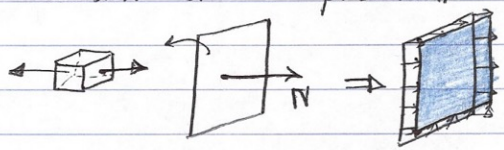
Ch8. Combined Loadings.

→ 8.2: State of stress caused by combined Loadings.

In this section you will have to find the combined state of stress at a point
So Remember:

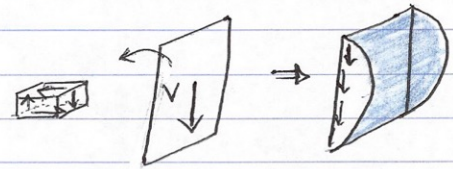
Normal force ⟼ It Does a normal stress (Tension or compression)

$$\sigma = \frac{N}{A}$$



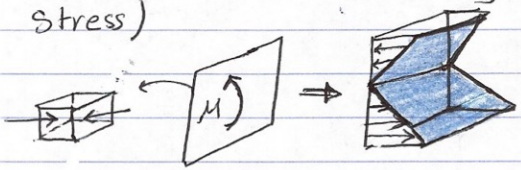
Shear force ⟼ It Does a shear stress

$$\tau = \frac{VQ}{It}$$



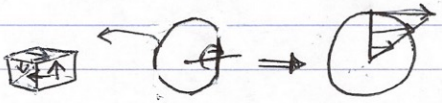
Bending Moment ⟼ It Does a stress (Bending stress)

$$\sigma = \frac{Mc}{I}$$



Torsional Moment ⟼ It Does a shear stress

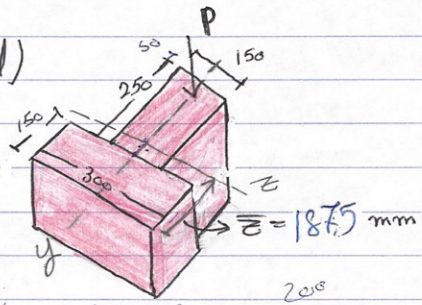
$$\tau = \frac{Tc}{J}$$



8-27

$\sigma_{all} = 6\ MPa$ (for wood)

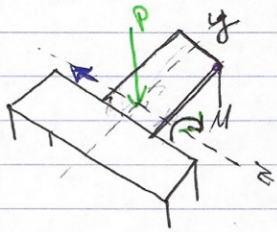
$P_{max} = ?$



location of $\bar{z}$:

$$\bar{z} = \frac{(0.075)(0.15)(0.3) + (0.3)(0.3)(0.15)}{(0.3)(0.15) + (0.15)(0.3)} = 187.5\ mm$$

Moving P:



$$M = (P)\left(\frac{450 - 187.5}{1000}\right)$$

$$M = 0.2125\,P$$

There are two stresses

$$\sigma_{all} = \sigma_P + \sigma_M$$

$$= -\frac{P}{A} + \frac{(M)c}{I}$$

$$= \frac{P}{(0.3)(0.15) + (0.15)(0.3)} + \frac{(0.2125P)(0.2625)}{I_z}$$

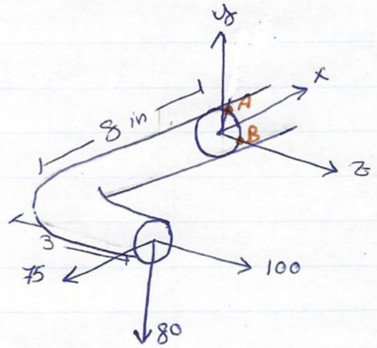
Finding $I_z = 1.5609 \times 10^{-3}$

$$6 \times 10^6 = 11.11P + 35.736P$$

$$P = 128\ kN$$

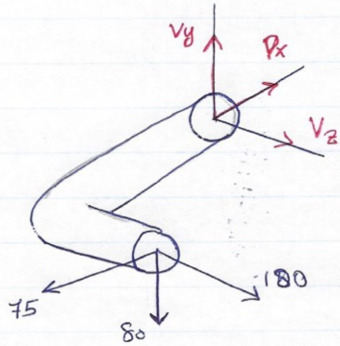
8.54

1. First find V_y, V_z, P_x using
$\Sigma F_x = 0$, $\Sigma F_y = 0$, $\Sigma F_z = 0$



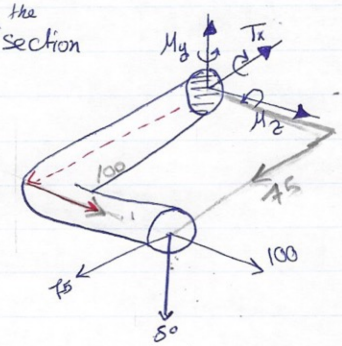
* $\Sigma F_y = 0$
$V_y - 80 = 0 \Rightarrow V_y = 80$ lb
* $\Sigma F_x = 0$
$P_x - 75 = 0 \Rightarrow P_x = 75$ lb
* $\Sigma F_z = 0$
$V_z + 100 = 0 \Rightarrow V_z = -100$ lb

