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ID :- 7919

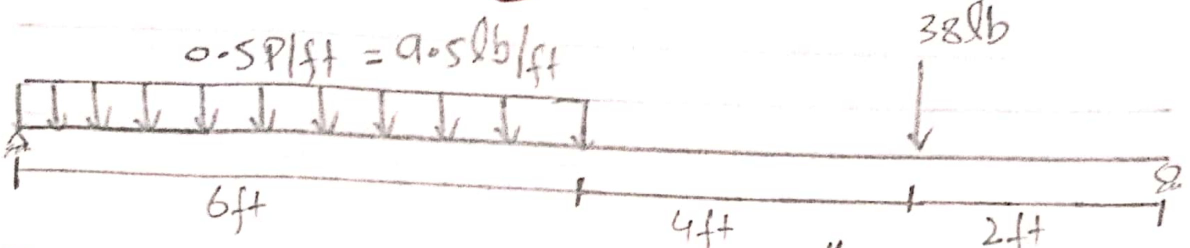
SUBJECT :- MOS (II)

SUBMITTED TO :- Sir Saqib

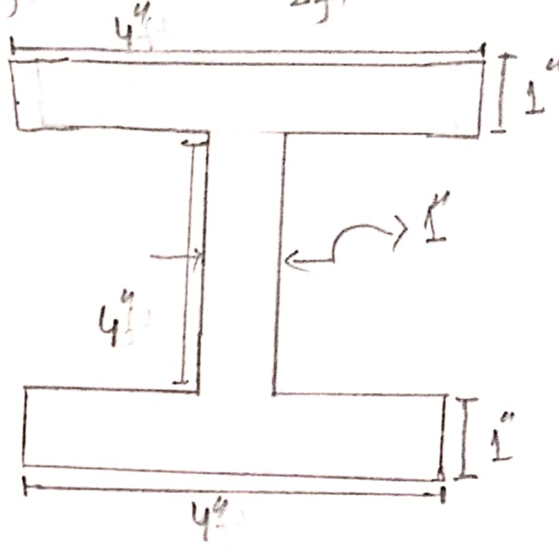
Question ①

Construct the Mohr's circle diagram and find the principale Stress and maximum in plane Shear Stress for the Stress State of a Point C located at the Center of uniformly distributed load and 1 inches below the top fiber of beam Cross Section Show in figur. However to Construct the Mohr's Circle it is necessary to draw the Shear stress and flexural Stress variation diagram for maximum Shear force and bending moment repectively. Compare the Result obtained from the Mohr's Circle With the Stress transformation equation

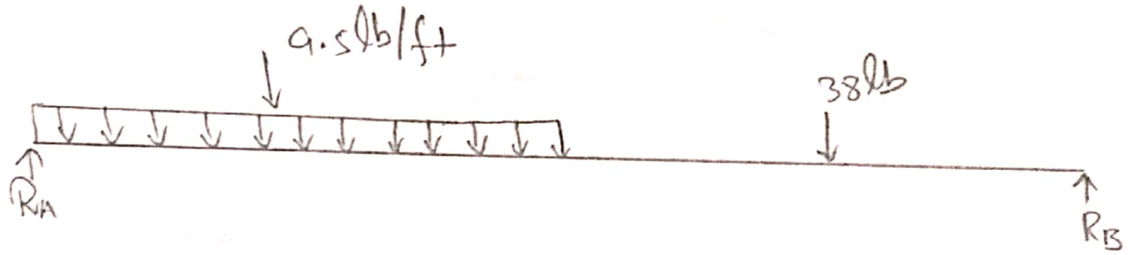
Hint ⇒ To Calculate the Stress in the beam Cross Section the moment of inertia must be Known.
Where P is the last two digits of Your Class registration number in Pound.



