Name Najeeh-Ud-Din

ID 7921

Section A

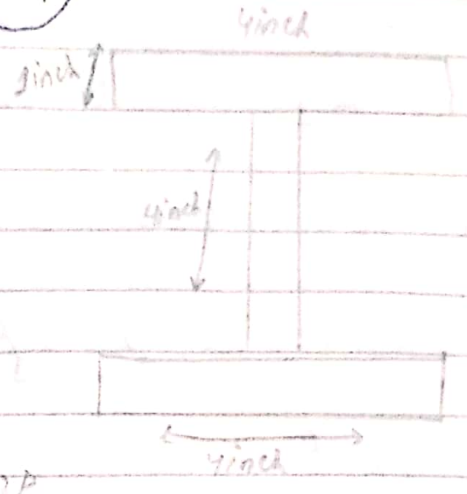
Subject MOS II

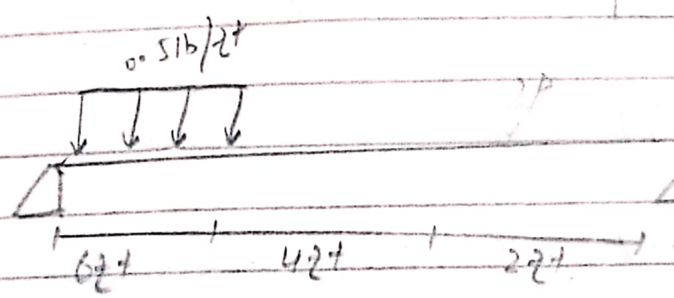
Submitted To Sir Saqib

Date 18 April 2020

Scanned with CamScanner

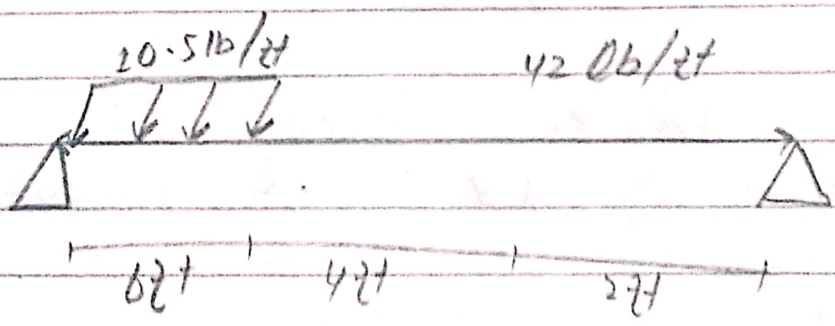
Given Beam





Note put the value of $p = 21$

So we know that



First to find unknown reaction at the support apply equillibrum equation.

