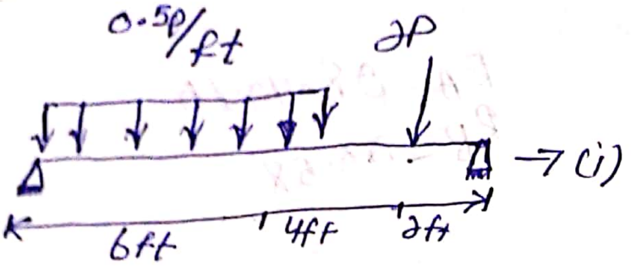
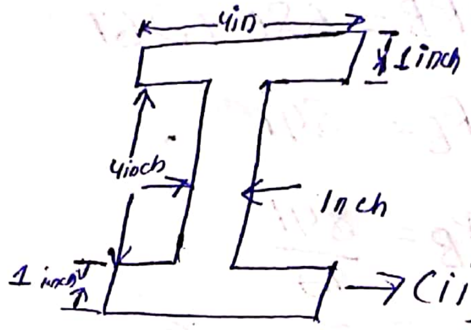
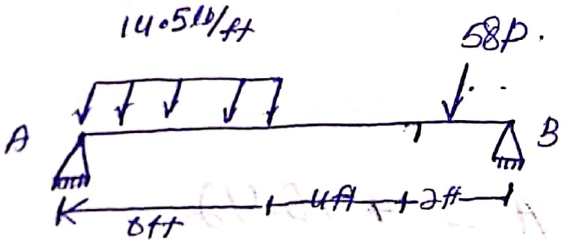




Sol:-

In the given fig the value of $P=29$, so $2P$ will become $58\ P$ and $0.5P/ft$ $14.5\ lb/ft$

So the fig(i) becomes.



Now to find the support reaction at point A & B.

Taking moment at A.

$\Sigma M_A = 0$

$\cancel{(R_B \times 12) - (58 \times 10)}$

$(R_B \times 12) - (58 \times 10) - (14.5 \times 6 \times 3)$

②

$R_B \times 12) - (58 \times 10) - (14.5 \times 6 \times 3)$

$\Rightarrow 12R_B - 580 - 261$

$12R_B = 841$

$R_B = 70.08$

Now

$\Sigma f_y = 0$

$\Rightarrow R_A + R_B - 14.5 \times 6 - 58.5$

$\Rightarrow R_A + 70.08 - 14.5 \times 6 + 58.5 = 0$

$R_A = 75.42$

Now find shear force at diff points.

shear force at $A = 75.42$

shear force at $C = 75.42 - (14.5 \times 6)$

$= 75.42 - 87$

$\Rightarrow -11.58$ lb

Shear force at $D = -11.58 - 58.5$

$= -70.08$

shear force at $B = 70.08 - 70.08$

$= 0$

Now Bending moment at $A = 0$

The bending moment is maximum at a point where shear force is zero and this point lies b/w A and C. The maximum bending moment can be find after drawing the shear force diagram.

