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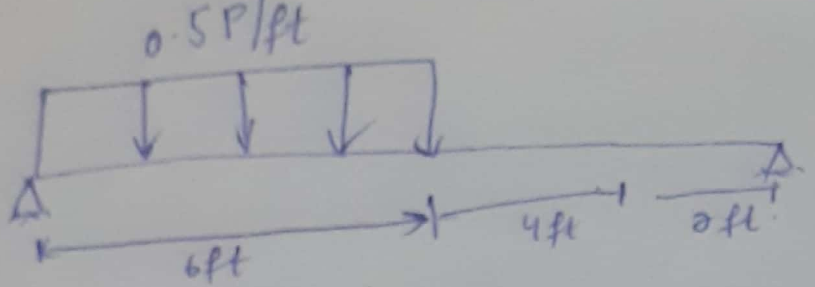
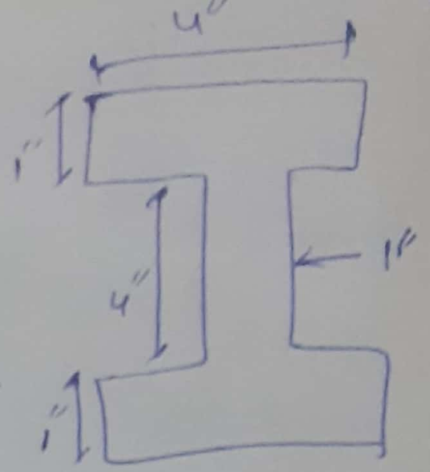
Section : B

Subject : Mos "II"

Teacher : Engr: Sir M. Saqib

MOS II

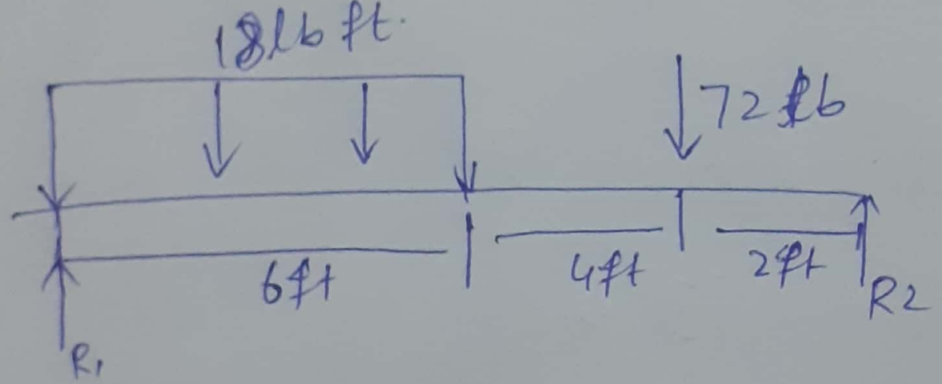




Solution:-

$P = 36$

$2P = 2(36) = 72$



STep 1:-

Find Reaction.

