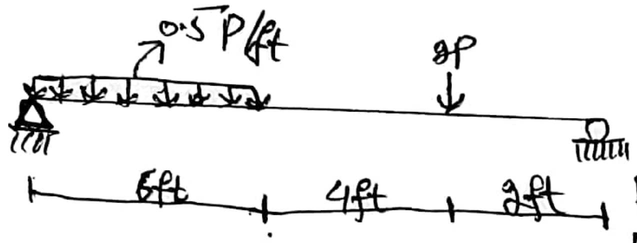
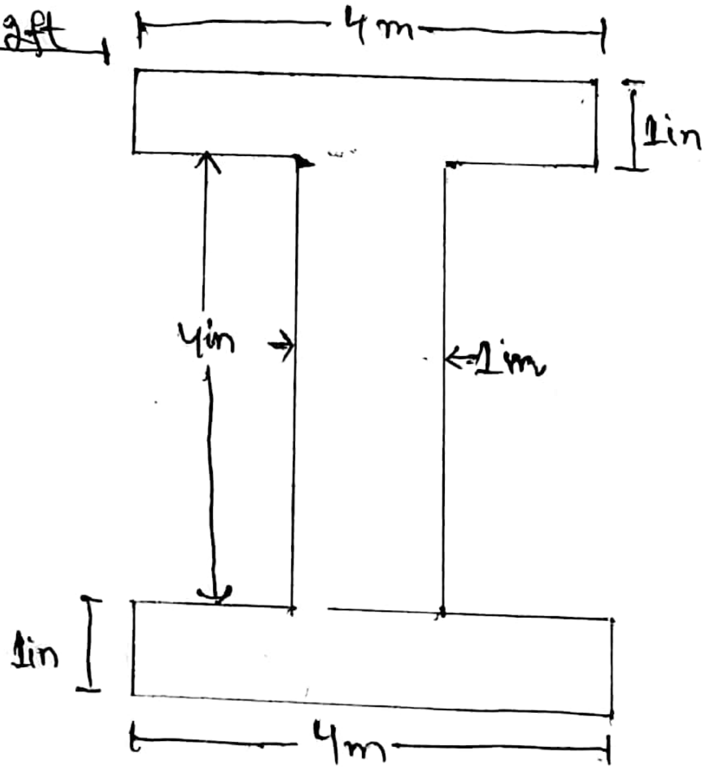
Questions:-





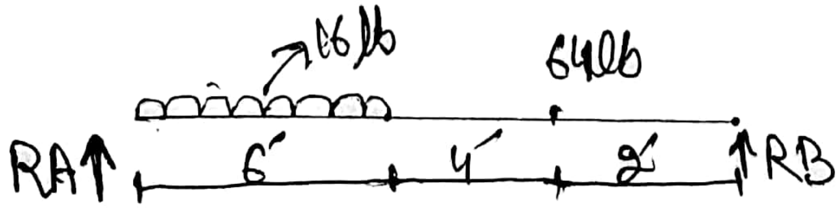
Solution

ID # 7532

$0.5P = 0.5 \times 32$
$= 16\ lb$

$2P = 2 \times 32$
$= 64\ lb$

Free body diagram:-



Support Reaction

$\Sigma M_A = 0$ (↺+)