Bending moment at $C = (75.42 \times 6) - (87 \times 3)$

$= 452.52 - 261$

$\Rightarrow 191.52$

Bending moment at $D = (75.42 \times 10) - (87 \times 3)$

$\Rightarrow 754.2 - 261$

$\Rightarrow \cancel{493.2}$

$\Rightarrow 145$

Bending moment at $B = 0$

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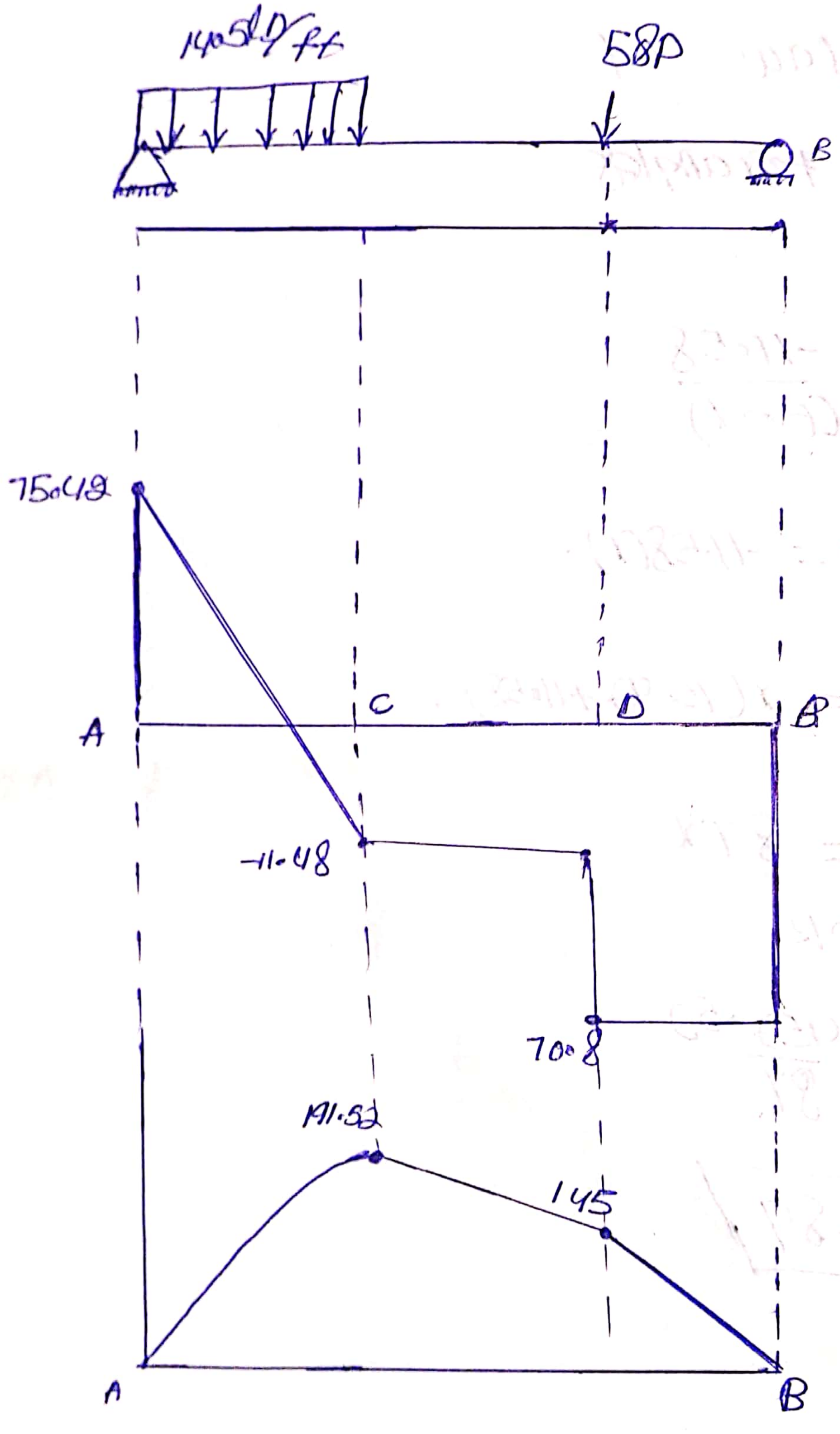
S.F and B.M.D:-



cons.

Now we will find the max bending moment from shear force a

From law of similar triangles we have

$$\frac{75.42}{x} = \frac{-11.58}{(6-x)}$$

$$75.42(6-x) = -11.58(x).$$

$$452.52 = x(75.42+11.58).$$

$$452.52 = 87x$$

OR

$$\frac{87x}{87} = \frac{452.52}{87}$$

$$\boxed{x = 4.89}$$

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Sow maximum bending moment at point F

