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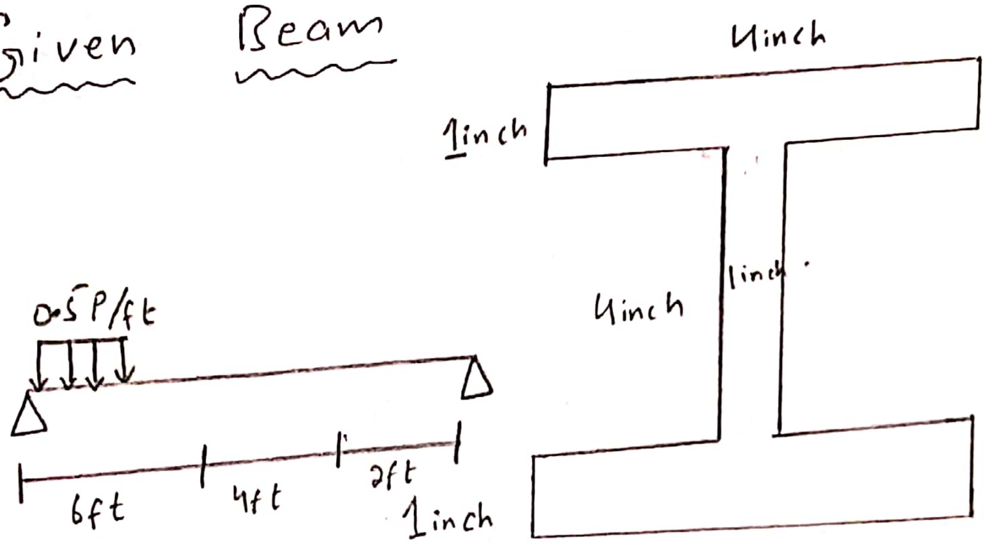
ID	7895
Section	A
Subject	Mos 2
Date	18 - April - 2020
Semister	4th
Student signature	

Question NO 01

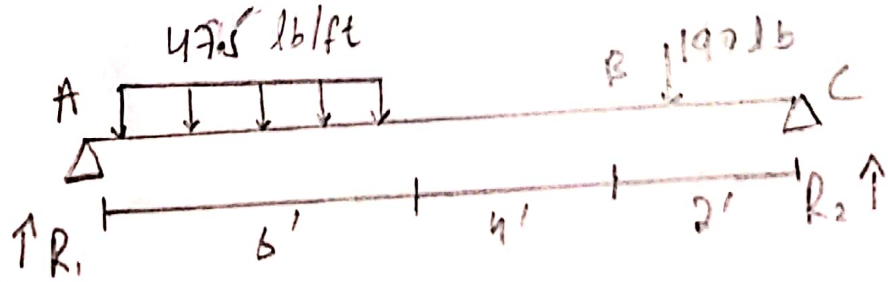
Ans

Given Beam



Note: Put the value of P = 95

So we have



First to find unknown reaction at the support apply equilibrium equation

(2)

$\Sigma f x = 0$ i.e $R_3 = 0$

$\Sigma f y = 0$ $\oplus\uparrow$ $\downarrow\ominus$

$R_1 + R_2 = (47.5 \times 6)\,lb + 190\,lb$

$R_1 + R_2 = 285 + 190$

$\boxed{R_1 + R_2 = 475}$ — (1)

Next

$\Sigma M A = 0$ $(+)$ $(-)$

$R_2 \times 12 - 10 \times 190 - (47.5 \times 6) \times 3 = 0$

$12 R_2 = 1900 + 855$

$12 R_2 = 2755$

$\boxed{R_2 = 229.58}$

(1) $R_1 + R_2 = 475$

$\Rightarrow$ $R_1 = 475 - 229.58$

$\Rightarrow$ $R_1 = 245.42\,lb$

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Now shear force at change point of Beam