$-(16\times6)(3)-(64)(10)+RB\times12=0$

$RB = \frac{928}{12}$

$RB = 77.33\ lb$

$\Sigma f_y = 0$ ↓− ↑+

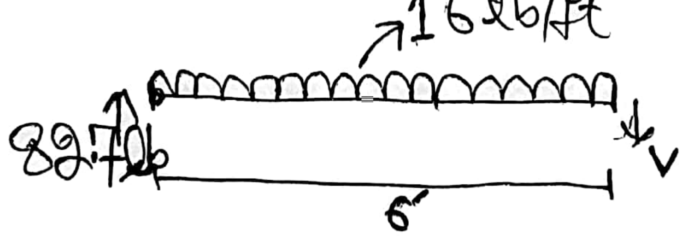
$RA-(16\times6)-64+77.33=0$

$RA = 160 - 77.33$

$RA = 82.7$

Shear force at change Point of beam

At 6':-



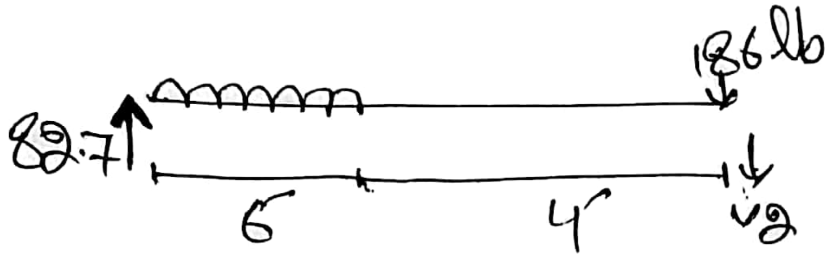
$\Sigma f_y = 0$ ↑+ ↓−

$-V_1 + 82.7 - (16\times6) = 0$

$V_1 = 82.7 - 96$

$V_1 = -13.3\ lb$

At 10:



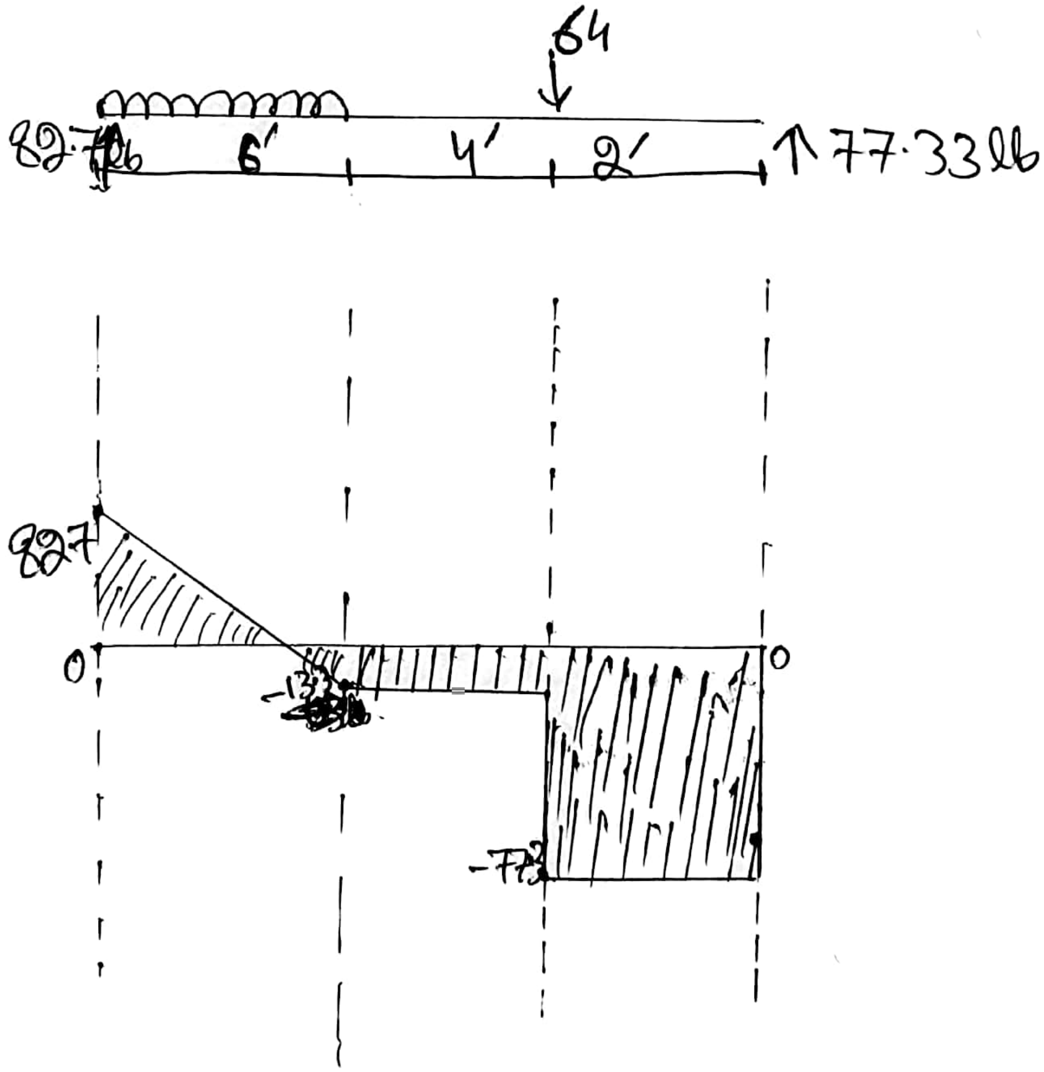
$\Sigma F_y = 0 \quad \uparrow + \downarrow -$