$(75.42 \times 4.89) - (14.5 \times 6)\left(\frac{4.89}{2}\right).$

$M_{max} = 368 - 87(2.44).$

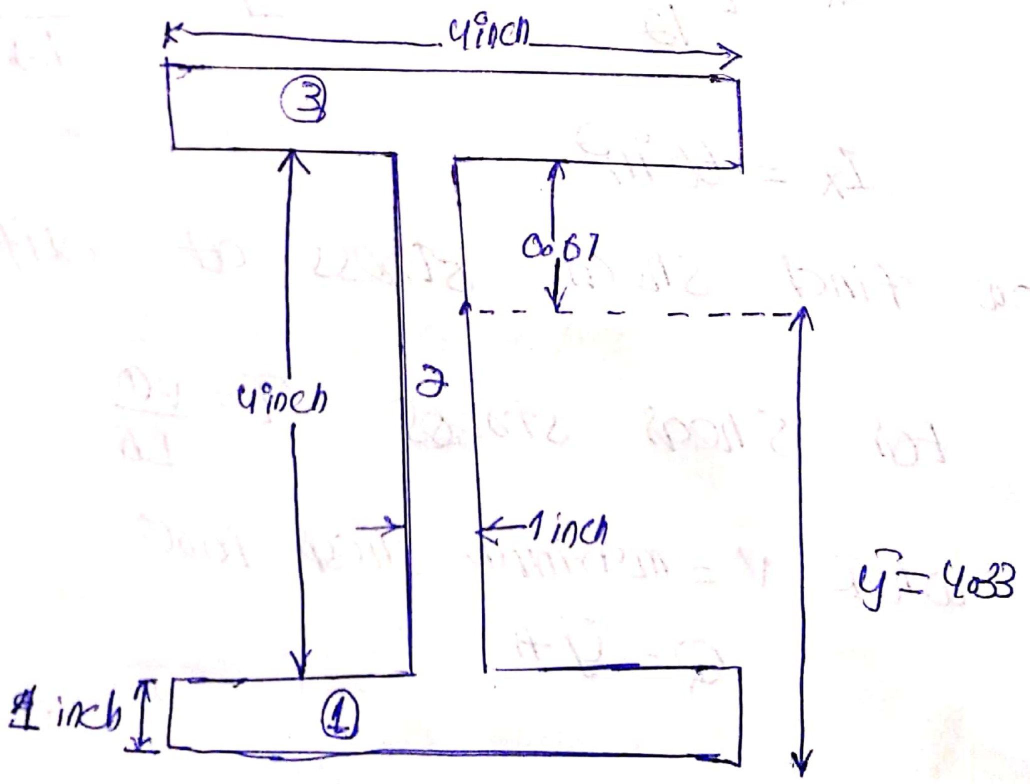
$= 368 - 212$

$\boxed{M_{max} = 156 \, lbft}$

Now we will find the shear stress

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

Moment of Inertia:-

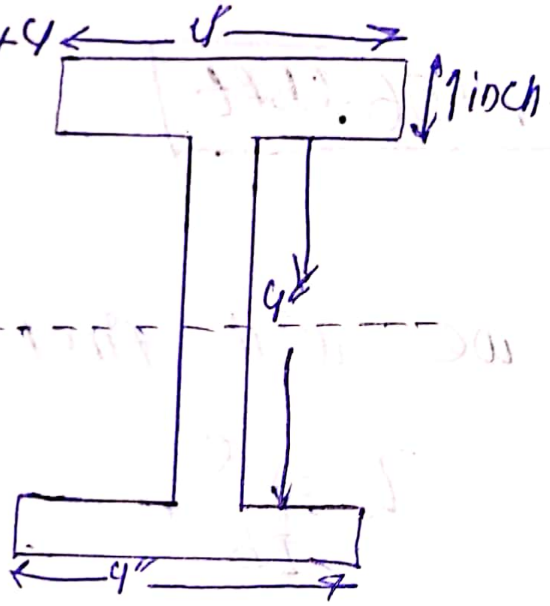


The centroid of the section about Y-a

$$\bar{y} = \frac{A_1 y_1 + A_2 y_2 + A_3 y_3}{A_1 + A_2 + A_3}$$

$$\bar{y} = \frac{(4)(0.5) + (4)(3) + 4(9.5)}{4+4+4}$$

$\bar{y} = 4.33$



Moment of inertial of I-Section:-

$$I_x = \left[\frac{(4)(1)^3}{12} + 4(1)(2.5)^2\right] \times 2 + \frac{(1)(4)^3}{12}$$