Scanned with CamScanner

$\Sigma f_x = 0$ i.e $R_1 = 0$

$\Sigma f_y = 0$

$R_1 + R_2 = (10.5 \times 6)\,lb + 42\,lb$

$R_1 + R_2 = 63 + 42$

$\boxed{R_1 + R_2 = 105} \rightarrow (1)$

Next

$\Sigma M_A = 0$

$R_2 \times 12 - 10 \times 42 - (10.5 \times 6) \times 3 = 0$

$12R_2 = 420 + 189$

$12R_2 = 609$

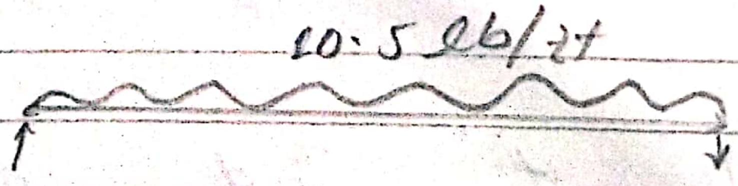
$\boxed{R_2 = 50.75}$

$R_1 + R_2 = 105$

$R_1 = 105 - 50.75$

$R_1 = 54.25\,lb$

Now shear force at change point of Beam



at 6ft

Shear force at 6ft from support

$\Sigma F_y = 0 \quad (+)\uparrow \quad (-)\downarrow$

$54.25 - 10.5 \times 6 - V6ft = 0$

$54.25 - 63 - V6ft$

$V6 = 43.75$

Now shear force at 10ft

$\Sigma F_y = 0 \quad (+)\uparrow \quad (-)\downarrow$

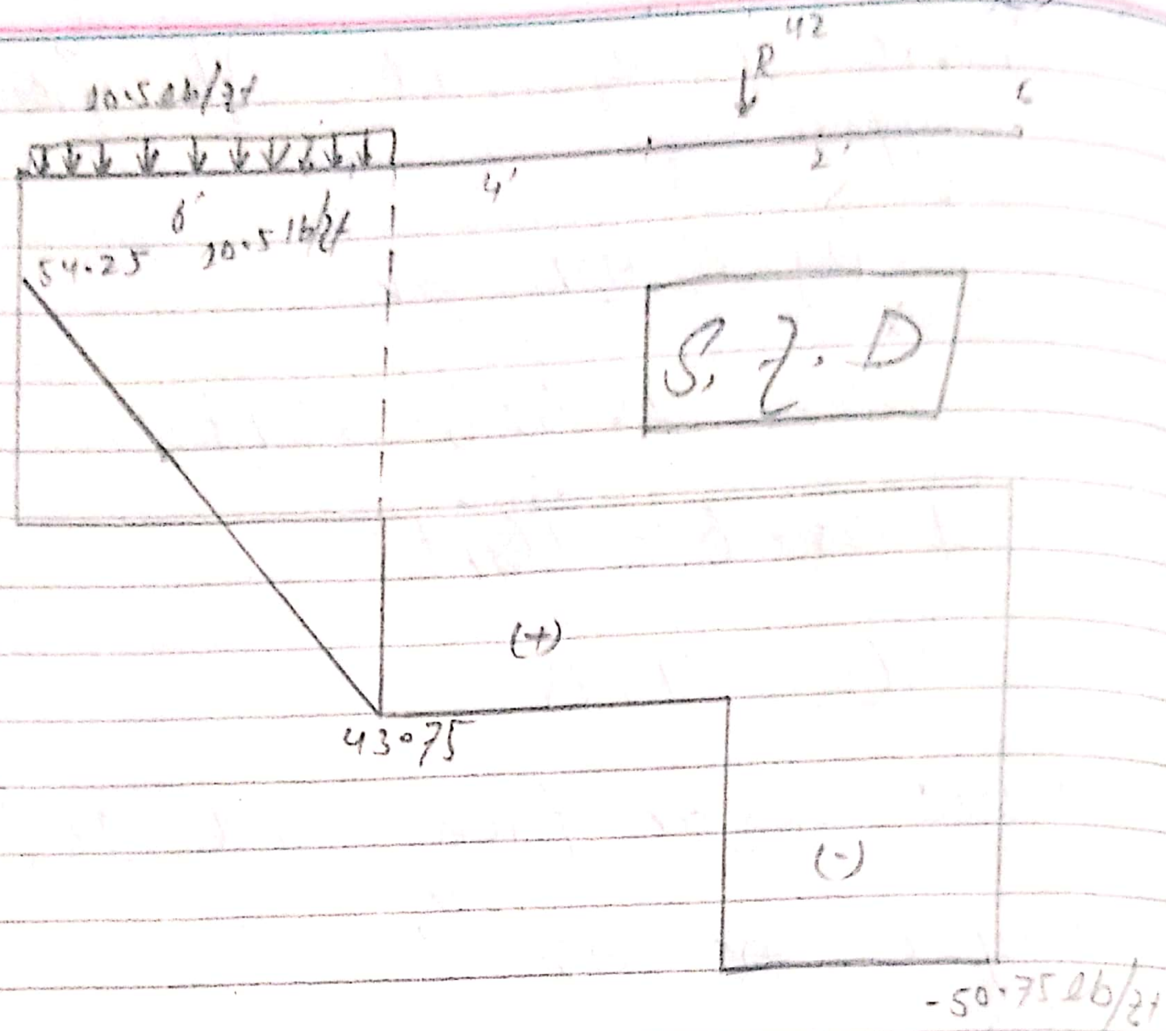
$54.25 - 10.5 \times 6 - 42 - V10ft$

$54.25 - 63 - 42$

$V10ft = -50.75\,lb$

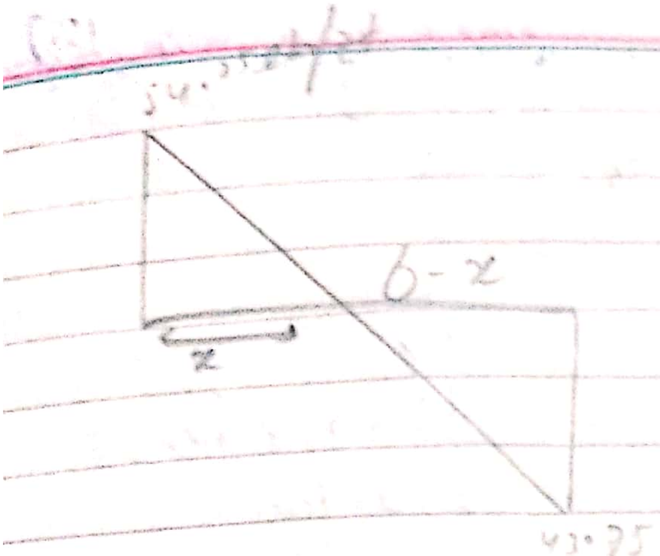
Now draw shear force and Bending moment diagram

Scanned with CamScanner



point of miximum Bending moment

As we know that the point where shear force is miximum the Bending moment is miximum so from point is zero shear corresponding point will have maximum Bending moment from shear force diagram we have.