Solution:



free body diagram



$\sum F_y = 0$ ↑+ ↓−

$R_A + R_B - 9.5 \times 6 - 38 =$

$\boxed{R_A + R_B = 95\,lb}$

$\sum M_A = 0$ ↺ + Anticlockwise positive

$R_B(12) - (38)(10) - (9.5)(6)(3) = 0$

$R_B(12) = 551$

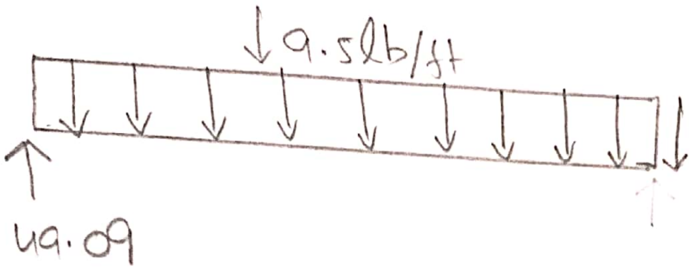
$R_B = \boxed{45.91\,lb/ft}$

Now

$R_A = 95 - R_B$

$\boxed{R_A = 49.09\,lb}$

Change Point of Beam

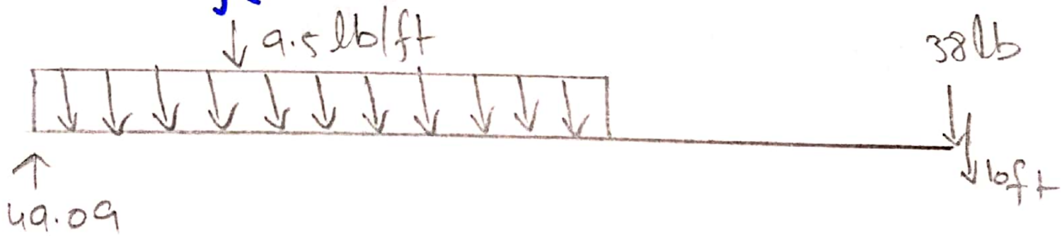