$I_x = 56 \text{ in}^2$

Now find shear stress at diff points

For shear stress $\tau = \frac{VQ}{Ib}$

where V = maximum shear force

$Q = \bar{y}A$

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Case 1:-
shear stress at top of fibre

$$\tau_{top} = \frac{VQ}{Ib} = \frac{(75.42)(0)}{56 \times 4}$$

$$\tau_{top} = 0.$$

case 2:-
0.5 inch below top fibre

$$\tau_{0.5} = \frac{(75.42)(1.42) \times (0.5) \times 4}{56 \times 4} \Rightarrow 0.95.$$

$$\tau_{0.5} \Rightarrow \bar{y} = 0.67 + 0.5 + \frac{0.2}{2}$$

$$\tau_{0.5} = 0.36 \text{ psi}$$

case 3:-
1 inch below top fibre

$$\tau_1 = \frac{(75.42)(1.17 \times 4)}{56 \times 4}$$

Here $\bar{y}_1 = 0.67 + \frac{1}{2} = 1.17$

$A = 1 \times 4 = 4.$

$\tau_1 = 0.59 \text{ psi}$

case 4

Shear stress at centroidal axis.

In this case take above centroidal axis and find Q.

$$Q = Q + Q_2$$

$$Q_1 = \bar{y}_1 A_1$$

$$Q_1 = \frac{0.67}{2}(0.67 \times 1)$$

$$\boxed{Q_1 = 0.224}$$

$$Q_2 = (0.67 + \frac{1}{2}) \times (4 \times 1)$$

$$\boxed{Q_2 = 4.68}$$

$$Q_\phi = Q_1 + Q_2$$

$$= 0.224 + 4.68$$

$$Q = 4.904$$

Total

$$\tau_{max} = \frac{(75.42)(4.904)}{56 \times 1} = 6.604$$

$$= 6.604 \text{ psi}$$

Case 5:-

shear stress below centroidal axis and above the bottom fibre.

$$\tau = \frac{VQ}{Ib} = \frac{75.42\,(2.165 \times 3)}{56 \times 4}$$

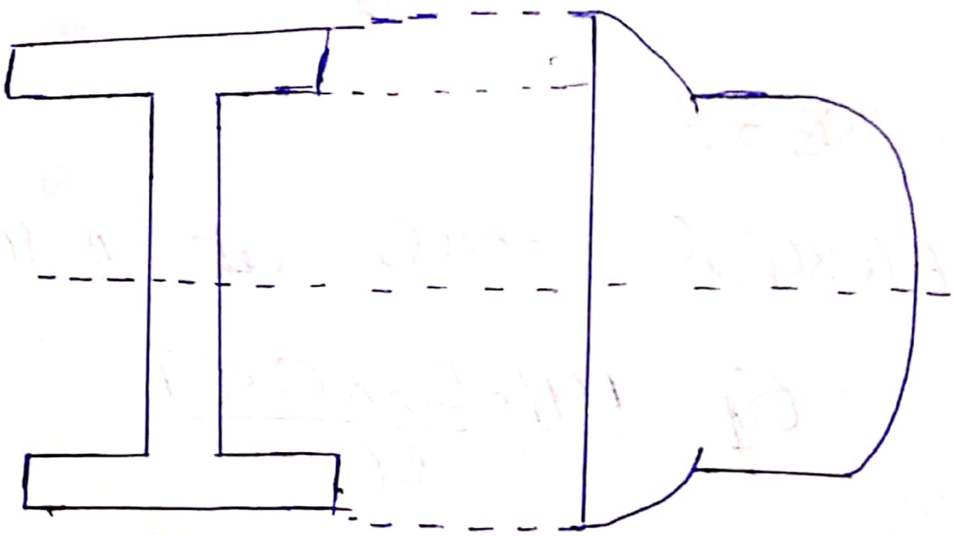
Here

$$\bar{y} = \frac{4.33}{2} = 2.165$$

$$A = 3 \times 1 = 3\,inch^2$$

$$\tau = 0.824\ Psi$$

shear stress variation diagram for I section.