we know that

$$\frac{54.25}{x} = \frac{43.75}{6-x}$$

$$(6-x)(54.25) - 43.75x$$

$$1472.52 - 54.25 = 43.75x$$
$$1472.52 = 43.75 + 54.25x$$
$$1472.52 = 72.75x$$

$$\boxed{x = 20.240\,ft}$$

Now determine the value of moment at 20.240ft

$$M_{20.240} = 54.25 \times 20.240 + (10.5 \times 20.240) \times \left(\frac{20.240}{2}\right)$$

$$M_{20.240} = 1098.02 + 212.52 \times 10.12$$

$$M_{20.240} = 1098.02 + 2150.70$$

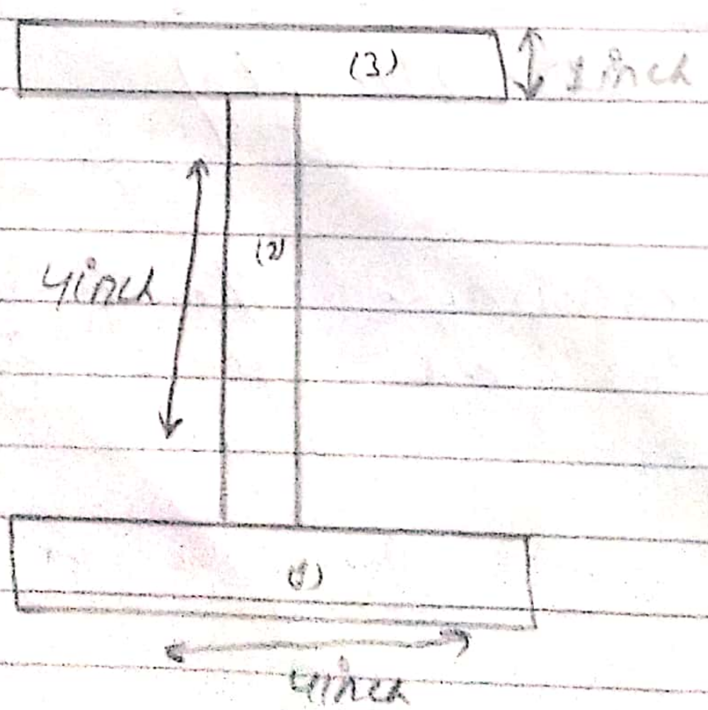
$$M_{20.240} = -1098.02 + 2150.70$$

$$M_{20.240} = 1052.68$$

for shear stress we have

$$S = \frac{VQ}{Ib}$$

So first we determine moment of inertia I to the given section of Beam.



As the given figure is symmetrical along Both the axis.

So. $\bar{x} = 4/2 = 2$ inch

$\bar{y} = 6/2 = 3$ inch

i.e $(\bar{x}, \bar{y}) = (2, 3)$

(Center of gravity)

exetremme left and bottom

Area of point (1) = $4 \times 1 = 4$ inch

Area of point (2) = $4 \times 1 = 4$ inch

Area of point (3) = $4 \times 1 = 4$ inch

moment of inertia about x-axis

(Centriod) $I \times 3$

Detemine the distance btw 1.Cg of the whole section and corresponding parts.