$-(16 \times 6) + 82.7 - 64 - V_2 = 0$

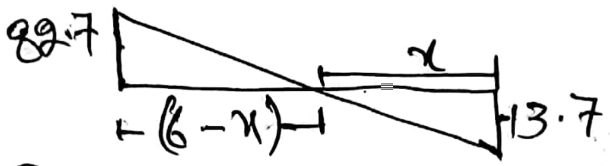
$V_2 = 82.7 - 160$

$V_2 = -77.3 \text{ lb}$

Shear force diagram:



Zero Shear Point



By similar triangles

$$\frac{89.7}{(6-x)} = \frac{13.7}{x}$$

$$89.7(x) = 13.7(6-x)$$

$$89.7x = 82.2 - 13.7x$$

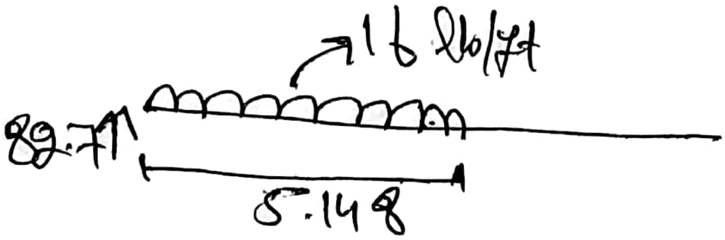
$$89.7x + 13.7x = 82.2$$

$$96.4x = 82.2$$

$$x = \frac{82.2}{96.4}$$

$$x = 0.852' ft$$

Taking section at 5.148 from left to end support



$\Sigma M_{5.148} = 0$ (↺+)

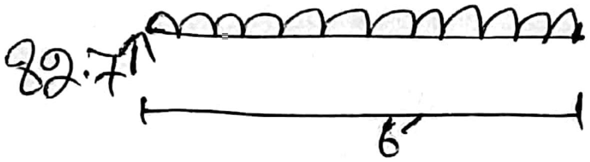
$-(82.7 \times 5.148) + 16\left(\frac{5.148}{2}\right) \times 5.148 + M_{5.148} = 0$

$-425.73 + 212.42 + M_{5.148} = 0$

$M_{5.148} = 425.73 - 212.42$

$M_{5.148} = 213.31$ lb.ft

Now At 6'