$\Sigma F_Y = 0 \quad \uparrow + \quad \downarrow -$

$-V_{6ft} + 49.09 - 9.5 \times 6 = 0$

$\boxed{V_{6ft} = -7.91\,lb}$

At 10ft



$\Sigma F_Y = 0 \quad \uparrow + \quad \downarrow -$

$-V_{10ft} + 49.09 - 9.5 \times 6 - 38 = 0$

$\boxed{V_{10ft} = -45.91}$

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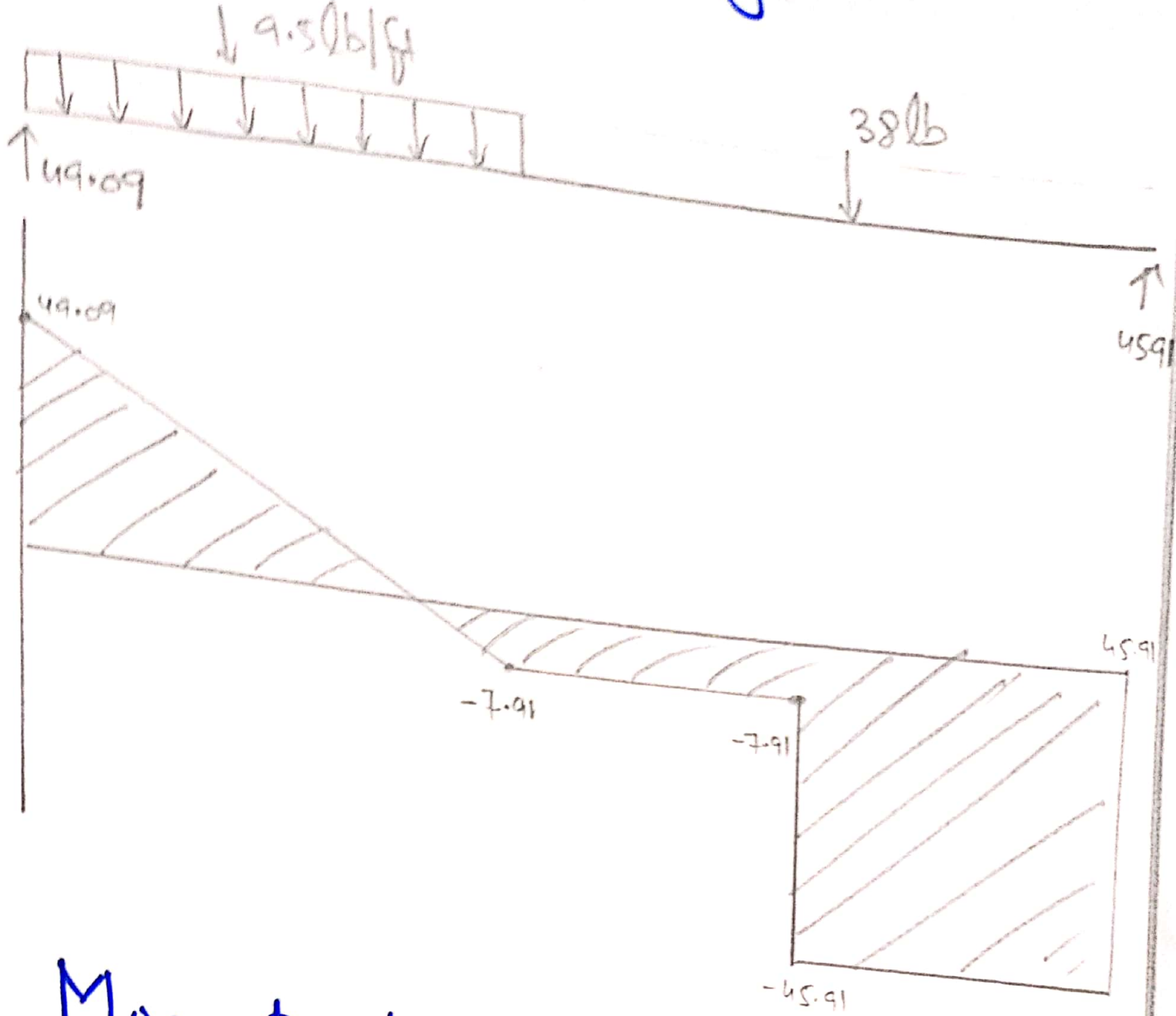
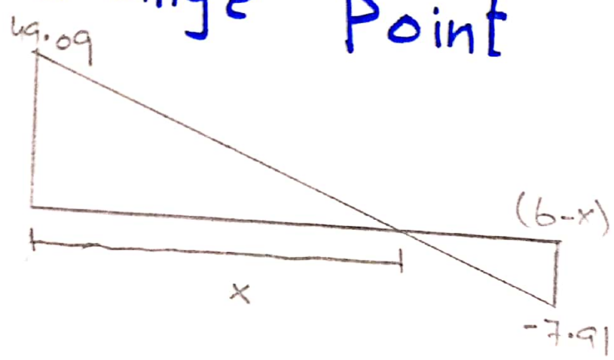
Shear force diagram ④



