{4}\ 16}{\pi d^{\cancel{4}3}}$$

$$= \frac{1833.46}{d^3}$$

$$\sigma_1, \sigma_2 = \frac{\sigma_{max}}{2} + \sqrt{\left(\frac{\sigma}{2}\right)^2 + \tau^2}$$

$$= \frac{6111.52}{2d^3} + \sqrt{\left(\frac{6111.52}{2d^3}\right)^2 + \left(\frac{1833.46}{2d^3}\right)^2}$$

$$\sigma_1 = \frac{6563.8}{d^3}, \quad \sigma_2 = \frac{-452.2}{d^3}$$

DET

$\sigma' = \frac{S_y}{n}$ $\qquad \sigma' = \sqrt{\left(\frac{6114.84}{d^3}\right)^2 + 3\left(\frac{1833.46}{d^3}\right)^2}$

$$\sigma' = \frac{6801.2}{d^3}$$

$$\frac{6801.2}{d^3} = \frac{42 \times 10^6}{3.5}$$

$$d = 82.7\,\text{mm}$$

MSST

$$n = \frac{S_y}{\sigma_1 - \sigma_2}$$

$$3.5 = \frac{42 \times 10^6}{\frac{6563.8}{d^3} - -\frac{452.2}{d^2}}$$

$$3.5 = \frac{42 \times 10^6}{\frac{7016}{d^3}}$$

$$d = 83.62\,\text{mm}$$