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Registration No: 7544

Subject: MOS-II

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Date: 16-04-2020

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Q Construct the mohr's Circle diagram and find principle stresses and maximum in plane shear stress for the stress of point C located at the center of uniformly distributed load and 1inch below the top fiber of beam cross section shown in fig. However construct the mohr circle it is nessery to draw shear stress and flexural stress variation diagram for maximum shearforce and bending moment respectively. Compare result from mohr circle with stress tranformation evaluation.

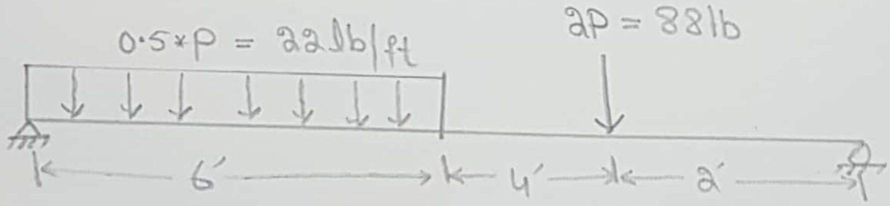
Note :- I.D is 7544

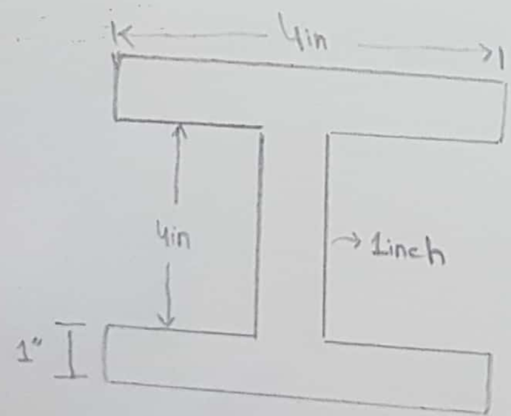
Soload is 44 lb.

$P = 44\ lb$

$0.5P = 0.5 * 44 = 22\ lb/ft^2$

$2P = 2 * 44 = 88\ lb$





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(2)

Solution :-

$$R_A + R_B = 220 \text{ lb}$$

* first find Reaction forces R_A & R_B.

$$\circlearrowleft + \quad \sum M_A = 0$$

$$-(22*6*3) - (88 \times 10) + 12R_B = 0$$

$$R_B * 12 - 1276 = 0$$

$$R_B = \frac{1276}{12}$$

$$\boxed{R_B = 106.33 \text{ lb}}$$

now we know that

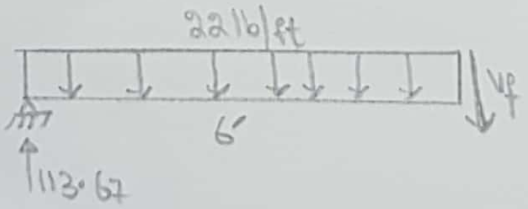
$$R_A + R_B = 220 \text{ lb}$$

$$R_A = 220 - R_B$$

$$R_A = 220 - 106.33$$

$$\boxed{R_A = 113.67 \text{ lb}}$$

* Now Shear force at change point of beam



Shear force at 6ft from left

$$\sum f_y = 0 \uparrow +$$

$$113 - (22*6) - V_{f6'} = 0$$

$$113.67 - 132 = V_{f6th}$$

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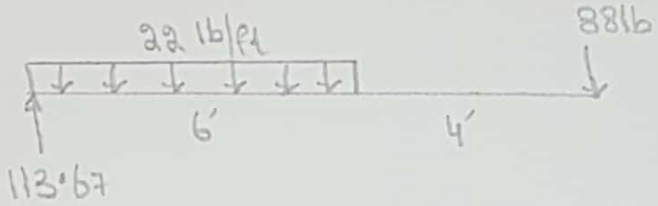
$$\boxed{V_{f_{6ft}} = -18.33\,lb}$$