$\Sigma f_x = 0$ $\qquad \Sigma f_y = 0$

$R_3 = 0.$ $\qquad R_1 + R_2 = (18 \times 6) + 72$

$R_1 + R_2 = (72 + 108)\,lb$

$R_2 + R_1 = 180\,lb$ — 1

$\Sigma M^+ = 0$

$12 R_2 - 10 \times 72 - (18 \times 6) \times 3 = 0$

$R_2 = \left(\frac{720 + 324}{12 ft}\right) lb - ft.$

$\boxed{R_2 = 87 lb.}$

Now put R_2 in eq 1 we get

$R_1 + 87 = 180$

$R_1 = 93 lb$

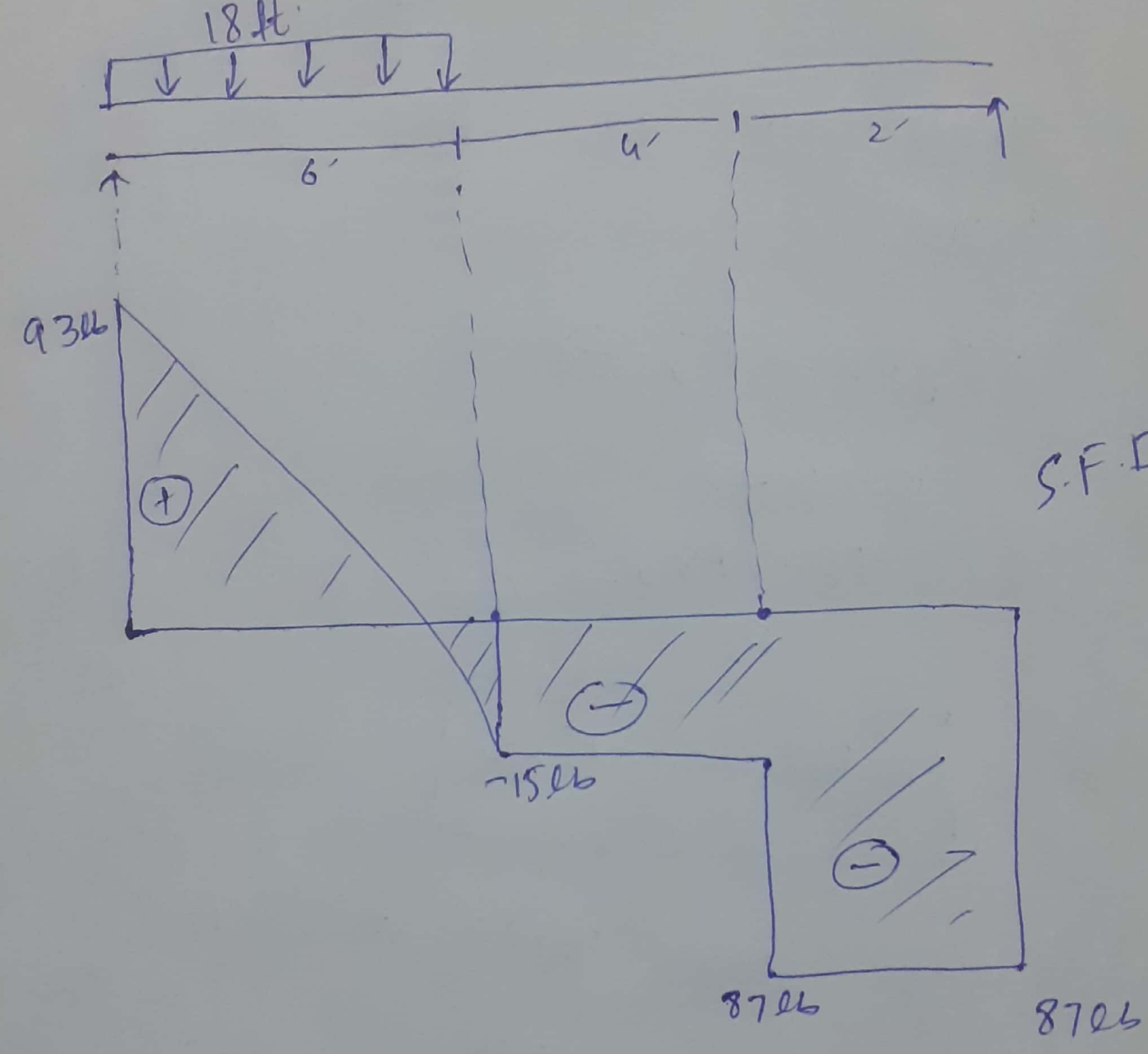
1 $R_1 + R_2 = 180 lb.$

$\Rightarrow R_1 = 180 - R_2$

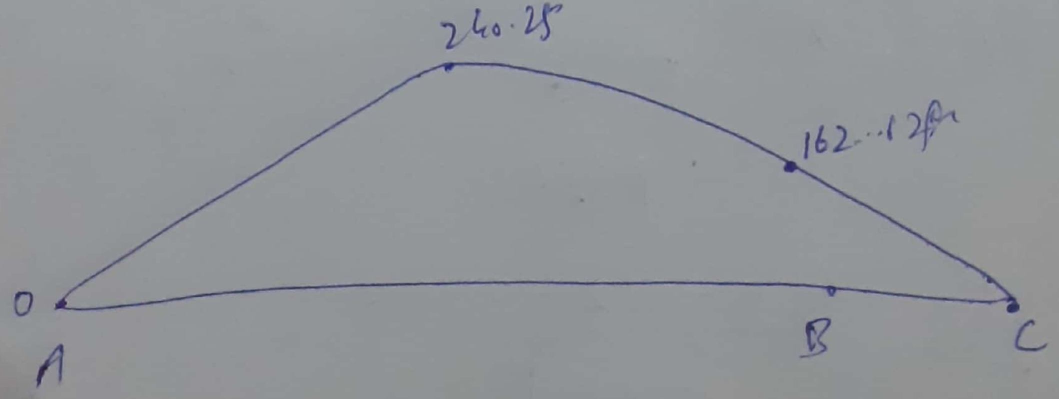
$R_1 = 180 - 87 lb$

$\Rightarrow \boxed{R_1 = \cancel{85 \rightarrow 25}\ lb \quad 93\ lb}$

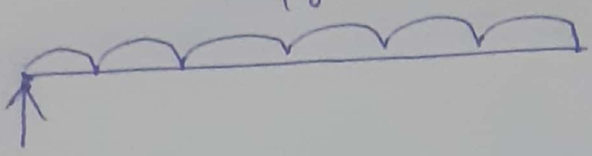
Now we draw Shear force and Bending Moment Diagram



S.F.D



No shear force at charg point of Beam



Shear force at 6ft from left support.