Scanned with CamScanner

Let

$C_{g_1}, C_{g_2}, C_{g_3}$ be in the center of gravity of point (1) (2) and (3) and k_1, k_2, k_3 be the distance btw $\bar{y}$ and y_1, y_2, y_3 respectivily

So

$k_1 = \bar{y} - y_1 = 3 - 0.5 = 2.5$ inch

$k_2 = \bar{y} - y_2 = 3 - 3 = 0$ inch

$k_2 = \bar{y} - y_3 = 3 - 0.5 = 2.5$ inch

So

$I_{xx} = \frac{b_1 h_1^3}{12} + a_2 k_1^3 + \frac{b_i h_2^3}{12} + a_2 k_i^3$

$+ \frac{b_3 h_1^3}{12} + a_3 k_3$

$I_{xx}\ \frac{(4)(1)^3}{12} + \frac{4(2.5)^2}{12} + \frac{(1)(4)^3}{12}$

$+ a_2(0) + \frac{4(1)}{12} + 4(2.5)$

Scanned with CamScanner

$$I_{xx} = \frac{4/12 + 25 + 64/12 + 4/12 + 25}{12}$$

I_{xx} 56inch^4

Now

$$I_{yy} = \frac{b_1^3 h_1}{12} + \frac{b_2^3 h_2}{12} + \frac{b_3^3 h}{12}$$

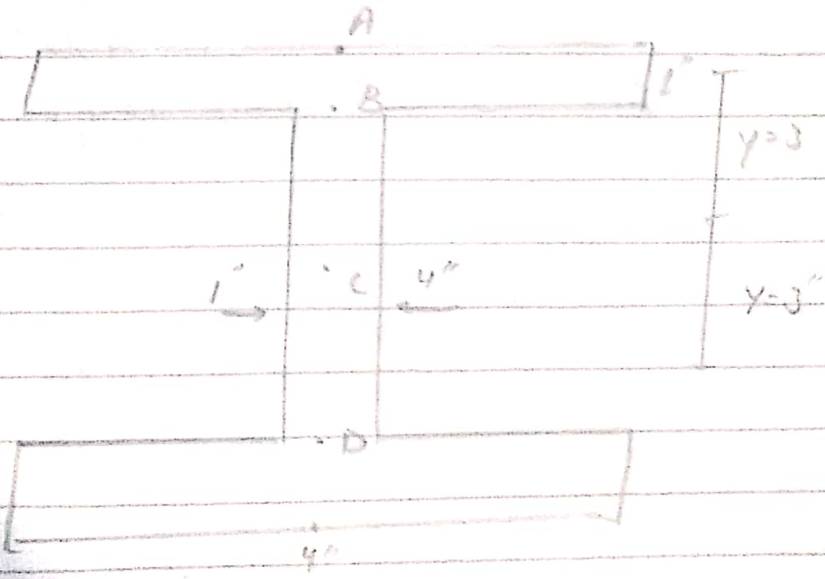
$$I_{yy} = \frac{(4)^3(1)}{12} + \frac{(1)^3(4)}{12} + \frac{(4)^3(1)}{12}$$

$$I_{yy} = \frac{64 + 4 + 64}{12} = 11 \text{inch}$$

NEXT

Find the next shear ~~force~~ stresses at various point we have

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



Scanned with CamScanner

(i) Shear stress at point "A" i.e At the top fiber

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

$V_{max} = 50.75$
$I = 67$

$\tau = \frac{50.75(6)}{67(4)}$

So $= \tau = 1$

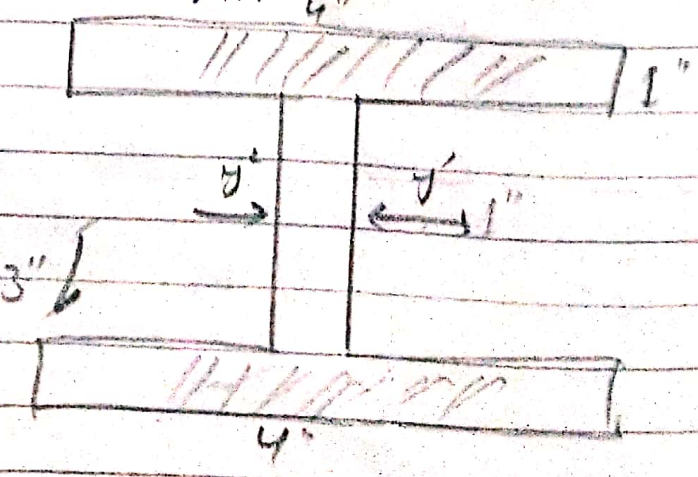
Here A = 1 Beam area of section exist above point A
i.e = $Q\bar{A}y(\cancel{A})$ $\bar{y} = 0$