ملاحظات :-
• عادة ما يعطي السؤال الفرض الموجب لكل
محور من (x, y, z) التزم بهذا الفرض
وافرض V_x, V_y, V_z بالاتجاه الموجب



→ Results until Now :-
$V_y = 80$ lb , $P_x = 75$ lb , $V_z = -100$ lb

2. find Moments : M_z, M_y, T_x ← moment around x is called Torque
we need to find resultant moments from moving 100, 80, 75 to the section
* To move 100
we need one move → one moment around y and It's in positive Direction (+y)



$M_y + (100)(8) - (75)(3) = 0$
$M_y = -575$ lb.in $(-y)$

(Moving 75 needs one move → negative moment in y direction)

* To move 80 :

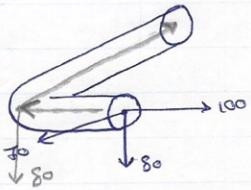
We need two moves → two moments

around x (+x) — around z (+z)

$\Sigma M_x = 0$

$T_x + (80)(3) = 0$

$T_x = -240$ lb.in



$\Sigma M_z = 0$

$M_z + (80)(8) = 0$

$M_z = -640$ lb.in

→ Results until Now:

$M_z = -640$, $T_x = -240$, $M_y = -575$

3- We find stress acting on Point B

σ_x , σ_z , σ_y

σ_x: caused by P_x

σ_z: caused by M_z

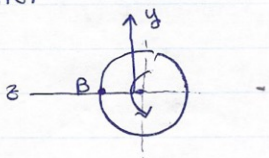
σ_y: caused by M_y

$A = \frac{\pi}{4} d^2 = \frac{\pi}{4}(1) = 0.785$

$I = \frac{\pi}{4} r^4 = \frac{\pi}{4}(0.5)^4 = 0.049$

$\sigma_x = \frac{P_x}{A} = \frac{75}{0.785} = 95.54$ psi (positive)

$\sigma_z = \frac{M_z y}{I} = \frac{(640)(0)}{I} = 0$

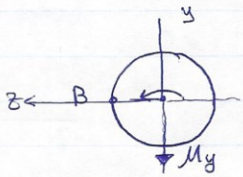


النقطة B تقطع خط الـ z فالبعد المسافة العمودية بينها وبينه (تذكر y هي المسافة العمودية بين النقطة والمحور الذي تدور الـ moment عليه

$$\sigma_y = \frac{M_y z}{I} = \frac{(575)(\frac{1}{2})}{0.049} \quad \text{(compression)}$$

$$= -5859.87$$

$$= -5.8598 \text{ ksi}$$



Now $\sigma_B = -5.8598 \times 10^3 + 95.54 = -5764.3 \text{ psi} = \ominus 5.76 \text{ ksi}$ compression

1. we find shear stresses acting on point B

τ_{xy} , τ_{xz} , $(\tau_{xy})_{\text{from Torque}}$

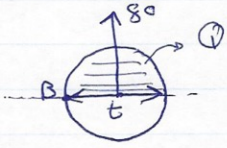
τ_{xy}: caused by V_y

τ_{xz}: caused by V_z

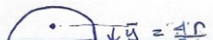
$(\tau_{xy})_{Tor}$: caused by T_x

$I = 0.049$

$$\tau_{xy} = \frac{V_y Q}{I t} = \frac{(80)(\bar{y}A)}{(0.049)(1)}$$



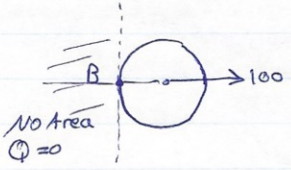
$$Q = \bar{y}A = \left(\frac{4r}{3\pi}\right)\left(\frac{\pi(0.5)^2}{2}\right)$$



$$= 0.0833$$

$$\tau_{xy} = +136.05 \text{ psi}$$

$$\tau_{xz} = \frac{V_z Q}{I t} = 0$$



$$(\tau_{xy})_{Tor} = \frac{Tc}{J} = \frac{(240)(0.5)}{\frac{\pi}{2}(0.5)^4} = +1222.93 \text{ psi}$$

So $(\tau_{xy})_{Total} = 136.05 + 1222.93 = 1358.97 \text{ psi} = 1.358 \text{ ksi}$