$\Sigma fy = 0 + \uparrow \downarrow \ominus$

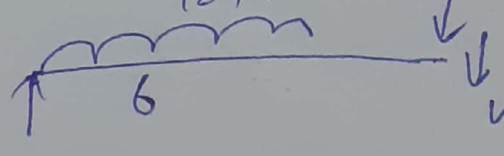
~~85.25~~

$93 - 18 \times 6 - V_{6ft} = 0$

$$\boxed{\Rightarrow V_{6ft} = -15\,lb.}$$

Now shear force at 10ft.

$\Sigma fy \oplus \uparrow \downarrow \ominus$



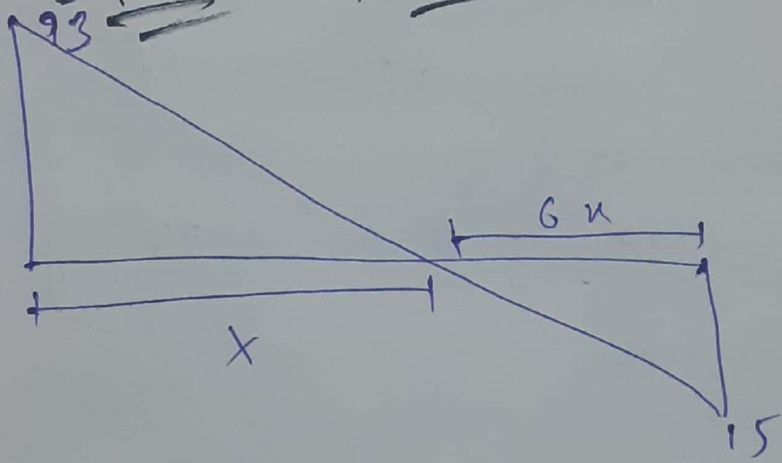
$93 - 18 \times 6 - 72 - V_{10} = 0$

$$\boxed{V_{10} = -87\,lb.}$$

Point of Maximum Bending moment

As we know that the point where Shear force is minimum the bending M is maximum So from point of zero Shear corresponding point will have maximum bending moment.

for **Shear force diagram**.



$$\frac{93}{x} = \frac{15}{6-x}$$

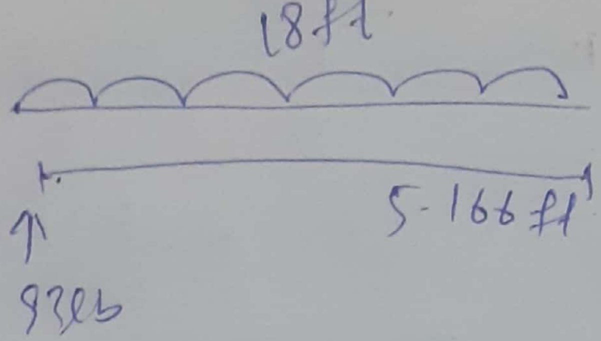
$$6-x(93) = x(15)$$

$$= 558 - 93x = 15x$$

$$= \frac{558}{108} = x$$

$$= \boxed{x = 5.166\,ft.}$$

Now deflection the value of moment at 5.166ft



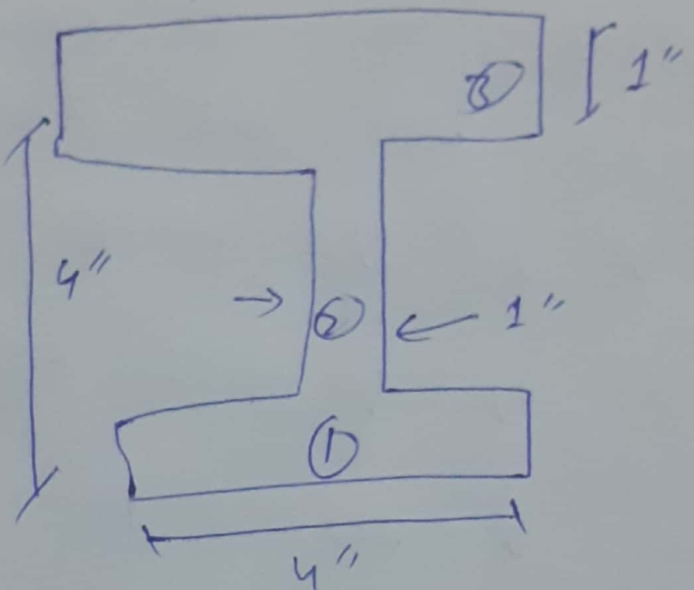
$$M_{5.166} = 93 \times 5.166 + (18 \times 5.166) \times \left(\frac{5.166}{2}\right) = 0$$

$$M_{5.166} = 480.438 - 240.188$$

$$\boxed{M.5.166 = 240.25 \text{ ft}}$$

for Shear stress we have $\tau = \frac{VQ}{Ib}$

So first we ~~define~~ ~~moment~~ D.M of Inertia I for given section of Bean



As we given figure symetrical along Both the axis So -

$\bar{x} = 4/2 = 2in$, $\bar{y} = 6/2 = 3in$

i-e $(\bar{x}, \bar{y}) = (2, 3)$ (center of gravity)