Shear force at point "B"

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

$\tau = \frac{50.75 \times (4 \times 1)(3 - 0.5)}{67 \times 4}$

$\tau = 30.29\ lb/in^2$



Scanned with CamScanner

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

$$\tau = \frac{50.75 \times [4 \times 1 \times (3-0.5) + (1/2)(2\text{[illegible]}}{67 \times 1}$$

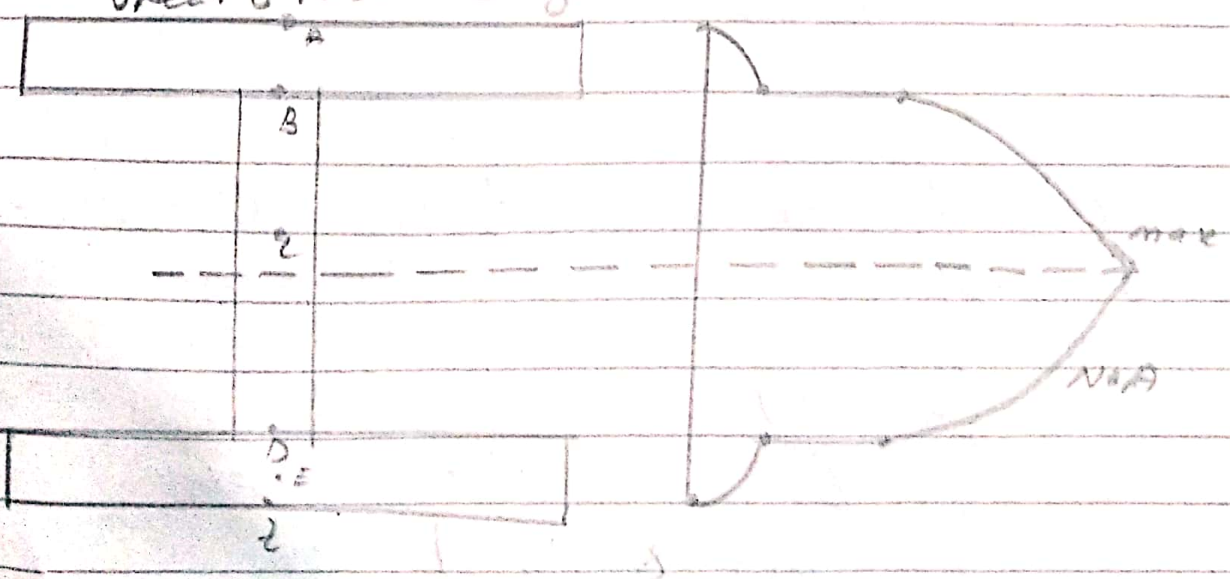
$$\tau = 8.332 \ lb/in^2$$

(iv) Shear stress at point D and E will be the same because of the symetry.

Note

The maximum shear stress value occur at the neutral axis and maximum value at the top of the section.

Shear Stress Diagram



Flexural stress Determine

$$\delta = \frac{My}{I}$$

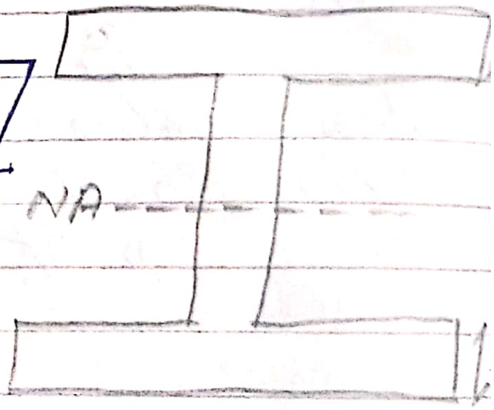
$$\delta = \frac{1052.68 \times 3}{67}$$