Moment At Change Point



$$\frac{49.09}{X} = \frac{7.91}{(6-x)}$$

$X = 5.16$

Moment is max where Share force is $=0$

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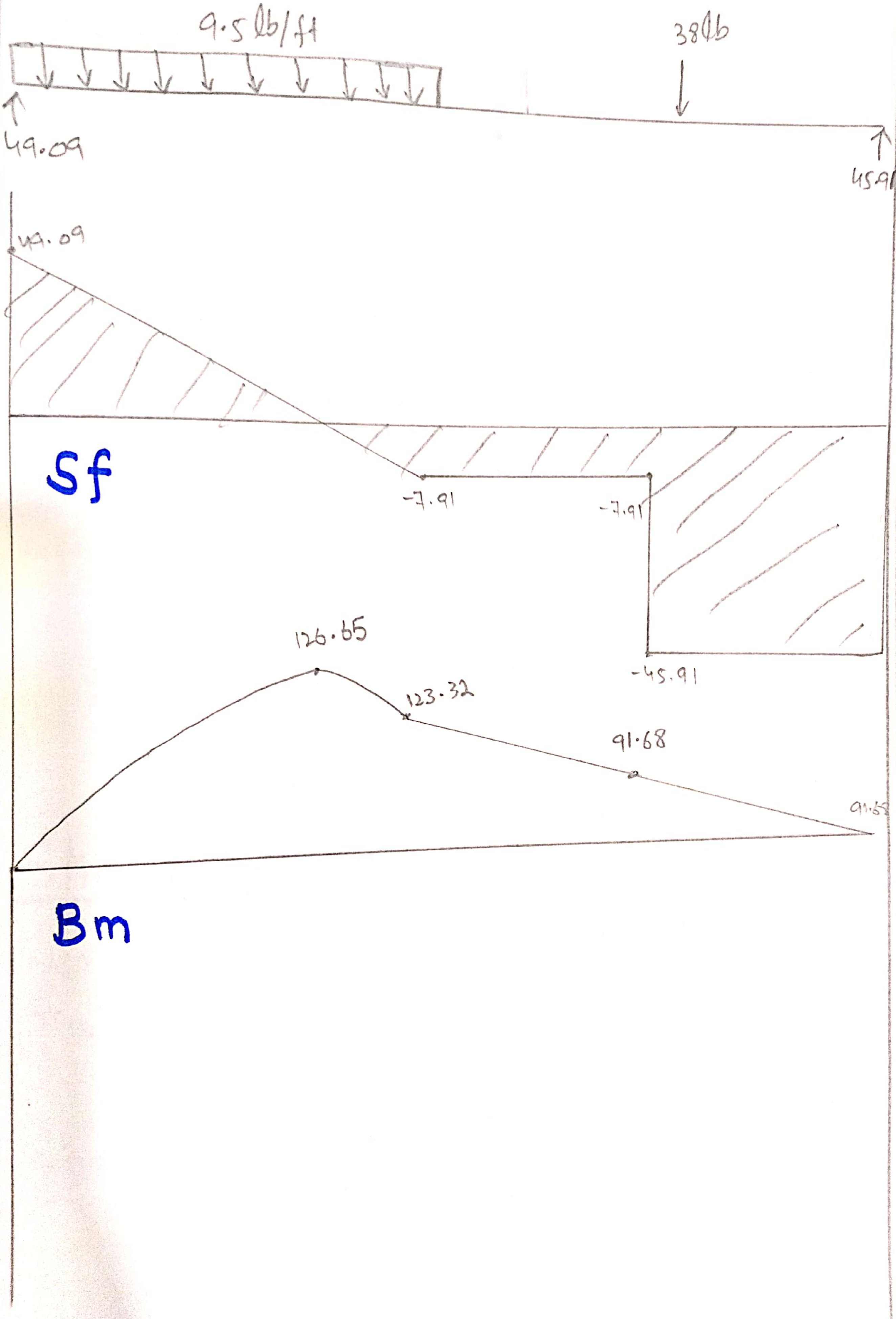
Shear force and movement diagram.



Moment at 3ft from left Support which is Point

$$\sum M_{3ft} = 0 \circlearrowleft +$$

$$M_{3ft} - (49.09 \times 3) + (9.5 \times 3 \times 1.5) = 0$$

$$\boxed{M_{3ft} = 104.52 \text{ lb}\cdot\text{ft}}$$

$$\sum F_Y = 0 \uparrow + \downarrow -$$

$$49.09 - 9.5 \times 3 = 0$$

$$\boxed{V = 20.59 \text{ lb}}$$

Shear stress ⇒

As per the Question the shear Stress $\tau = \frac{VQ}{Ib}$ at C point occurs the Shear Stress lies at C point is