Area of point 1 $= 4 \times 1 = 4in^2$

// // $= 4 \times 1 = 4in^2$

// // $= 4 \times 1 = 4in^2$

Moment of inertia about x-axis I_{xx}.

Determine distance b/w C.G of the whole Declion 2nd the corresponding parts

Let G_1, G_2, G_3 be the center of gravity of point ①, ② & ③ and K_1, K_2, K_3 be the distance b/w $\bar{y}$ & y_1, y_2, y_3 respectively.

So $k_1 = \bar{y} - y_1 = 3 - 0.5 = 2.5 in$

$k_2 = \bar{y} - y_2 = 3 - 3 \quad 0 in.$

$k_3 = \bar{y} - y_2 = 3 - 0.5 = 2.5 in.$

So $I_{xx}, \frac{b_1 h_1^3}{12} + a_1 k_1^2 + \frac{b_2 h_2^3}{12} + a_2 k_2^2 + \frac{b_3 h^3}{12} + a_3 k_3^2$

$I_{xx} = \frac{(4)(1)^3}{12} + 4(2.5)^2 + \frac{(1)(4)^2}{12} + a_2(0) + \frac{(4)(1)^3}{12} + 4(2.5)^2$

$I_{xx} = 4/12 + 25 + \frac{64}{12} + 4/12 + 25$

$\Rightarrow I_{xx} = \frac{4 + 12(25) + 64 + 4 + 12(25)}{12}$

$= \boxed{I_{xx} = 56 in.}$

Now

$$I_{yy} = \frac{b_1^3 h_1}{12} + \frac{b_2^3 h_2}{12} + \frac{b_3^3 h_1}{12}$$

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

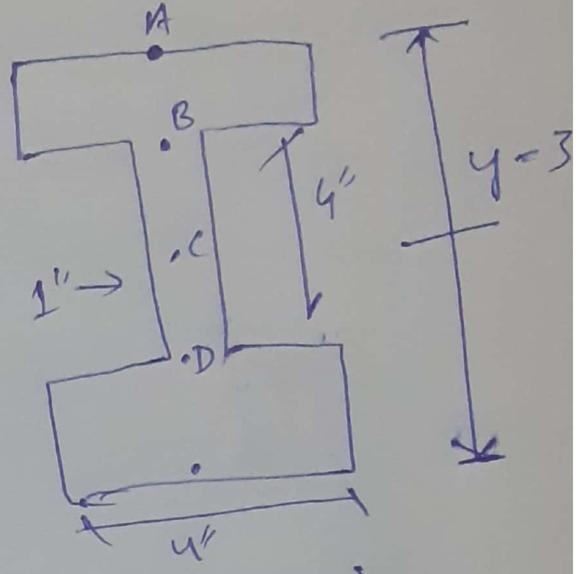
$$I_{yy} = \frac{64}{12} + \frac{4}{12} + \frac{64}{12}$$

$$I_{yy} = \frac{64+4+64}{12} = \frac{13\cancel{2}}{\cancel{12}} = \boxed{11 in^4}$$

Scanned with CamScanner

Next find the shear stresses at various point. We know that $\tau = \frac{VQ}{Ib}$ (10)

Shear Stress



(i) Shear stress at point A i.e at the Top fiber

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

$\because Q = A\bar{y}$ $\quad C = (2, 3)$

So $\tau = \frac{87(0)}{73(4)}$

{Hence A = 0 Because area of the section exist above point A is i.e $Q = A\bar{y} = 0(\bar{y}) = 0$.}