Shear force at 6 ft from support

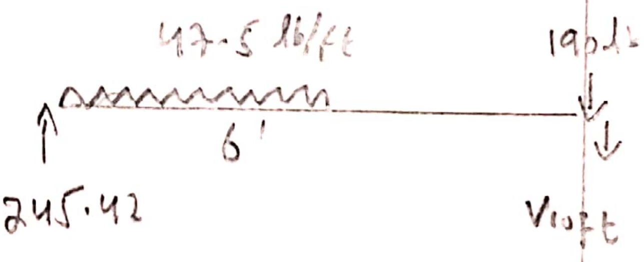
$\Sigma f_y = 0 \quad \oplus\uparrow \quad \downarrow\ominus$

$$245.42 - 47.5 \times 6 - V_{6ft} = 0$$

$$\Rightarrow V_{6ft} = -39.58$$

$\ominus$ Now shear force at 10 ft

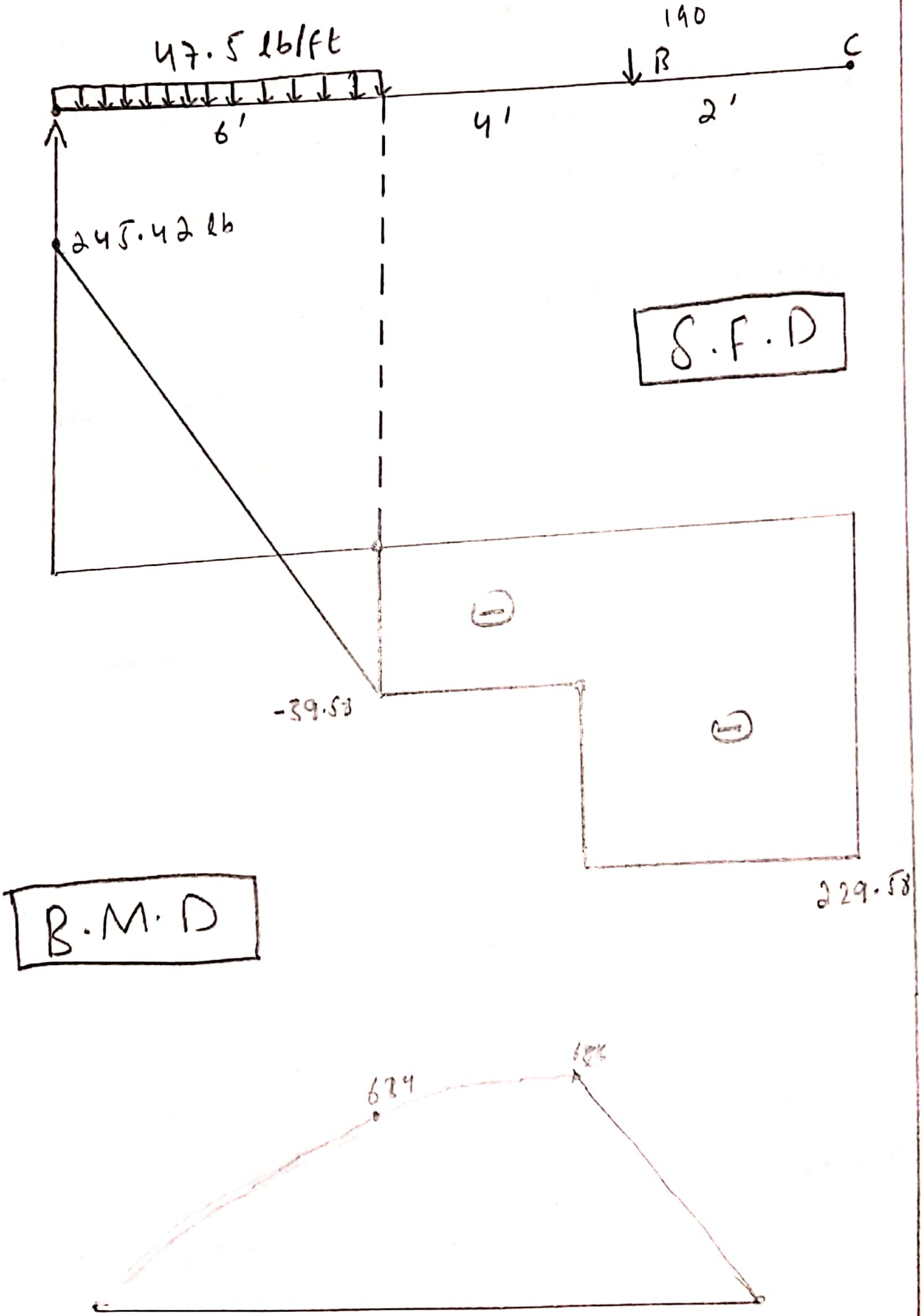
$\Sigma f_y = \oplus\uparrow \quad \downarrow\ominus$