Now we will find the flexural stress at different points along the length of beam.

$$\sigma = \frac{My}{I} \rightarrow (4).$$

case 1:-

Flexural stress at top fibre

$$\sigma_{top} = \frac{191.52 \times 1.67}{56}$$

$$\sigma_{top} = 5.7114 \text{ psi}$$

case 2:-

Flexural stress at 0.5 below top fiber.

$$\sigma_{0.5} = \frac{191.52 \times 1.17}{56} \Rightarrow 4 \text{ psi}$$

case 3:-

Flexural stress at 1 inch below.

$$\sigma_1 = \frac{191.52 \times 0.67}{56}$$

$$\sigma_1 = 2.052 \text{ psi}$$

case 4:-

Flexural stress at centroid

$$\sigma_{con} = \frac{My}{I} = 0 \quad \& \quad y = 0.$$

case 5:-

Flexural stress at 3 inch above the botton fibre

$$\sigma_3 = \frac{My}{I} = \frac{191.52 \times 1.33}{56} \Rightarrow 4.54.$$

here $y = 1.33$

$\sigma_3 = 1.33 psi$

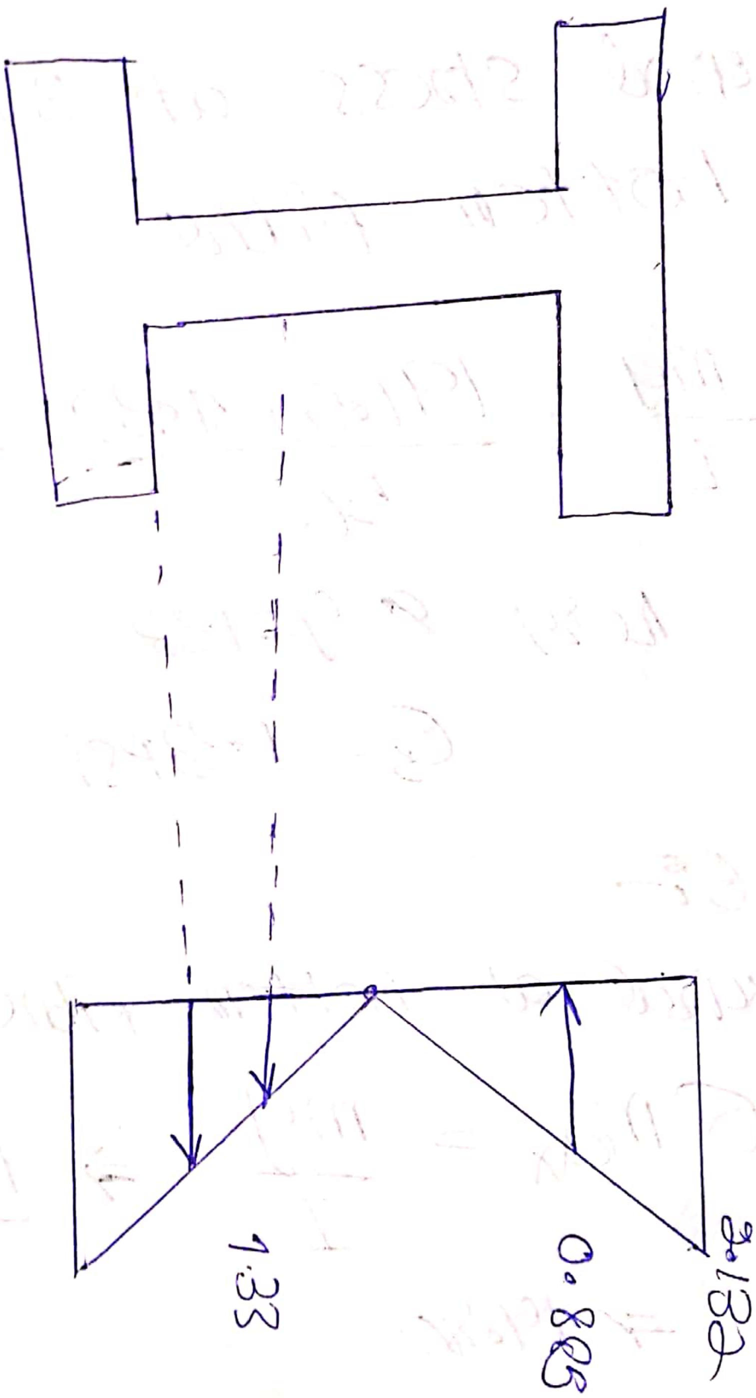
case 6:-

Flexural at bottom fibre

$$\sigma_{Max} = \frac{My}{I} \Rightarrow \frac{191.52 \times 4.33}{56}$$

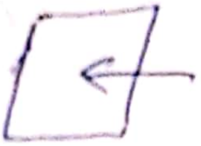
$\Rightarrow 14.80.$

∴ Flexural stress diagram.