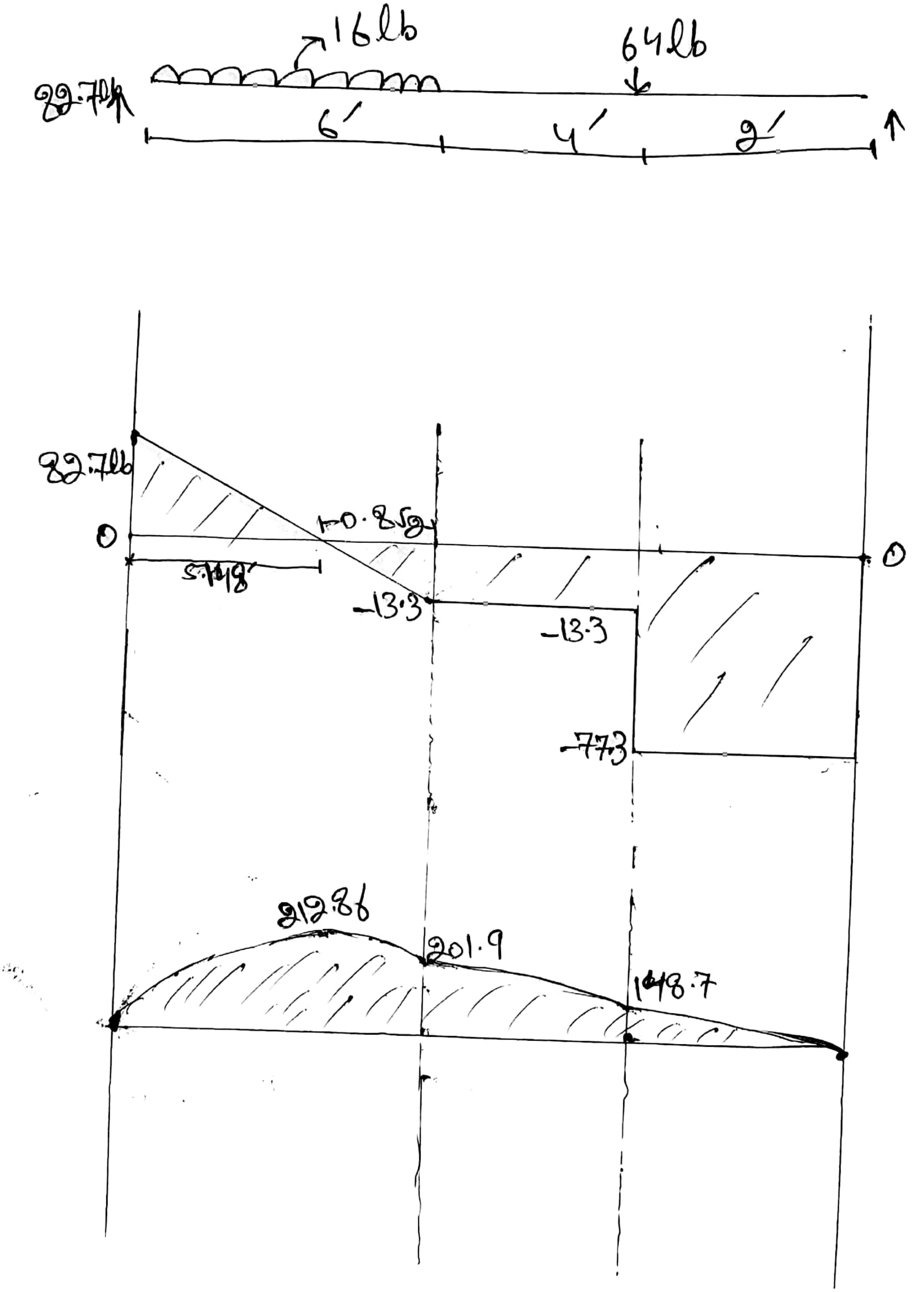
$\Sigma M = 0$ (↺+)

$M_6 = -(82.7 \times 6) + (16 \times 6)(3)$

$M_6 = -496.2 + 288$

$M_6 = -208.2$

Shear force and bending moment diagram



Shear Stress:

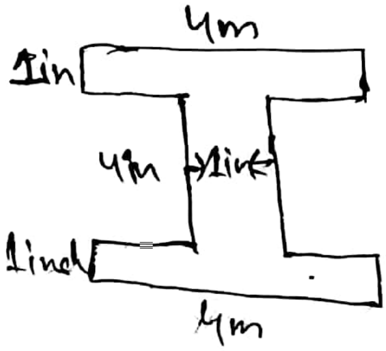
∵ Stress

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

maximum shear force is 82.7

To find the Shear stress

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



Moment of inertia:-

we have the following formula

$$\bar{y} = \frac{A_1y_1 + A_2y_2 + A_3y_3}{A_1 + A_2 + A_3}$$

$A_1 = 4 \times 1 = 4$

$A_2 = 4 \times 1 = 4$

$A_3 = 4 \times 1 = 4$

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

$$\bar{y} = \frac{4 \times 0.5 + 4 \times 3 + 4 \times 5.5}{4 + 4 + 4}$$

$$\bar{y} = 3'$$

Now moment of inertia.