20.59 lb

Moment of Inertia of I section

To find the Moment of Inertia first find the Geometric Center

$$\bar{I}_{xx} = \bar{I}_{xx_1} + \bar{I}_{xx_2} + \bar{I}_{xx_3}$$

$$\bar{I}_{xx_1} = \frac{1}{12}(4)(1^3) + (4)(2.5)^2 = 25.33$$

$$I_{xx_2} = \frac{1}{12}(4^3)\times(1) + (4)(0) = 5.33$$

$$\bar{I}_{xx_3} = 1/12\,(1^3)(4) + 4(3-55)^2 = 25.33$$

$$\bar{I}_{xx} = \bar{I}_{xx_1} + \bar{I}_{xx_2} + \bar{I}_{xx_3}$$

$$\bar{I}_{xx} = 25.33 + 5.33 + 25.33$$

$$I_{xx} = 25.33 + 5.33 + 25.33$$

$$I_{xx} = 56 in^4$$

$$I_{yy} = I_{y1} + I_{y2} + I_{y3}$$

$$= \frac{bh^3}{12} + \frac{bh^3}{12} + \frac{bh^3}{12}$$

$$= \frac{4^3 \times 1}{12} + \frac{1^3 \times 4}{12} + \frac{1 \times 4^3}{12}$$

$$= \boxed{I_{yy} = 11 in^4}$$

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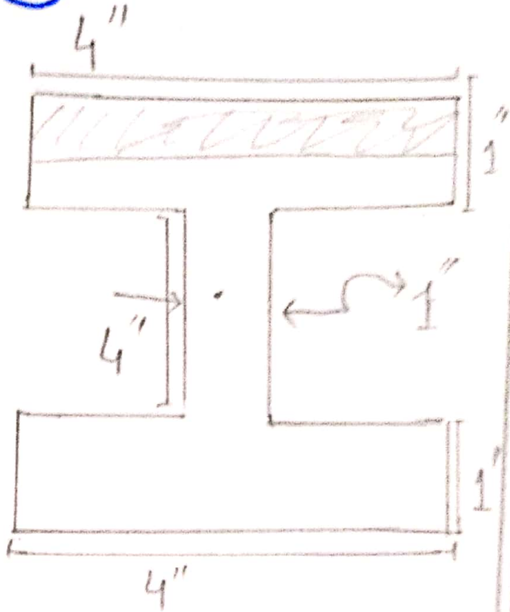
Shear stress at point C

1" below the top fibre



$$\tau_{xy} = \frac{VQ}{Ib}$$

$$Q = Ay$$

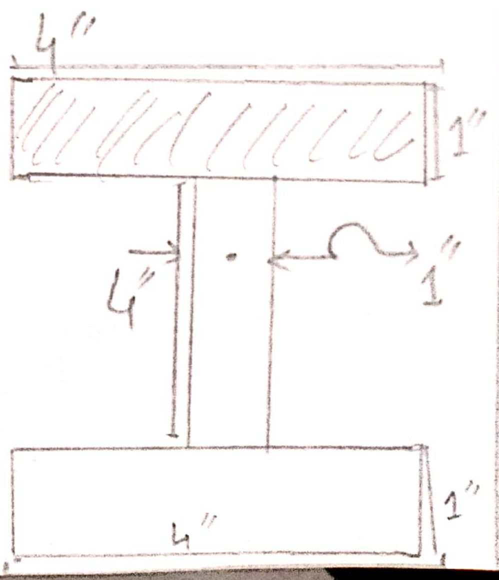
$$Q = 1 \times 4 \times 2.5 = 10\ in^2$$