* Now Shear at 10ft

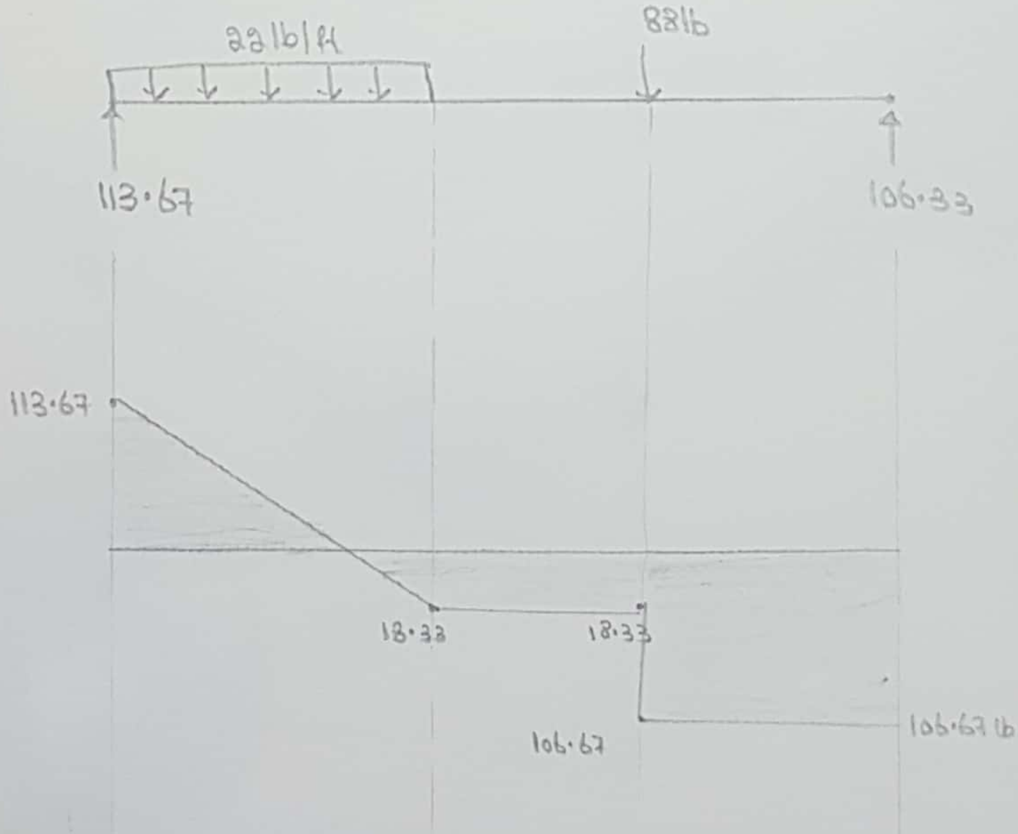


$\Sigma F_y = 0 \; +\uparrow$

$$113.67 - (22 * 6) - 88 - V_{f_{10'}} = 0$$

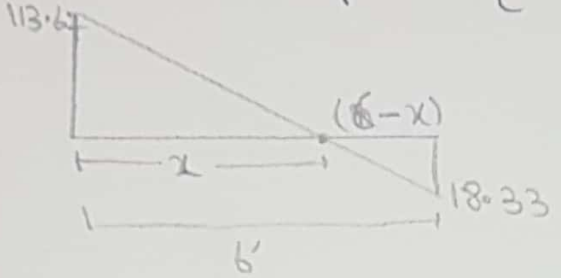
$$V_{f_{10ft}} = 106.33 \; (-ve)$$

<u>Shear force and Moment diagram</u>



* Moment at Change Point

find Zero Shear Point first



by Similar triangles.

$$\frac{113.67}{x} = \frac{18.33}{(6-x)}$$

$$682.02 = 113.67x + 18.33x$$

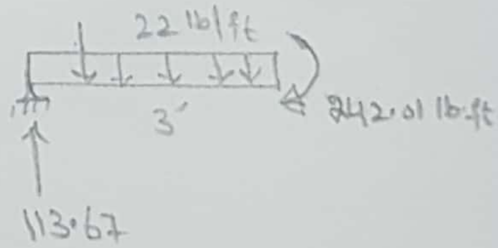
$$x = \frac{682.02}{132}$$

$$\boxed{x = 5.17 \text{ ft}}$$

(i) at Center of UDL 3ft from left.

