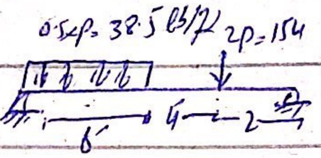
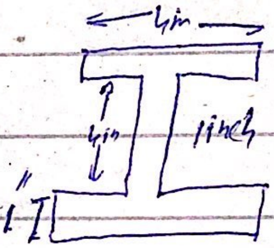
Name = Nadeem Iqbal
. ID = 7277
Subject = MOS II

Pg # 1

Q: Construct the ~~mohrs~~ mohr's circle diagram and find principle stress and max in plan shear stress for the stress of point C located at the ~~H~~ centre of uniformly distributed load and 1 inch below the top fiber of beam cross-section shown fig. However construct the mohr circle it is nessecary to draw shear stress and flexural stress variation diagrams for max shear force & bending moment respectfully. Compare result from mohr circle with stress tranformation equation.





ID = 7277
$0.5 \times P = 0.5 \times 77 = 38.5$ lb/ft
$2P = 2 \times 77 = 154$ lb
$P = 77$

Solution:

1st find reaction forces
RA & RB

$\circlearrowleft^{+} \Sigma M_A = 0$

$$(-38.5 \times 6 \times 3) - (154 \times 10) + 12\,R_b = 0$$

$$R_b \times 12 - 847 = 0$$

$$R_b = \frac{847}{12}$$

$$\boxed{R_b = 70.5\ lb}$$

Scanned with CamScanner

Now we know that

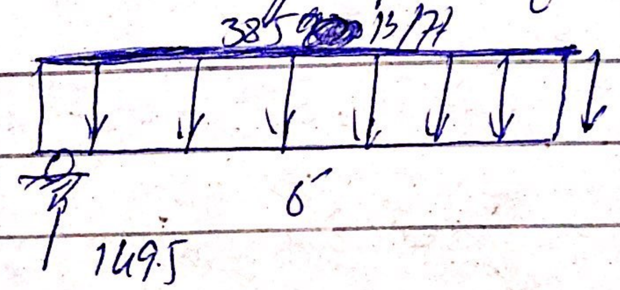
$RA + Rb = 220$ lb

$RA = 220 - Rb$

$RA = 220 - 70.5$

$\boxed{RA = 149.5 \text{ lb}}$

Now Shearforce at Change point of beam



Shearforce at 6ft from left

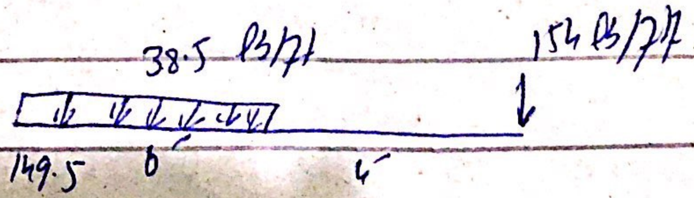
$\Sigma F_y = 0 \uparrow +$

$149.5 - (38.5 \times 6) - V_{f6'} = 0$

$149.5 - 231 = V_{f6ft}$

$\boxed{V_{f6ft} = -81.5 \text{ lb}}$

Now Shear at 10ft

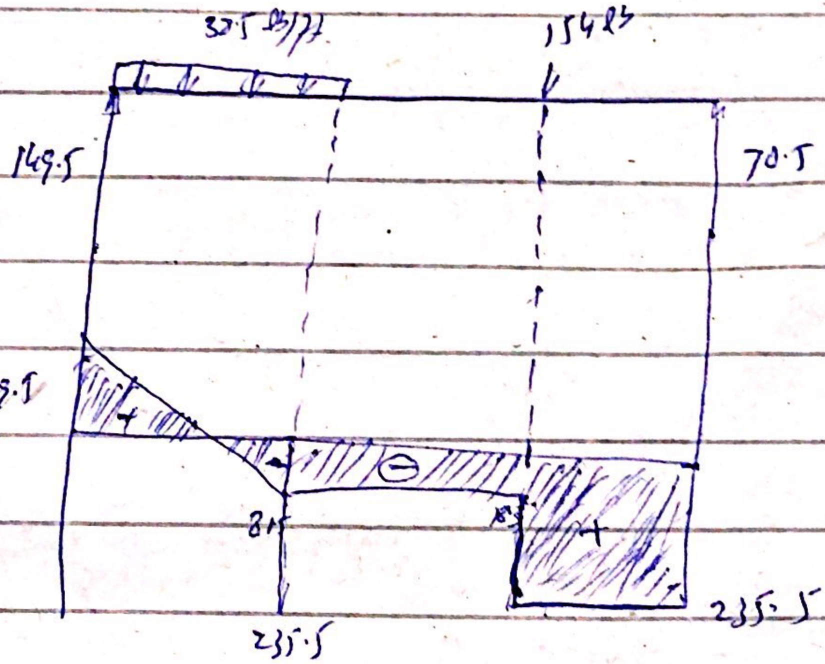


$\Sigma F_y = 0 \; +\uparrow$

$149.5\,(38.5\times6) - 154 - V_{70} = 0$

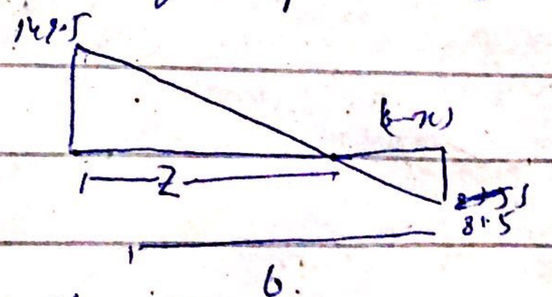
$V_{70} = 235.5$ (-ve)