$$\tau_{xy} = \frac{20.59 \times 10}{56 \times 4}$$

$$\boxed{\tau_{xy} = 0.919\ lb/in^2}$$

Flexure Stress at Point C

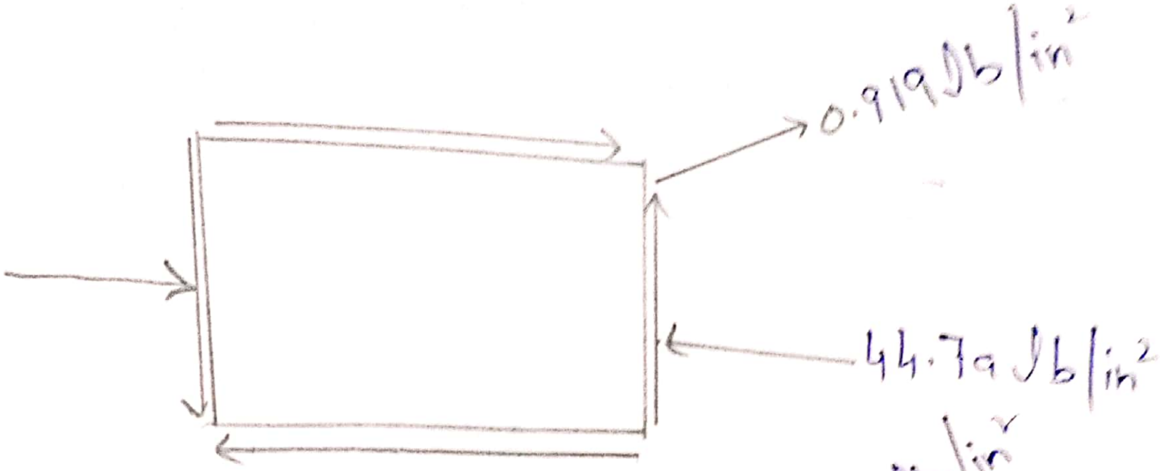
1" below from The Top fibre

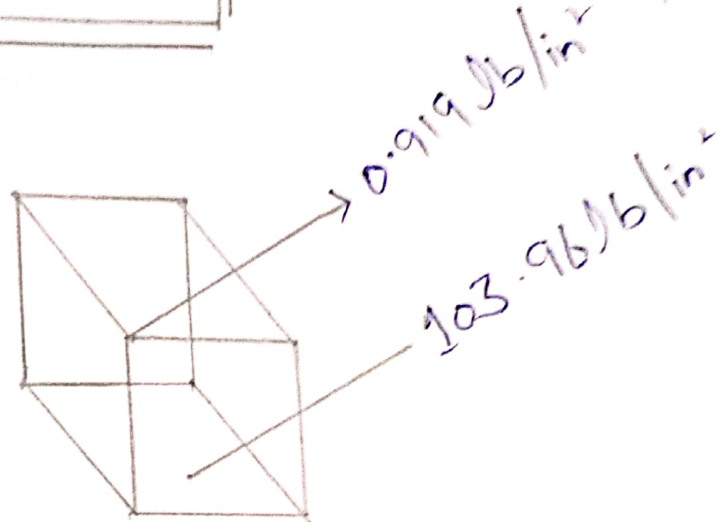


$$\sigma_x = \frac{My}{I}$$

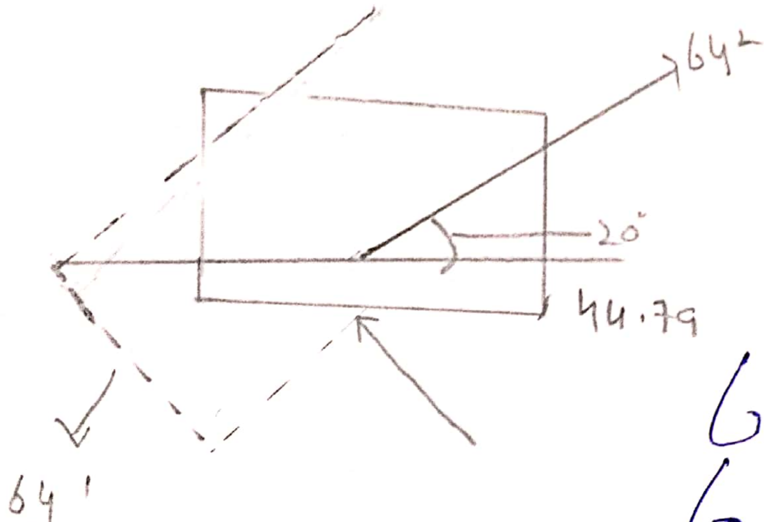
$$= \frac{12 \times 104.52 \times 2}{56}$$

$$= \boxed{44.79\ lb/in^2}$$





Find the Stress State Condition of Point C at Assum angle As 20° anticlockwise Orientation