$V_{max} = 87 lb$

$I = 73$

$$\boxed{\tau = 0}$$

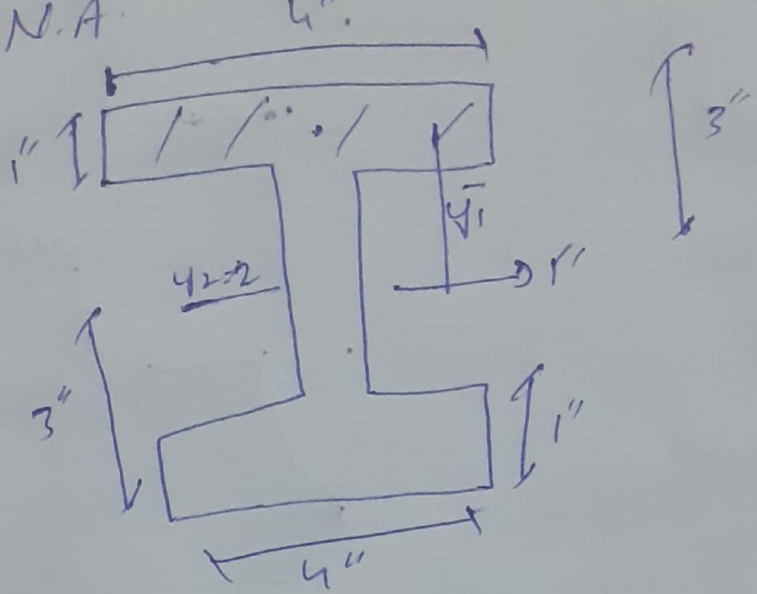
(ii) Shear stress at point "B"

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

$$\tau = \frac{87 \times (4 \times 1)(3 - 0.5)}{73 \times 4}$$

$$\boxed{\tau = 3.574 \, lb/in^2}$$

(iii) Shear Stress at Point "C" i-e at N.A



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

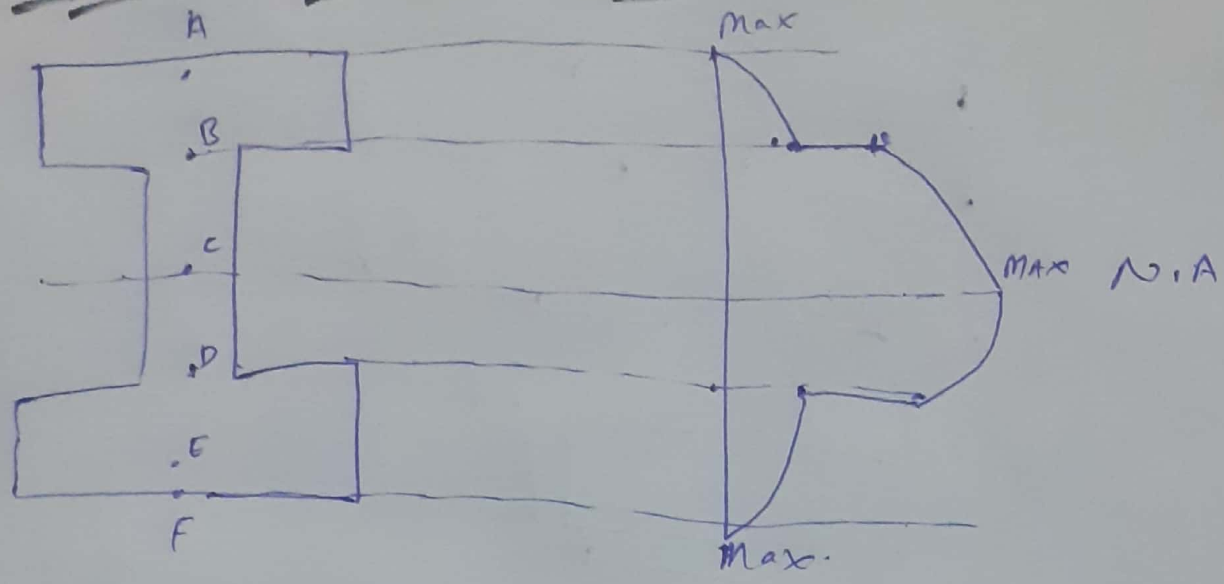
$$\tau = \frac{87 \times [4 \times 1 \times (3-0.5) + (1 \times 2)(2-1)]}{73 \times 1}$$

$$\tau = \frac{87 \times 12}{73}$$

$$= \boxed{14.30 \text{ lb/in}^2}$$

(iv) Shear Stress at Point D, and E will be the same because of the symetry.