Shearforce and moment bending



Moment at change point and zero shear point

1st



by similar triangle

$$\frac{149.5}{x} = \frac{81.5}{(6-x)}$$

$$149.5 \times 6 = 897$$

$$897 = 149.5x + 81.5x$$

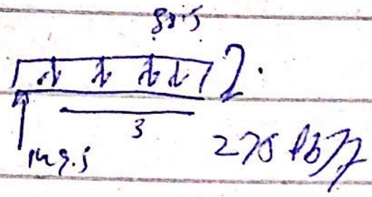
$$x = \frac{897}{231}$$

$$\boxed{x = 3.8871}$$

(i) at centre of UDL 3ft from left

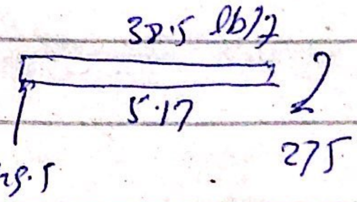
$$C^+ \quad M = -149.5 \times 3 + \left(38.5 \times 3 \times \overset{1.5}{\cancel{3.88}}\right)$$

$$\boxed{M = 275 \text{ lb/ft}}$$



at a distance 3.88 from left support

(ii) $M = -149.5 \times \overset{3.88}{\cancel{5}} + \left(38.5 \times \overset{3.88}{\cancel{5}} \times \frac{3.88}{2}\right)$



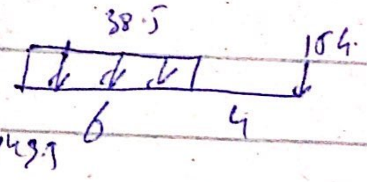
$M = \cancel{27}$

$$\boxed{M = 290.21 \text{ lb}}$$

(iii) at distance from left

$$\circlearrowright^{+} \quad M = -(149.5 \times 6) + (38.5 \times 6) \times 3$$

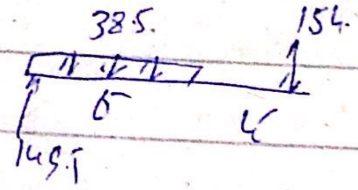
$$\boxed{M = 204 \text{ lb/ft}}$$

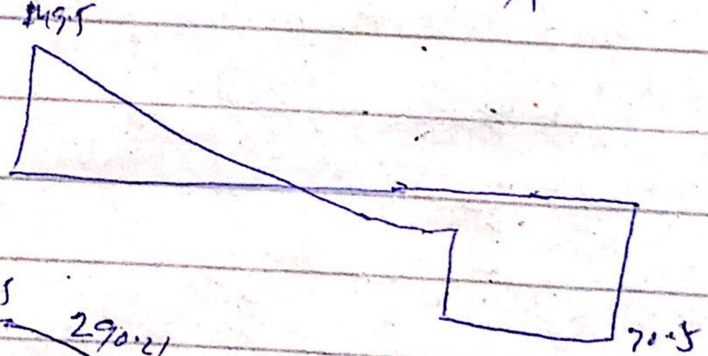


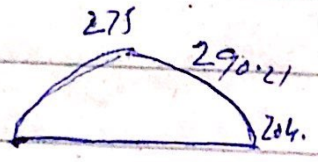
(iv) at a distance of 10' from left

$$\circlearrowright^{+} \quad M = (-149.5 \times 10) + (38.5 \times 6 \times 7)$$

$$\boxed{M = 122 \text{ lb/ft}}$$







Shear Stress

As per the ~~question~~ question the max shear stress $\tau = \frac{VQ}{It}$ occur where the max shear force lies in above diagram where the maximum shear force