$$(+\circlearrowleft) \quad M = -113.67 * 3 + (22 * 3 * 1.5)$$

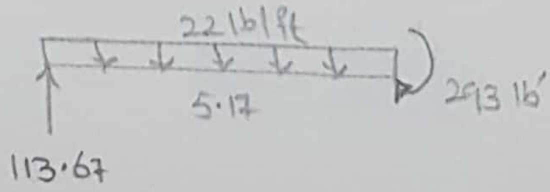
$$M = 242.01 \text{ lbft.}$$



(ii) at a distance 5.17 from left support

$$(+\circlearrowleft) \quad M = -113.67 * 5.17 + \left(22 * 5.17 * \frac{5.17}{2}\right)$$

$$M = 293 \text{ lb.ft}$$



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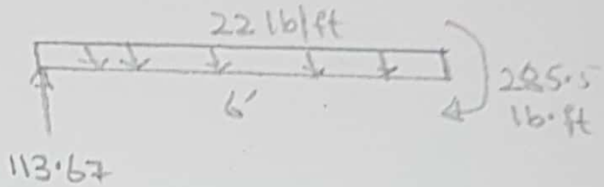
5)

(iv) at distan 6ft from left.

$$(+\curvearrowleft) \quad M = (-113.67 * 6) + (22*6)*3$$

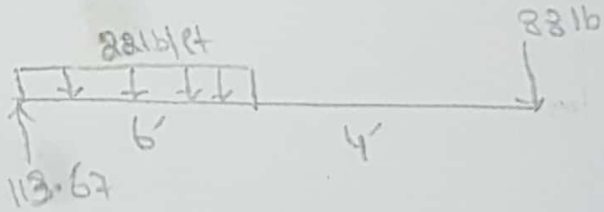
$$M = 285.5 \text{ lb.ft}$$

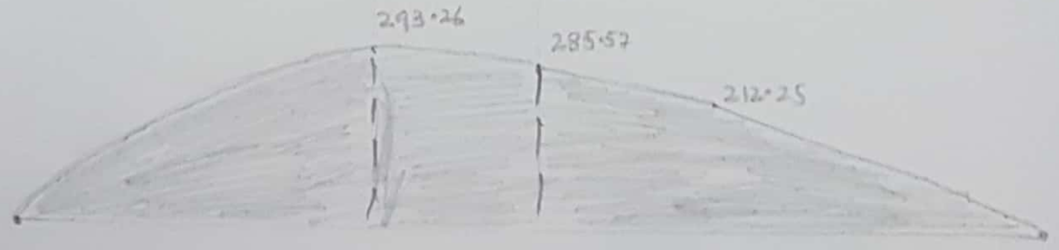


(v) at a distance of 10' from left.

$$(+\curvearrowleft) \quad M = (-113.67 * 10) + (22 * 6 * 7)$$

$$M = 212.7 \text{ lb ft}$$





① **Shear stress**

As per the Question the maximum Shear Stress $\tau = \frac{VQ}{It}$ occurs where the maximum Shearforce lies in above diagram max- shearforce is 47.66 lb

$+\uparrow \sum F_y \Rightarrow 113.67 - 22\times 3 - V = 0$

$V = 47.66\,lb$

* **Find Moment of inertia:-**

$I_{xx} = I_{xx_1} + I_{xx_2} + I_{xx_3}$ from given question:-

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

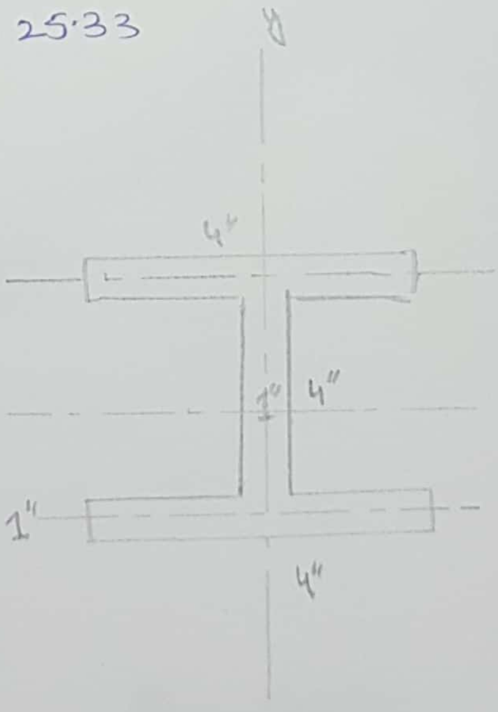
$I_{xx_2} = \frac{1}{12}(4^3)(1) + 4(0)^2 = 5.33$