$\sigma_x = -44.79 psi$

$\sigma_y = 0$

$\tau_{xy} = 0. psi$

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$$\sigma_{x'} = \frac{\sigma_x + \sigma_y}{2} + \frac{\sigma_x - \sigma_y}{2} \cos 2\theta + \tau_{xy} \sin 2\theta$$

$$\sigma_{x'} = \frac{-44.79 + 0}{2} + \frac{-44.79 - 0}{2} \cos 2(20) + 0.91$$

$$\sin 2(20)$$

$$\boxed{\sigma_{x'} = -38.96 \rightarrow \text{Compressive}}$$

$$\sigma_{y'} = \frac{\sigma_x - \sigma_y}{2} - \frac{\sigma_x - \sigma_y}{2} \cos 2\theta - \tau_{xy} \sin 2\theta$$

$$-0.91$$

$$\sigma_{y'} = \frac{-44.79 + 0}{2} - \frac{44.79 - 0}{2} \cos 2$$

$$20 \sin (2)(20)$$

$$\boxed{\sigma_{y'} = -4.65 \text{psi} \rightarrow \text{Compressive}}$$

for $\tau_{x'y'}$

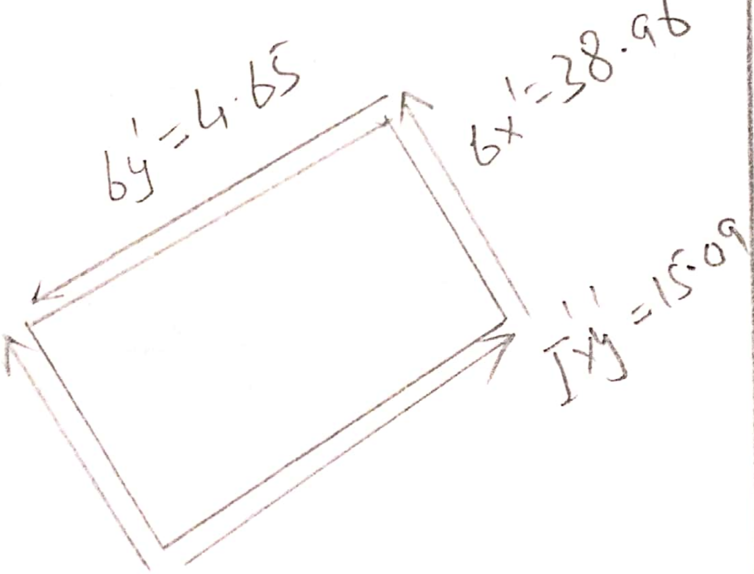
$$\tau_{x'y'} = \frac{-\sigma_x - \sigma_y}{2} \sin 2\theta + \tau_{xy}$$

$$\cos 2\theta$$

$$= -\frac{-44.79 - 0}{2} \sin 2(20) + 0.91 \cos 2(20)$$

$$\tau_{x'y'} = 15.09$$

Now Stress State after 20° Colockwise orientation is Shown



Find it Principle Stresses

$$\sigma_{1,2} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$\sigma_{1,2} = \frac{-44.79 + 0}{2} \pm \sqrt{\left(\frac{-44.79 - 0}{2}\right)^2 + (0.91)^2}$$