$$245.42 - 47.5 \times 6 - 190 - V_{10ft} = 0$$

$$\Rightarrow V_{10ft} = -229.55 \text{ lb}$$

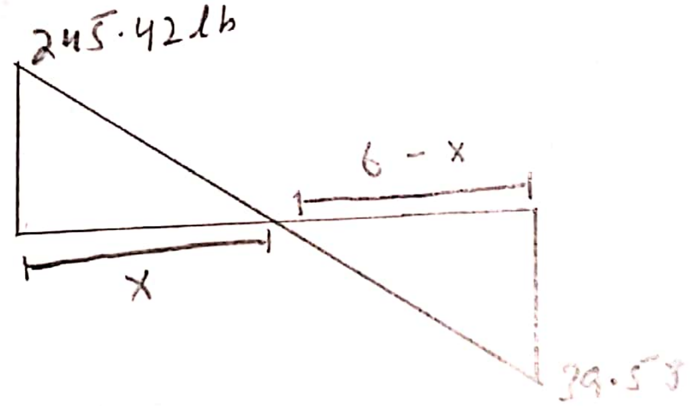
Now draw Shear force and Bending moment diagram we have



⇒ Point of Maximum Bending Moment

As we know that the point where shear force is minimum the bending moment is maximum so from point of zero shear corresponding point will have maximum Bending Moment

From shear force diagram we have



we know that

$$\frac{245.42}{x} = \frac{39.58}{6-x}$$

$\Rightarrow (6-x)(245.42) = 39.58x$

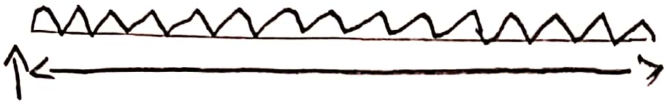
$\Rightarrow 1472.52 - 245.42x = 39.58x$

$\Rightarrow 1472.52 = 39.58x + 245.42x$

$\Rightarrow 1472.52 = 285x$

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

Now determine the value of moment at 5.166 ft



245.42 5.166 ft

$$M_{5.166} - 245.42 \times 5.166 + (47.5 \times 5.166) \times \left(\frac{5.166}{2}\right) = 0$$

$$M_{5.166} - 1267.83 + 245.38 \times 2.583$$

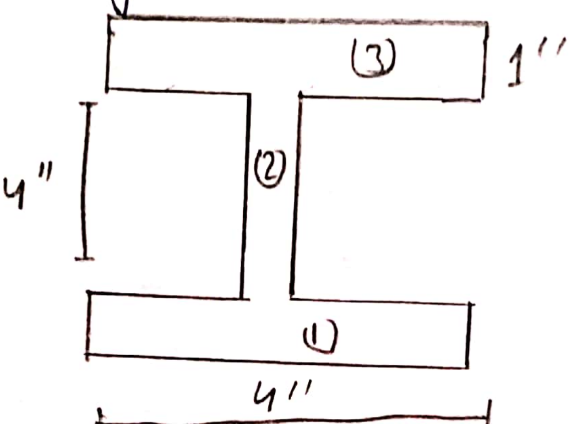
$$M_{5.161} - 1267.83 + 633.81$$

$$M_{5.166} = 634.02 \text{ lb ft}$$

For shear stress we have:

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

So first we determine moment of inertia I f Ø the given section of Beam



As the given figure is symmetrical along Both the axis

So $\bar{x} = 4/2 = 2$ inch

$\bar{y} = \frac{6}{2} = 3$ inch

i.e $(\bar{x}, \bar{y}) = (2, 3)$

(centre of gravity)

extreme left and Bottom

Area of point (1) $= 4 \times 1 = 4 \text{inch}^2$

Area of point (2) $= 4 \times 1 = 4 \text{inch}^2$

Area of point (3) $= 4 \times 1 = 4 \text{inch}^2$

Moment of inertia about x - axis (centriod I) I_{xx}

Determine Distance b/w C.G of the whole Section and corresponding parts

Let G_1, G_2, G_3 be in the centre of gravity of point K_1, K_2, K_3 (1) (2) and (3) and be the distance b/w $\bar{Y}$ and y_1, y_2, y_3 respectively

So

$K_1 = \bar{y} - y_1 \Rightarrow 3 - 0.5 \Rightarrow 2.5$ inch

$K_2 = \bar{y} - y_2 \Rightarrow 3 - 3 \Rightarrow 0$ inch

$K_3 = y - y_3 = 3 - 0.5 \Rightarrow 2.5$ inch

So

$$I_{xx} = \frac{b_1 h_1^3}{12} + a_1 K_1^2 + \frac{b_2 h_2^3}{12} + a_2 K_2^2 + \frac{b_3 h_3^3}{12} + a_3 K_3^2$$