$I_{xx_3} = \frac{1}{12}(1^3)(4) + (3-5.5)^2 4 = 25.33$

$I_{xx} = I_{xx_1} + I_{xx_2} + I_{xx_3}$

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

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



$I_{yy} = I_{yy_1} + I_{yy_2} + I_{yy_3}$

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

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

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

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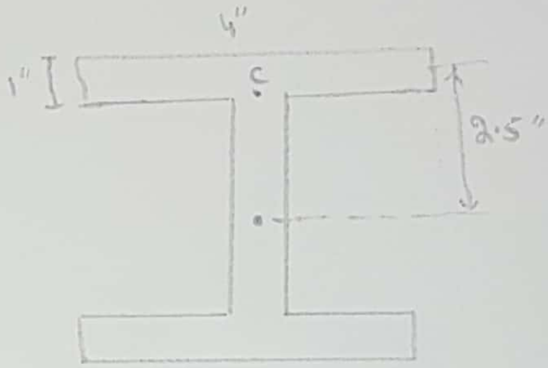
(7)

* finding shear stress at point "C" (1" below from top fibre)

$$\tau_{xy} = \tau_{yx} = \frac{VQ}{IB}$$

$$Q = A\bar{y}$$



$$A = 1 * 4$$

$$A = 4 in^2$$

$$Q = 1 * 4 * 2.5$$

$$Q = 10 \text{ in}$$

$$\tau_{xy} = \tau_{yx} = \frac{47.66 * 10}{56 * 4}$$

$$\tau_{xy} = 2.12 \text{ lb/in}^2$$

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

$$= \frac{12 * 242.61 * 2}{56}$$

$$\sigma_x = 103.97 \text{ lb/in}^2$$

fluxure stress at point C

$$\sigma = 103.97 \text{ lb/in}^2$$

Stress stress at point "C"

$$\tau = 2.12 \text{ lb/in}^2$$

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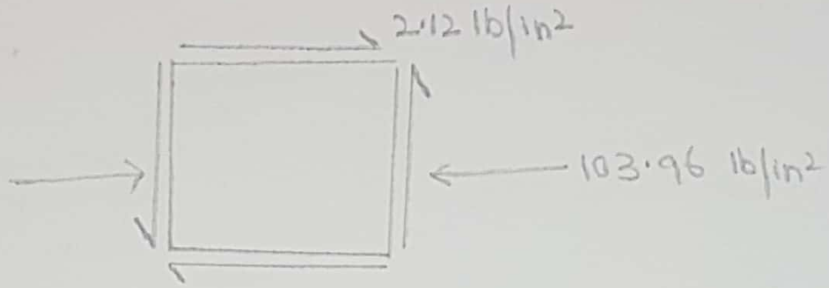
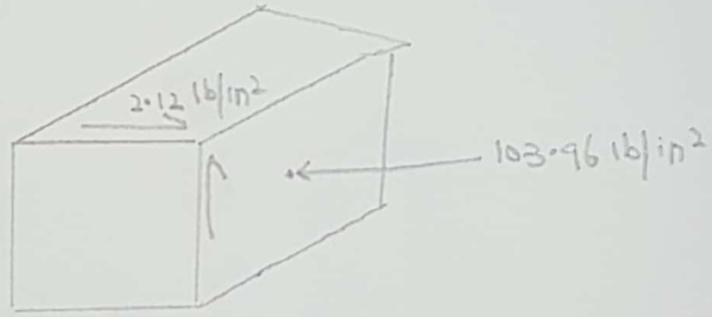
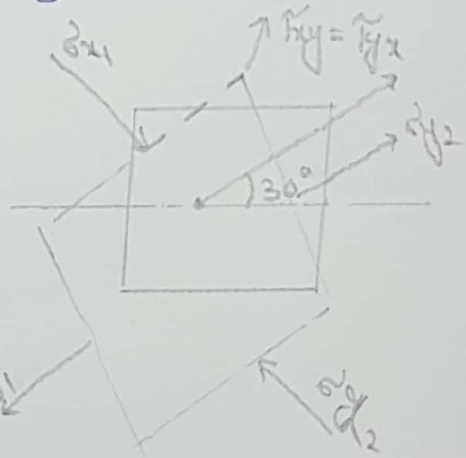