$$\sigma_{1,2} = -22.395 \pm 22.41$$

$$\sigma_y = -22.395 + 22.41 = 0.018\ psi$$

$$\sigma_x = -22.395 - 22.395 = 44.79\ Psi$$

find $\theta_p = ?$

$$\tan 2\theta_p = \frac{\tau_{xy}}{(\sigma_x - \sigma_y)/2} \Rightarrow \frac{0.91}{(-44.79-0)/2}$$

$$\boxed{\theta_p = -0.081}$$

Put in general Equation

$$\sigma_{x\,max} = \frac{-44.79+0}{2} + \frac{-44.79-0}{2}\cos 2(-0.081)$$

$$+\ 0.91 \sin 2(-0.081)$$

$$\sigma_{x\,max} = 44.79\ Psi$$

Max in Plane Shear Stress

In This Case $\rightarrow$ $\tan 2\theta_s = \frac{-(\sigma_x - \sigma_y)/2}{\tau_{xy}}$

$$\tan 2\theta_s = \frac{-(-44.79-0)/2}{0.91}$$

$\boxed{\theta_s = 49.21 \rightarrow \text{anticlockwise}}$

Put in the general Equation for $I_{x'y'}$

$$I_{x'y'} = -\left[\frac{6x - 6y}{2}\right] \sin 2\theta + I_{xy} \cos 2\theta$$

$$= -\left(\frac{-44.79 - 0}{2}\right) \sin 2(49.21) + 0.91 \cos 2(44.21)$$

$$\boxed{I_{x'y'} = 22.17 \text{ psi}}$$

↳ Max in Plane Shear Stress

To Draw the Mohr's Circle for the given Problem

Centre Coordinate ⇒

$$(h, k) = \left[\frac{-47.79 + 0}{2}, 0\right]$$

$$= [-22.395, 0]$$

Radius of Mohr's Circle

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

$$r = \sqrt{\left(\frac{-47.79 - 0}{2}\right)^2 + (0.91)^2}$$

$$\boxed{r = 22.21 \text{ psi}}$$

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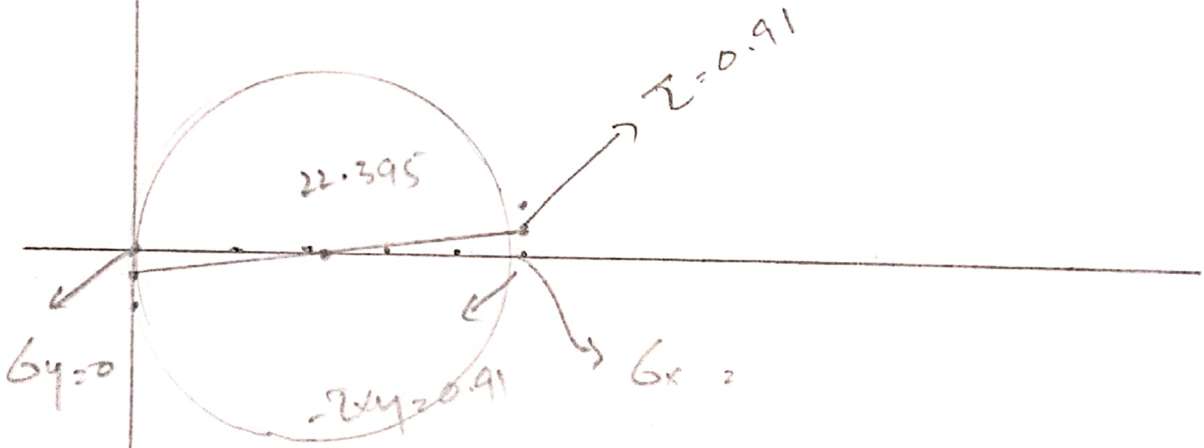
Sketch of Mohr's Circle



$\sigma_{x_1} = 103.67$

$\sigma_{xy} = 0$

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Conclusion ⇒ As Shown from Mohr's Circle The value obtain that of Principle Stress and maximum Shear Stress are Almost Same with value obtained from transformation equations.