$$\delta = 47.13 \ lb/in^2$$

(ii) flexural stress at point B

$$\delta = \frac{1052.68 \times (3-0.5)}{67}$$

$$\delta = \boxed{39.27 \ lb/in^2}$$



(iii) flexural stress at point "C

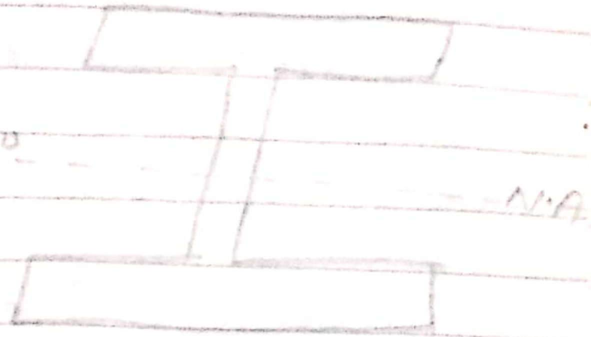
$$\delta = \frac{My}{I}$$

$$\delta = \frac{1052.68 \times (3-1)}{67}$$

$$\delta = 31.42 \ lb/in^2$$

Scanned with CamScanner

(iv) Flexural stress at neutral axis (N.A)



$$\delta = \frac{My}{I}$$

$$\delta = \frac{1052.68\times(0)}{67}$$

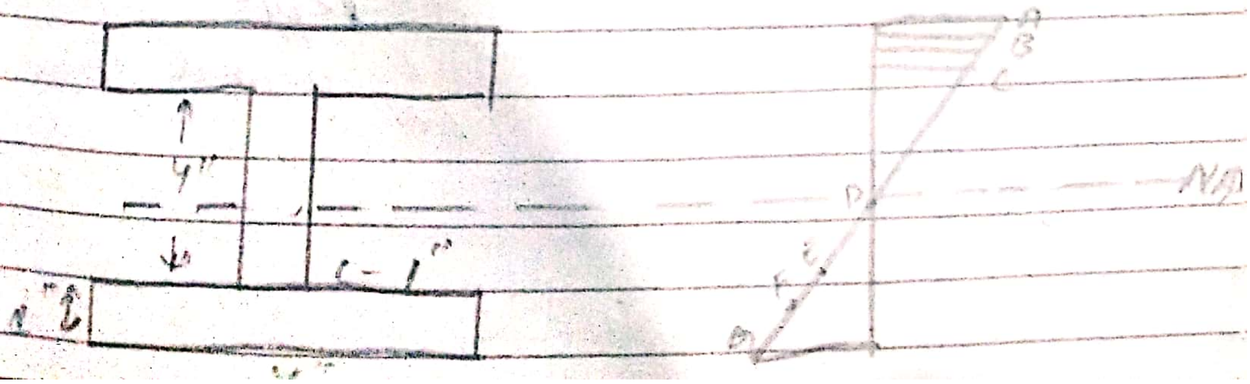
$$\delta = 15.71\ lb/in^2$$

Flexural stress value at point E, f and g remain the same because of symetry

Note

The flexural stress value is maximum at extreme top and bottom fiber at zero at N.A.

Flexural stress diagram



Stress State

Find stress state of a point element located 3 ft from left support and 1 inch below from top fiber.

Flexural stress at point "C"

$\sigma = 18.92 psi$

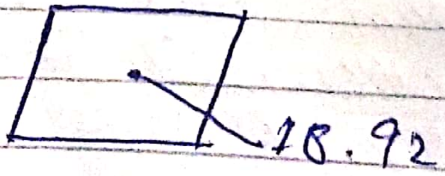
Shear stress at point "C"

$\tau = 8.332 \, lb/in^2$

(iv) Shear stress at point "C"

$\tau = 8.332$ Psi ~~lb/in²~~

Consider point "C" is a planner element



As the flexural stress is perpendicular to the cross section can be represented normal stress

$\tau = 8.332$ psi is comprective Becouse point "C" lies in compression Zone of Beam cross section.

If point C lies below the centrid them Stress would be tensile

$\tau = 8.332$ psi

$\tau = 8.332$ psi

$\sigma_x = 18.92$ psi

Combine Stress on 2d element.