* Assume that element rotates at 30° rotation



* ass we derive following equation for stress transformation

$$\sigma_x' = \frac{\sigma_x + \sigma_y}{2} + \left(\frac{\sigma_x - \sigma_y}{2}\right)(\cos 2\theta) + \tau_{xy} \sin 2\theta$$

$$\sigma_x' = \frac{-103.76 + 0}{2} + \left(\frac{-103.76 + 0}{2}\right)(\cos 2 * 30^\circ) + 2.12 \sin 60^\circ$$

$$\sigma_x' = -172.07 \text{ lb/in}^2$$

for $\sigma_{y'}$

$$\sigma_{y'} = \frac{\sigma_x+\sigma_y}{2} - \left(\frac{\sigma_x-\sigma_y}{2}\right)(\cos 2\theta) - \tau_{xy}\sin\theta$$

$$\sigma_{y'} = \frac{-103.6+0}{2} - \left(\frac{-103.6-0}{2}\right)(\cos 60^\circ) - 2.12\sin 60^\circ$$

$$\sigma_{y'} = -121.00\ lb/in^2$$

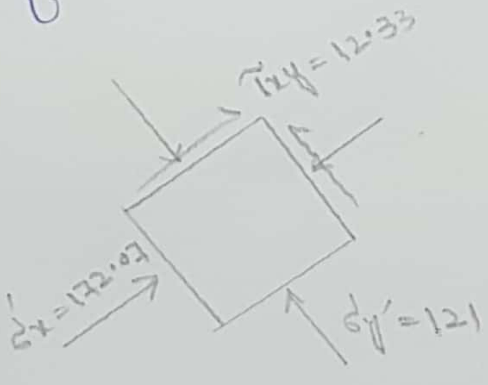
for,

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

$$\tau_{x'y'} = -\frac{103.6-0}{2}\sin 60 + 2.12\cos 60$$

$$\tau_{x'y'} = 12.33\ lb/in^2$$

* Now stress state after 30° clockwise orientation is shown



* Find Principle stress:-

We know that the principle stress equation as

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

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$$\sigma_{1,2} = \frac{-103.67+0}{2} \pm \sqrt{\left(\frac{-103.67-0}{2}\right)^2 + (2.21)^2}$$

$$\sigma_{1,2} = -51.83 \pm 51.88$$

$$\sigma_y = \sigma_1 = 0.05 \text{ lb/in}^2$$

$$\sigma_x = \sigma_2 = -51.83 - 51.88 = -103.7 \text{ lb/in}^2$$

or

first find $\theta_p = ?$

$$\tan 2\theta_p = \frac{\tau_{xy}}{(\sigma_x - \sigma_y/2)} = \frac{2.21}{(-103.6-0)} = -70$$ Clockwise

"Put in general equation"

$$\sigma_{x'max} = \frac{-103.67+0}{2} + \left(\frac{-103.67-0}{2}\right) \cos(2)(-2.70)$$
$$+ 2.21 \sin 2(-2.70)$$

$$\boxed{\sigma_{x'max} = 103.67}$$

* Max in plane shear stress in this case

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

$$\tan 2\theta_s = 23.21$$

$\theta = 175.11$ Anti-clockwise.