	$A (in^2)$	$I_x (in^4)$
1)	4	$\frac{4 \times (1)^2}{12} = 0.333$
2)	4	$\frac{1 \times (4)^3}{12} = 5.333$
3)	4	$\frac{4 \times (1)^3}{12} = 0.333$

(Now "d")

1) $d = (\bar{y} - y_1) = (3 - 0.5) = 2.5$

2) $d = (\bar{y} - y_2) = (3 - 3) = 0$

3) $d = (3 - 5.5) = -2.5$

Now Ad^2

1) $4 \times (2.5)^2 = 25$
2) $4 \times 0^2 = 0$
3) $4 \times (-2.5)^2 = 25$

Now

$Ix = Ix + Ad^2$

1) $0.333 + 25 = 25.333$
2) $5.333 + 0 = 5.333$
3) $0.333 + 25 = 25.333$

Total

$I = Ix_1 + Ix_2 + Ix_3$

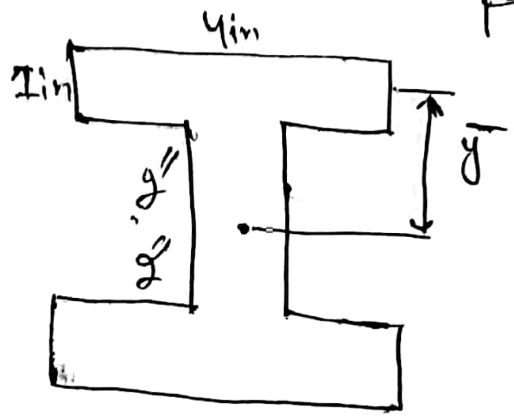
$I = 25.333 + 5.333 + 25.333$

$I = 55.999 \text{ in}^4$

Now Shear Stress

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

$V_{max} = 82.7$



$\bar{y} = 2 + 0.5 = 2.5$

$A = 1 \times 4 = 4$

$Q = 4 \times 2.5 = 10$

There fore

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

$$t = \frac{(82.7)(10)}{(85.996)(4)}$$

$t = 3.692$ Psi

<u>Now Flexural Stress Analysis</u>

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

where M is maximum moment in B.M.D

$M = 212.86$

$$\sigma = \frac{(212.86)(2)}{55.996}$$

$$\sigma = 7.602 \text{ psi}$$

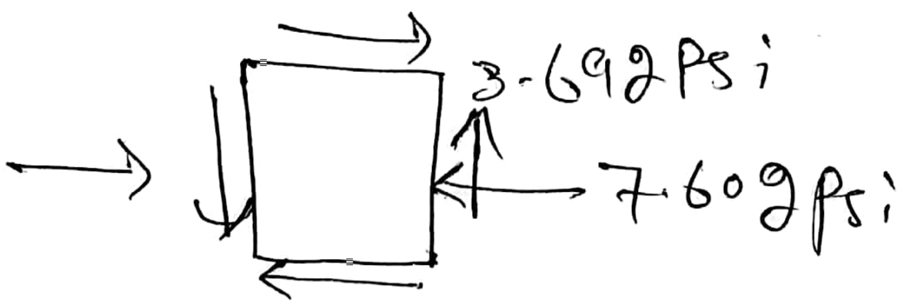
So, shear stress at point "C" is

$$\tau = 3.692 \text{ psi}$$

flexural stress at point "C"

$$\sigma = 7.602 \text{ psi}$$

Combine stress on 2D element



find the stress state at Point "C" at degree of 30°

clockewise orientation

Solve

Given stress state.

$\sigma_x = -7.602$

$\sigma_y = 0$

$\tau_{xy} = 3.692$

$\sigma_{x'} = ?$

$\sigma_{y'} = ?$

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

As we know that

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

for $\sigma_{x'}$

$$\sigma_{x'} = \frac{-7.602}{2} + \frac{-7.602}{2} (\cos(2)(-30)) + (3.692)\sin(2)(-30))$$

$$\delta x' = -3.801 - 3.801(\cos(2)(-30)) - 3.865$$

$$= -3.801 + 113.960 - 3.865$$

$$\delta x' = 106.29$$

For $\delta y'$

$$\delta y' = -\frac{7.602}{2} - \left(\frac{7.602}{2}\right)\cos(2)(-30) - (3.699)\sin(2)(-30))$$