Shear stress Diagram

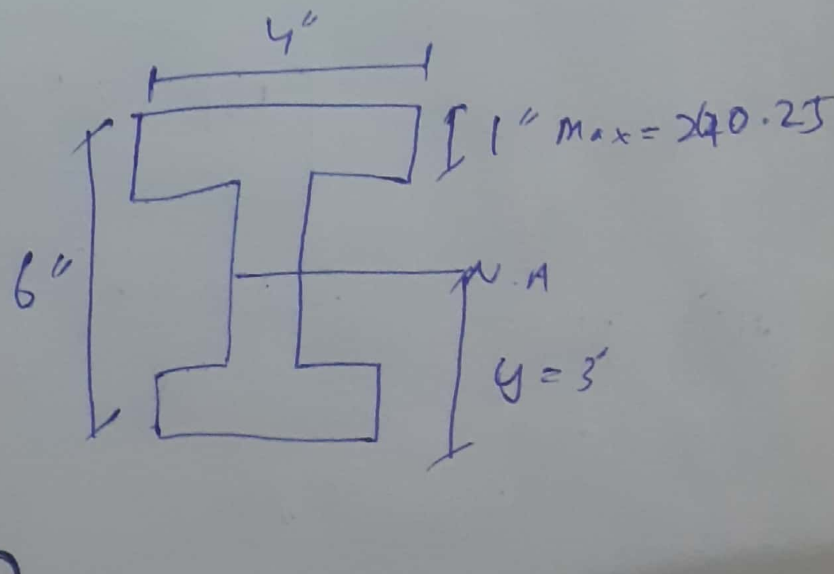


Flexural stress deformation:-

$$S = \frac{MY}{I}$$

(i) flexural stress at the top fiber @ point A.

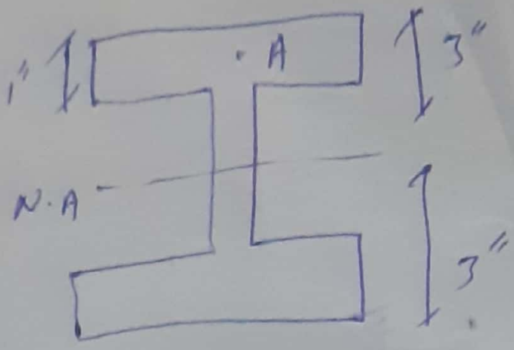
$$S = \frac{My}{I}$$



$$S = \frac{240.25 \times 3}{73}$$

$$\boxed{S = 9.87324 /in}$$

(ii) flexural stress at Point B.

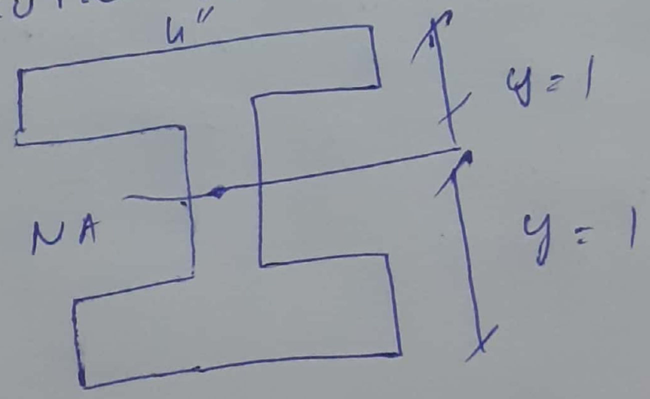


$\delta = \frac{my}{I}$

$\delta = \frac{240.25 \times (3-0.5)}{73}$

$\boxed{\delta = 9.86 \ lb/in^2}$

(iii) flexural stress at point C.

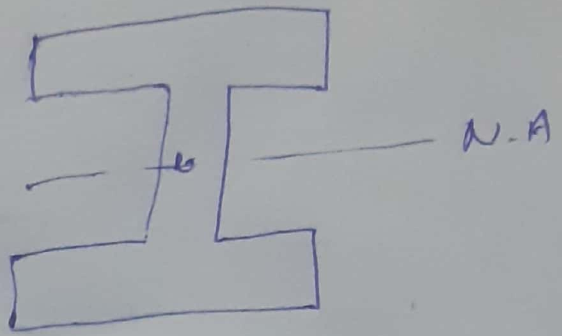


$\delta = \frac{my}{I}$

$\delta = \frac{240.25 \times (3-1)}{73}$

$\delta = \boxed{9.85 \ lb/in^2}$

(IV) flexural stress at Nutral Axis (N.A)