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

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

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

$$I_{xx} = 56 \text{ inch}^4$$

Now

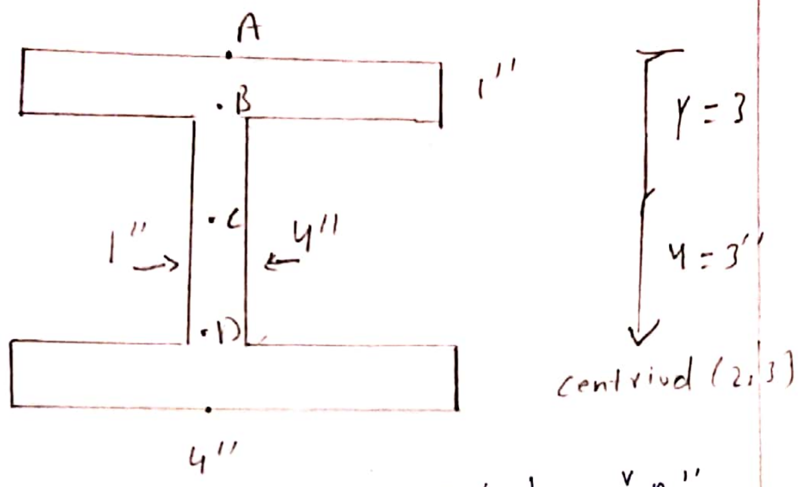
$$I_{yy} = \frac{b_1^3 h_1}{12} + \frac{b_2^3 h_2}{12} + \frac{b_3^2 h}{12}$$

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

$$I_{yy} = \frac{64 + 4 + 64}{12} = 11 \text{ inch}^4$$

Next find the Shear stresses at various point we have

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



(i) Shear stress at point "A" i.e At the top fiber

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

$V_{max} = 229.55\ lb$

$I = 67\ in^4$

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

So $\tau = \frac{229.55(0)}{67(4)}$

Here $A = 0$ Beam no Area of the Section exist above point A i.e $Q = A\bar{y} = 0(\bar{y}) = 0$

$\tau = 0$

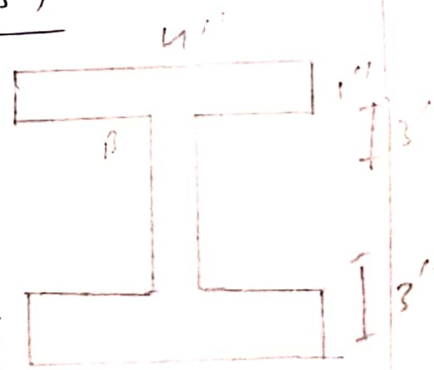
ii) Shear stress at point "B"

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

$$\tau = \frac{229.55 \times (4\times1)(3-0.5)}{67 \times 4}$$

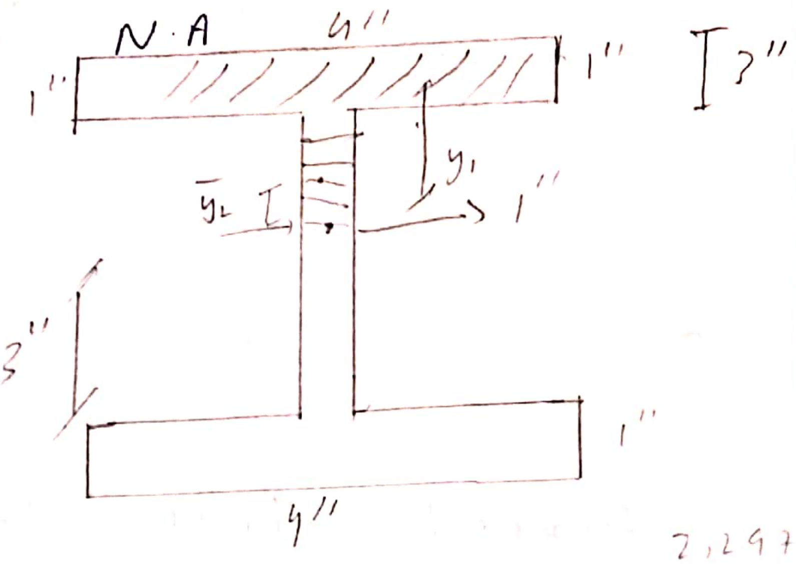
$$\tau = 8.56\ lb/in^2$$

$\bar{y}$



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

Shear stress at point "c" i.e at N.A



7,297

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

$$\tau = \frac{229.55 \times [4 \times 1 \times (3-0.5) + (1 \times 2)(2-1)]}{67 \times 1}$$