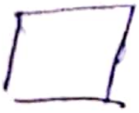
Now we will find the stress on a plane of point which is in compression above the centroid of a section

consider point "C" on planes element

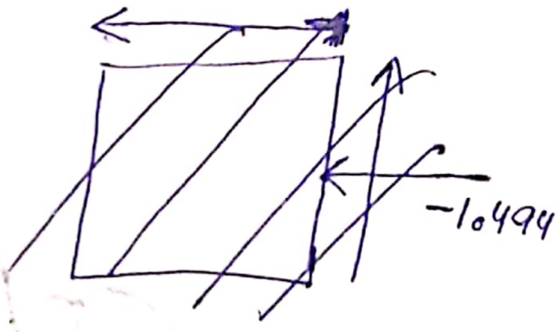
 $\sigma_x = 2.052$ psi

shear stress will be

$\boxed{\tau = 0.59}$ → case 3.

 $\uparrow \tau = 0.59$

Here



$\sigma_x = -1.494$ psi

$\sigma_y = 0$

$\tau_{xy} = -0.36$ psi

Eq for normal stress

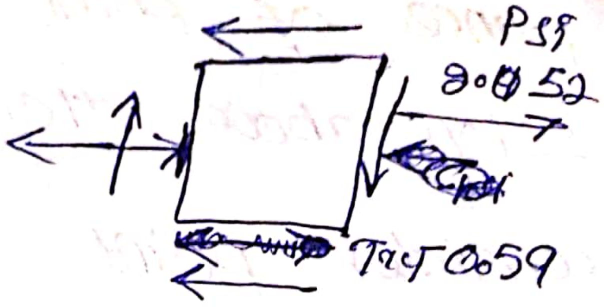
$$\sigma_{1,2} = \frac{\sigma_x + \sigma_y}{2} + \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + (-0.59)^2}$$

$$\sigma_{1,2} = \frac{-2.052}{2} + 0 \pm \sqrt{\left(\frac{-2.052}{2}\right)^2 + (-0.59)^2}$$

$$\sigma_{1,2} = -1.026 \pm \sqrt{-1.026 + 0.3481}$$

$$\sigma_{1,2} = -1.026 \pm \sqrt{-0.6779}.$$

$$\sigma_{1,2} = -1.026 \pm 0.8233.$$



construction of mohr's circle.

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

$$r = \sqrt{\left(\frac{2.059}{2}\right)^2 + (0.59)^2}$$

$$r = \sqrt{3.2239} \Rightarrow r = 1.7977$$

mohr's circle