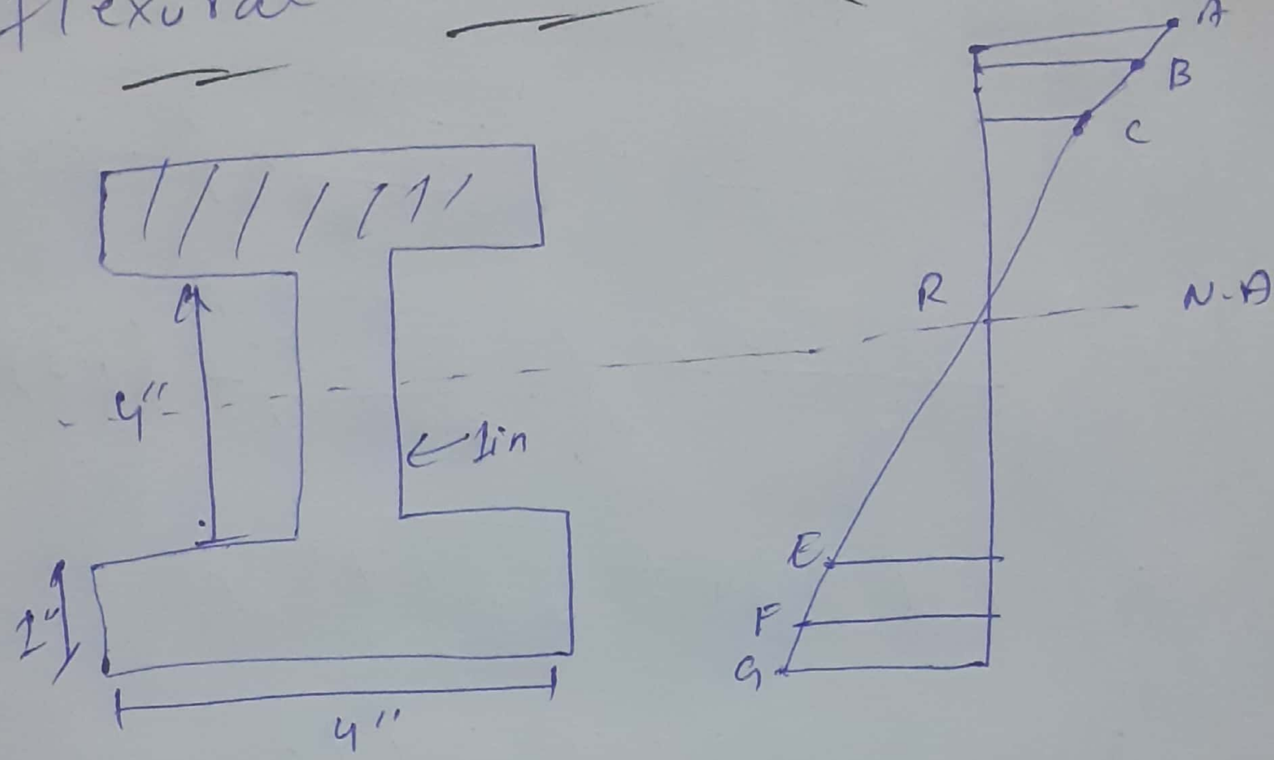


$$f = \frac{my}{I}$$

$$f = \frac{240.25 \times 0}{73}$$

$$\boxed{f = 0\, lb/in^2}$$

flexural stress value at point E, F, & G remain the same because of symetry. the upper portion above the N.A shows Tension and below the N.A shown compression flexural stress diagram:



Equation for Stress transformation:- (16)

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

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

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

for $\sigma_{x'}$

$$\sigma_x = \frac{240.25+0}{2} + \frac{240.25-0}{2}\cos 2(-20) + (0.9)\sin 2(-20)$$

$$\sigma_{x'} = 120 + \overset{80}{\cancel{120}} - 0.385$$

$$\boxed{\sigma_{x'} = \cancel{239.615\ psi}\ 199.61\ psi}$$

for $\sigma_{y'}$

$$\sigma_{y'} = \frac{240.25+0}{2} - \frac{240.25}{2}\cos 2(20) - (0.6)\sin 2(-20)$$

$$\sigma_{y'} = 120 - \overset{80}{\cancel{100}} + 0.385$$

$$\sigma_{y'} = 40.385$$

for $\tau x'y'$

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

$$\tau x'y' = -\frac{(-240.25) - 0}{2} \sin(2(-20)) + 0.6 \cos(2(-20))$$

$$= -77.21 + 0.459$$

$$\boxed{\tau x'y' = -76.751}$$

Principle stresses:-

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

$$\sigma_{1,2} = \frac{9.8732 + 0}{2} \pm \sqrt{\left(\frac{9.8732 - 0}{2}\right)^2 + (0.6)^2}$$

$$\sigma_{1,2} = 4.936 \pm \sqrt{24.73}$$

$$\sigma_{1,2} = 4.936 \pm 24.73$$

$$\sigma_y = \sigma_1 = 4.936 + 24.73 = 29.6 \text{ psi}$$

$$\sigma_x = \sigma_2 = 4.936 - 24.73 = -19.794.$$

or first find $\theta_p = ?$

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

$$= \boxed{\theta_p = 0.144.}$$

Put in genral equation a

$$\sigma_x = \frac{9.8732+0}{2} + \frac{9.8732-0}{0} \cos(2(0.144)) + 0.65\ldots$$

$$\sigma_x = 4.9366 + 4.9366 = 9.873$$

$$\boxed{\sigma_{max} = 9.8732}$$

∴ These calculation show that the given state of stress is itself a principle stress correction in which the shear stress is oproximatlly equal to zero.