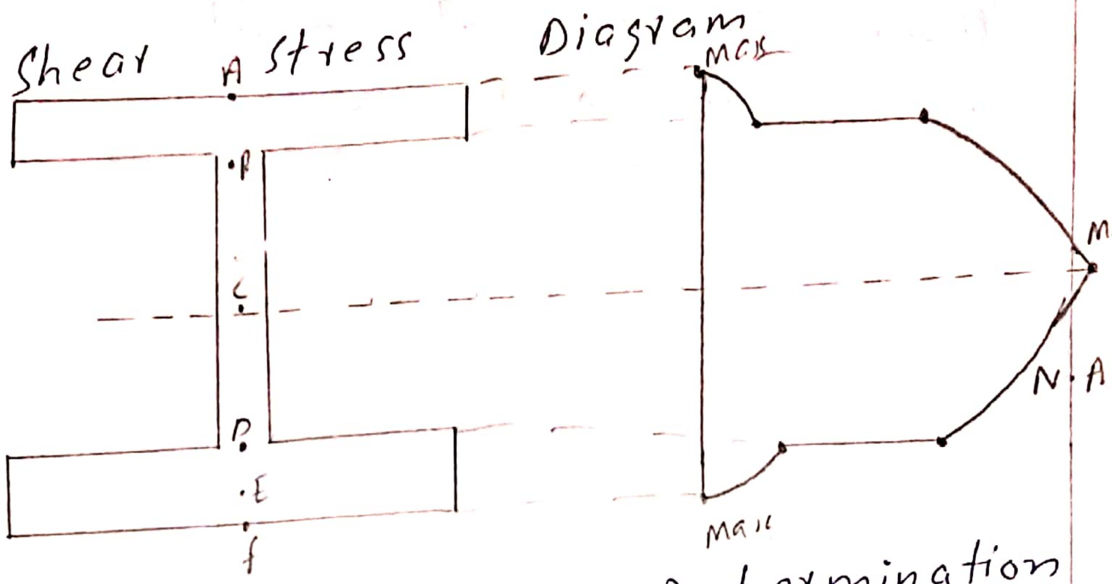
$$\tau = 34.29 \ lb/in^2$$

iv) Shear stress at point D and E will be the same because of the Symmetry

<u>Note:</u> The maximum shear stress value occur at the Neutral axis and minimum value at the top of the Section.

(11)

Shear Stress Diagram



flexural Stress Determination

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

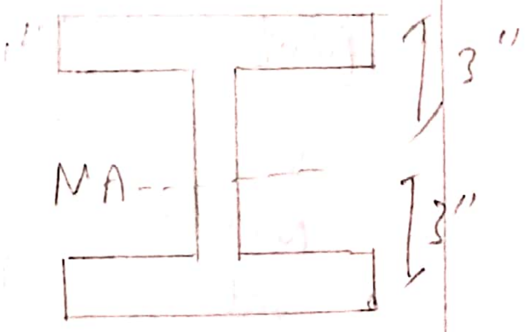
i) Flexural stress at the top fiber point A

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

$$S = \frac{634.02 \times 3}{67}$$

$$S = 28.38 \text{ lb/in}^2$$

ii) Flexural stress at point "B"



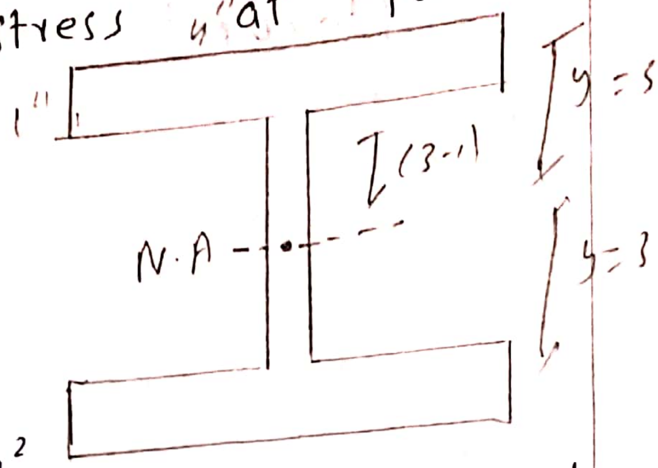
$$S = \frac{My}{I}$$

$$S = \frac{634.02 \times (3-0.5)}{67}$$

$$S = 23.65 \text{ lb/in}^2$$

1268:04 (12)