$\Sigma F_y = 149.5 - 38.5 + 3 - V = 0$

$\boxed{V = 33\ lb}$

2nd moment of inertia

$I_{xx} = I_{xx_1} + I_{xx_2} + I_{xx_3}$ from given direction

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

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

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

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

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

$I_{xx} = 56\ in^2$

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

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

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

$\boxed{I_{yy} = 11\ in^2}$

Finding shear at point C 1 below from top flange

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

$Q = Ay$

$A = 1 \times 4$

$A = 4 \, in^2$

$Q = 1 \times 4 \times 2.5$

$Q = 10 \, in$

$\tau_{xy} = \tau_{yx} = \frac{34 \times 10}{56 \times 4}$

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

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

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

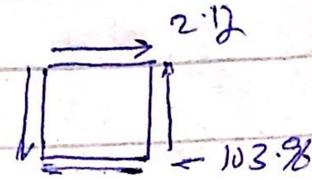
$\boxed{\sigma_x = 103.97 \, lb/ft}$

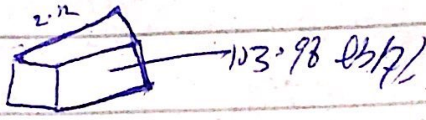
Flure stress at point C

$\sigma = 103.97 \, lb/in$

Stress at point C

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





Assume that element rotates at 30 rotation as we derive following equation for stress transformation

$$\delta_x = \frac{\delta_x + \delta_y}{2} = \left(\frac{\delta_x - \delta_y}{2}\right) \cos 2\theta \; \tau_{xy} \sin 2\theta$$

$$\delta_{x'} = \frac{103.76 + 0}{2} + \left(\frac{-103.76 + 0}{2}\right)(\cos 2 \times 30) + 2.12 \sin 60$$

$$\boxed{\delta_x = -172.07 \text{ lb/in}^2}$$

For δ_y

$$\delta_{y'} = \frac{\delta_x + \delta_y}{2} - \left(\frac{\delta_x - \delta_y}{2}\right)(\cos 2\theta) - \tau_{xy} \sin\theta$$

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

$$\boxed{\delta_{y'} = -121.00 \text{ lb/in}^2}$$

Scanned with CamScanner

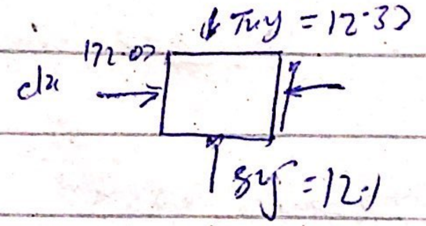
For

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

$$\tau_{x'y'} = \frac{-103.6-0}{2}\sin 60 + 2.12\cos 80$$

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

Now stress state after 30° clockwise orientation is shown



2nd principle stress

we know that the principle stress equation as

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

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

$$\sigma_{1,2} = -51.83 \pm 51.80$$

$$\sigma_y = \sigma_1 = 0.05\ lb/in^2$$

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

1st find θp = ?

$$\tan 2\theta p = \frac{\tau_{xy}}{(\delta x - \delta y/_2)} = \frac{2.21}{(-103.6-0)} = -70$$

clockwise

put general equation

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

$$+ 2.25\sin 2(-2.70)$$

$$\boxed{\delta x'_{max} = 103.67}$$

Max in plan shear stress in this case

$$\tan 2\theta = \frac{-(\delta x - \delta y)/_2}{\tau_{xy}}$$

$\tan 2\theta = 23.21$

$\theta = 175.11$ Anticlockwise

put in the general equation for τ_{xy}

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

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

$\tau_{x'y'} = -6.57 \text{ lb/in}$ {max in plane shear stress}

<u>Mohr circle</u>

Centre coordinate

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

$= [51.33, 0]$

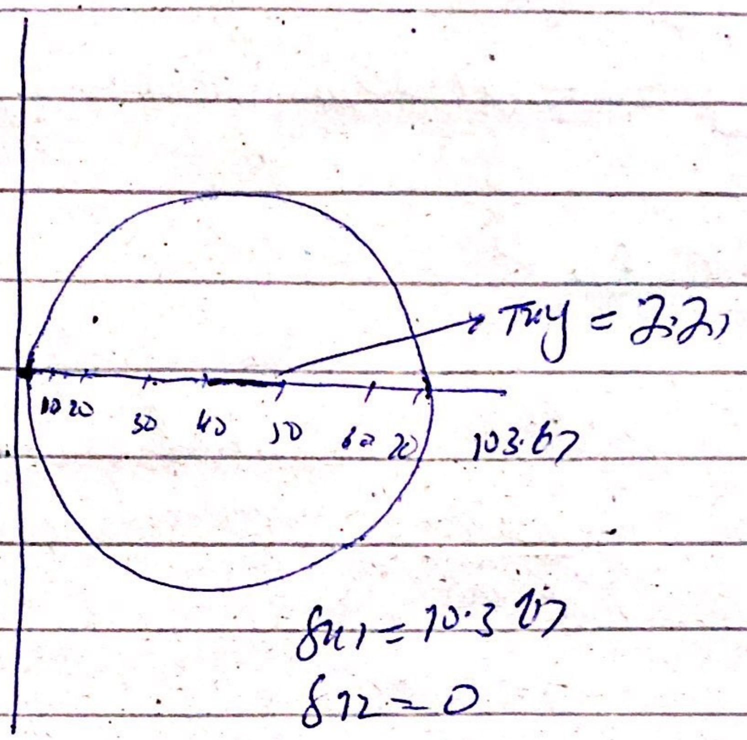
Radius of mohr circle is

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

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

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

Scanned with CamScanner



$\delta_{x1} = 70.367$

$\delta_{12} = 0$