Max in plane shear stress in this case

$$\tan 2\theta - \frac{(\sigma_x - \sigma_y)/2}{\sigma_{xy}}$$

$$\tan 2\theta = -\frac{(240.25-0)/2}{0.6}$$

$$\tan 2\theta = 120 \text{ Anti clockwise}$$

Put This in the Given eq. (20)

for $\tau x'y'$

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

$$\tau_{x'y'} = \left(\frac{240.25 - 0}{2}\right)\sin(2(120)) + 0.6(0.5)$$
$2(cos)$.

$$\boxed{\tau_{x'y'} = 120.125\ \text{psi}}$$

Mohr's Circle

(21)

Centre Coordinate:

$$(h, k) = \left[\frac{240.25 + 0}{2}, 0 \right]$$

$$= [120.12, 0]$$

Radius of Mohr's circle is

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

$$= \sqrt{\left(\frac{240.25 - 0}{2}\right)^{2} + (0.6)^2}$$

$$= \left(\frac{240.25}{2}\right)^2 + (0.6)^2$$

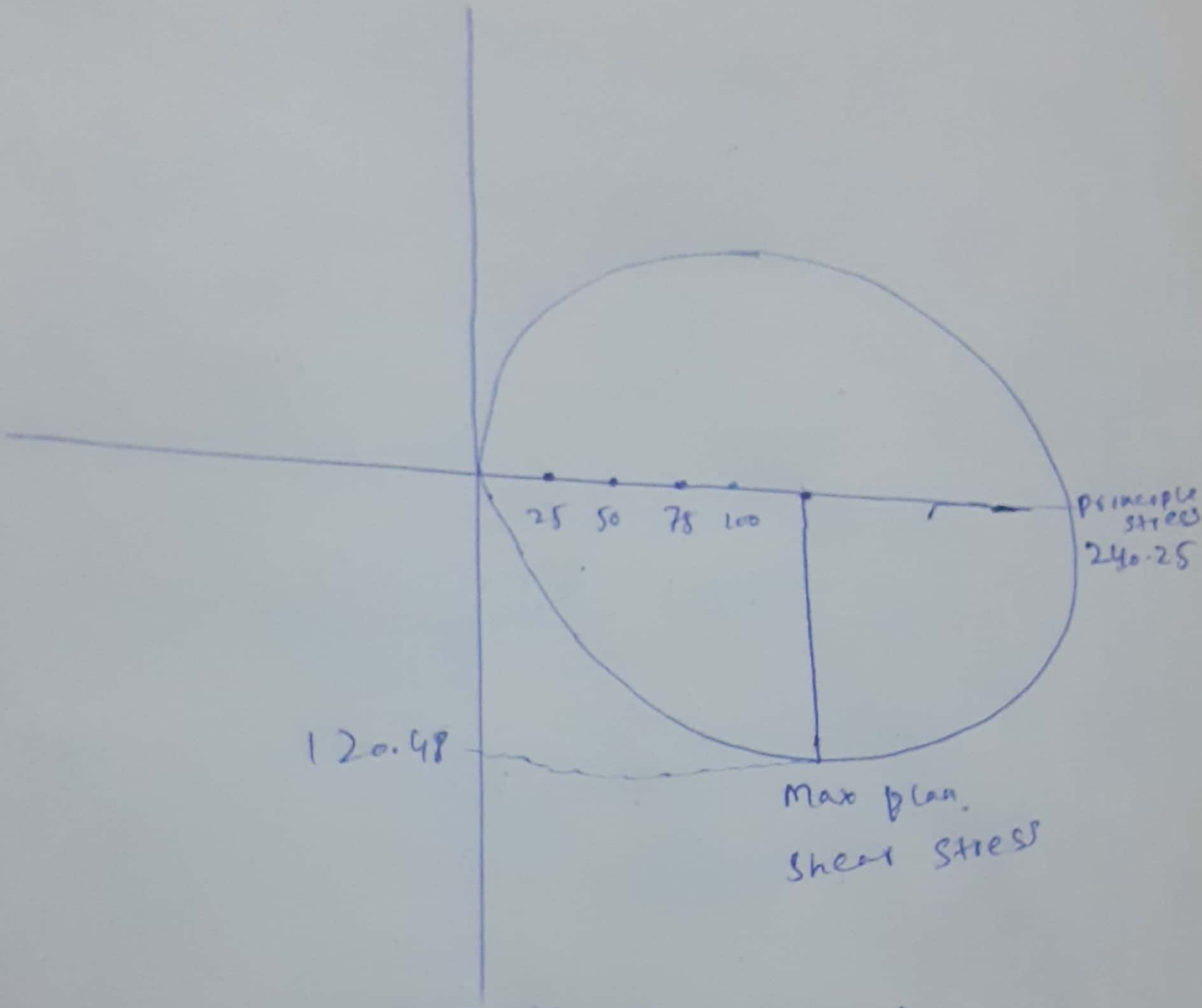
$$120.125 + 0.36$$

$\cancel{120.12 \text{ psi}}$ $\boxed{= 120.48}$

Scale

Psi = 1 cm

(20)



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