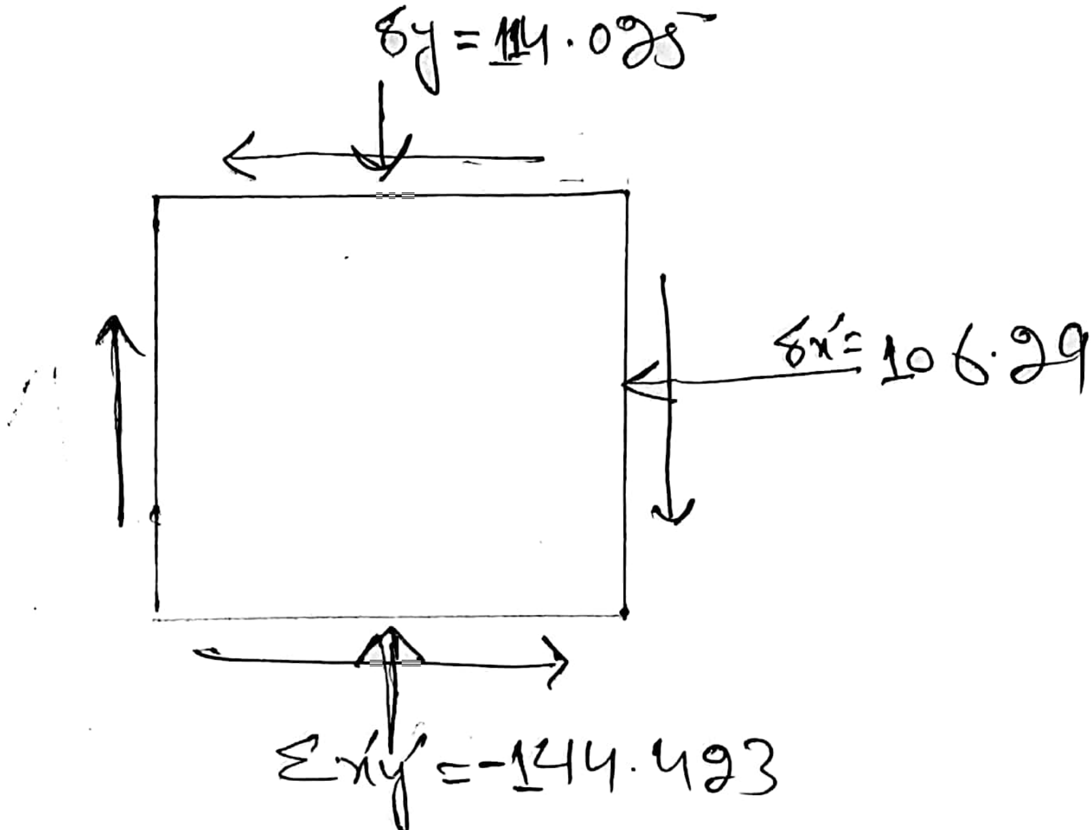
$$\delta y' = 114.025$$

For $\varepsilon \bar{x}\bar{y}$

$$\varepsilon x'y' = \left(-\frac{7.602}{2}\right) - 0\sin(2)(-30) + 3.699\cos(2)(-30)$$

$$\varepsilon x'y' = -144.423$$

Now the new stress state after 30°



Find its Principle stress

$$\sigma_{12} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \varepsilon_{xy}^2}$$

$$\sigma_{12} = \frac{-7.602 + 0}{2} \pm \sqrt{\left(\frac{-7.602 - 0}{2}\right)^2 + (3.692)^2}$$

$$= -3.801 \pm 5.298$$

$$\sigma_y = \sigma_1 = -3.801 + 5.298 = 1.497$$

$$\sigma_x = \sigma_2 = -3.801 - 5.298 = -9.099$$

Max in Plane Shear stress

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

$$= \sqrt{\left(\frac{-7.602 - 0}{2}\right)^2 + (3.692)^2}$$

$$\tau_{xy} = 5.298$$

To Draw Moh's circle for the Given problem

As we know that

$$\left(\frac{\sigma_x + \sigma_y}{2}, 0\right)$$

centre coordinate

$$(h, k) = \left(\frac{-7.602}{2}, 0\right)$$

$$= (-3.801, 0)$$

radius of mohr's circle is

$$r = \sqrt{\left(\frac{\sigma x - \sigma y}{2}\right)^2 + \varepsilon xy^2}$$

$$r = \sqrt{\left(\frac{-7.602 - 0}{2}\right)^2 + (3.692)^2}$$

$$r = 4.6724$$