Find the principal Stress

we have also find

$\sigma_x = 18.92$

$\sigma_y = 0$

$\tau_{xy} = 8.332$

Scanned with CamScanner

principle stress equation

$$\sigma_{x,y} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$\sigma_{x,y} = \frac{-18.92+0}{2} \pm \sqrt{\left(\frac{18.92-0}{2}\right)^2 + (8.332)^2}$$

$$\sigma_{x,y} = -9.46 \pm \sqrt{89.49 + 69.42}$$

$$\sigma_{x,y} = -9.46 \pm \sqrt{158.91}$$

$$\sigma_{x,y} = -9.46 \pm 12.60$$

$$\sigma_{x} = -9.64 + 12.60 = 2.96$$

$$\sigma_y = -9.64 - 12.60 = -22.24$$

OR First find $\theta_p = ?$

$$\tan 2\theta_p = \frac{\sigma_{xy}}{(\sigma_x - \sigma_y)/2}$$

$$\tan 2\theta_p = \frac{8.332}{(-18.92)/2}$$

$$\tan 2\theta_p = -0.880$$

$$2\theta_p = \tan^{-1}(-0.880)$$

Scanned with CamScanner

$$\frac{2\theta_p}{2} = \frac{-41.34}{2}$$

$$\boxed{\theta_p = -20.67}$$

put in General equation

$$\sigma_{max} = \frac{-18.92+0}{2} + \frac{-18.92+0}{2}$$

$$\cos 2(-20.67) + 8.332 \sin 2(-20.67)$$

$$\sigma_{p\,max} = \cos(-41.34) + 8.332 \sin(-41.34)$$

$$\sigma_{p\,max} = 0.75 + 8.332 - 0.660$$

$$\sigma_{p\,max} = 8.423$$

max in plane shear stress in this case

$$\tan 2\theta_s = \frac{-(\sigma_x - \sigma_y)/2}{\sigma_{xy}}$$

$$\tan 2\theta_2 = \frac{-(-18.92-0)/2}{8.332}$$

$$\tan 2\theta_s = \frac{9.46}{8.332}$$

$$\tan 2\theta_s = 1.13$$

Scanned with CamScanner

$2\theta_s = \tan^{-1} 1.13$

$2\theta_s = 48.49$

$\theta_s = \frac{48.46}{2}$

$\theta_s = 24.24$

put in these General equation.

$$T_{x'y'} = -\left[\frac{\delta x - \delta y}{2}\right] \sin 2\theta + \delta xy \cos 2\theta$$

$$T_{x'y'} = -\left[\frac{-18.92 - 0}{2}\right] \sin 2(24.24) + 8.332 \cos^2(24.24)$$

$$T_{x'y} = 9.46(0.2 + 8.332 + 0.6)$$

$$86.388$$

Scanned with CamScanner

TO Draw Mohr's circle center co-ordinate

$$(h, k) = \left(\frac{\sigma x + \sigma y}{2}, 0\right)$$

$$\Rightarrow \left(\frac{-18.92 + 0}{2}, 0\right)$$

$$\Rightarrow \left(\cancel{\frac{-9.46}{2}}, 0\right)$$

$$\Rightarrow (-9.46, 0)$$

Radius of Mohr's circle

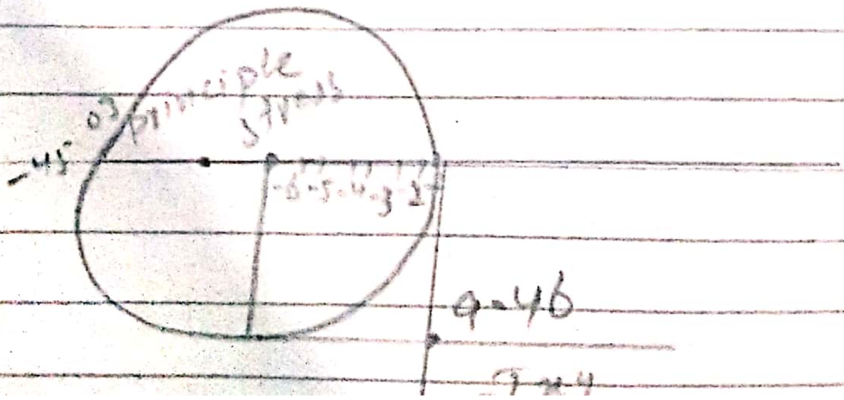
$$r = \sqrt{\left(\frac{\sigma x - \sigma y}{2}\right)^2 + \tau_{xy}^2} \quad \sqrt{\left(\frac{-18.92 - 0}{2}\right)^2 + (8.332)^2}$$

$$r = \sqrt{89.4916 + (8.332)^2}$$

$$r = \sqrt{158.91}$$

$$\boxed{r = 12.606}$$

Scale: 1 psi : km



Scanned with CamScanner