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Put this in the general equation for $\tau_{x'y'}$

$$\tau_{x'y'} = -\left(\frac{\sigma_x - \sigma_y}{2}\right)\sin 2\theta + \tau_{xy}\cos 2\theta$$

$$\tau_{x'y'} = -\left(\frac{-103.67 - 0}{2}\right)\sin 2(175.11) + 2.21\cos 2(175)$$

$\tau_{x'y'} = -6.57$ lbin [Max in plane shear Stress]

<u>Mohr's Circle</u>

Center Coordinate

$$(h,h) = \left[\frac{-103.67 + 0}{2}, 0\right]$$

$$= [-51.33, 0]$$

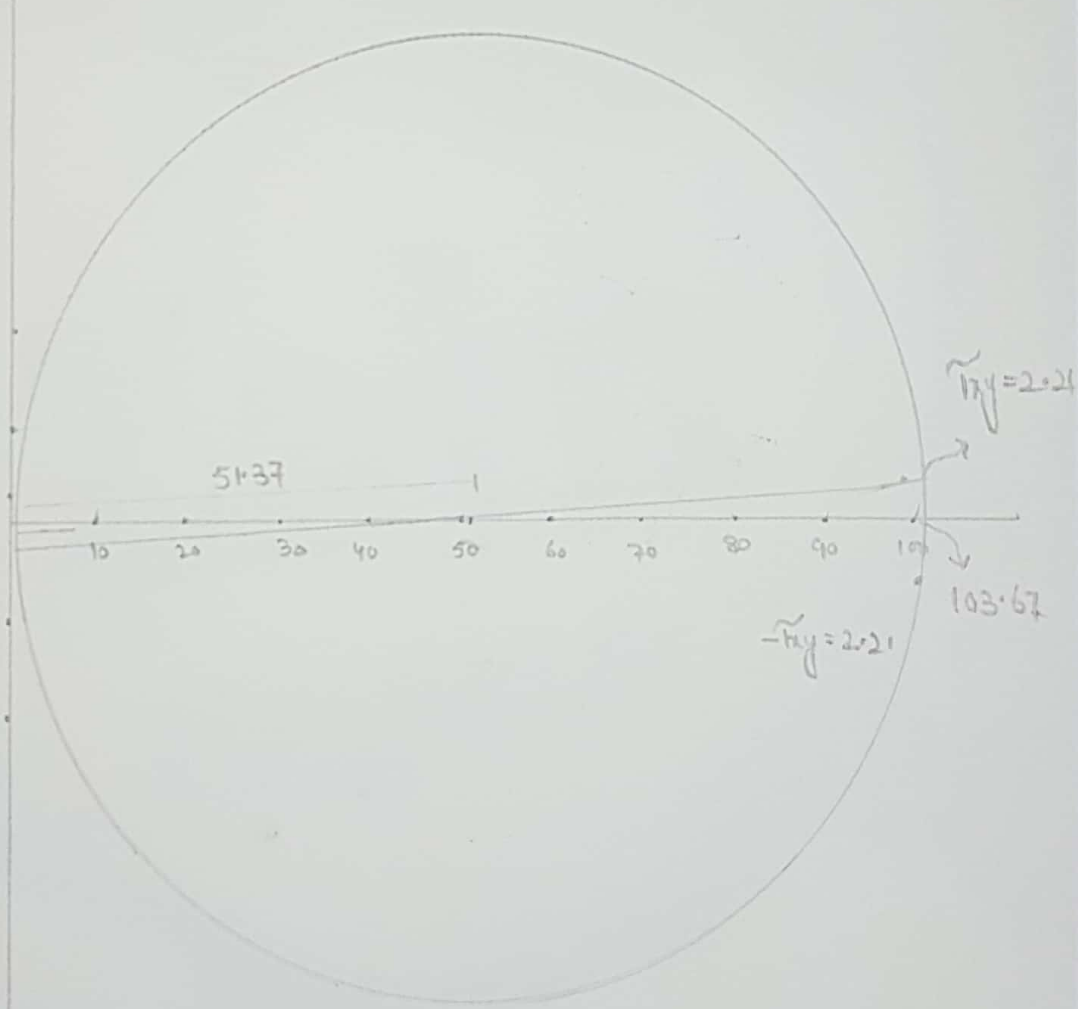
Radius of mohr Circles is

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

$$r = \sqrt{\left(\frac{-103.67 - 0}{2}\right)^2 + (2.21)^2}$$

$$\boxed{r = 51.33 \text{ in}}$$

Mohr circle



$\sigma_{x_1} = 103.67$

$\sigma_{x_2} = 0$

* As shown from Mohr circle:
The value obtain that of principal stress and maximum shear stress are almost same with value obtained from transformation evaluation.