(iii) Flexural stress "at Point "C"

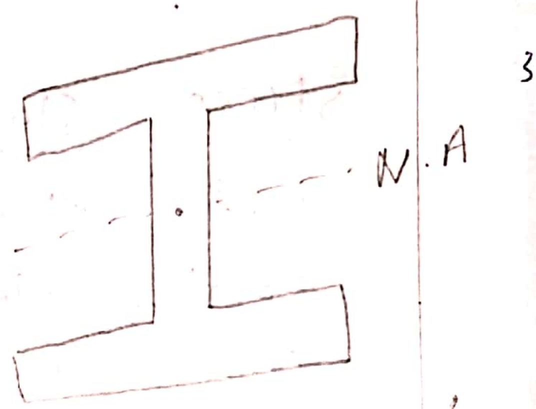


$$S = \frac{My}{I}$$

$$S = \frac{634.02 \times (3-1)}{67}$$

✓ $S = 18.92$ lb/in^2

iv) flexural stress at Neutral axis (N.A)



$$S = \frac{My}{I} \quad \because y = 0$$

$$S = \frac{634.02 \times 0}{67}$$

$S = 0$ lb/in

flexural stress value at point E, f and g remain the same because of the symetry. The upper portion above the N.A shows Tension and below the N.A show compression

Note:- The flexural stress value is maximum at extreme top and bottom fiber at zero at N.A

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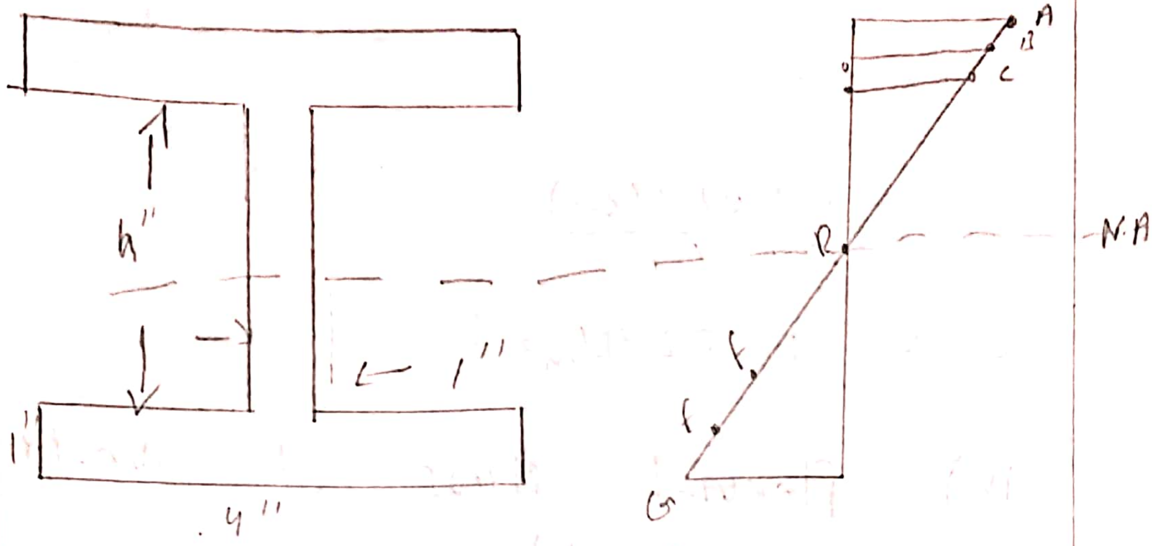
flexural stress diagram



Stress State:

find stress state of a point element located 3ft from left support and 1inch below from top fiber

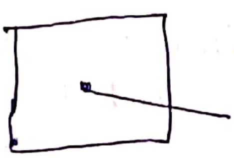
flexural stress at point "C"

σ = ~~6.71 psi~~ 18.92 psi

Shear stress at point "C"

τ = 34.29 psi

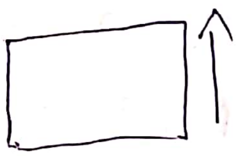
Conside Point "C" is a planner element


18.92

As the flexural stress is perpendicular to the cross section can be represented normal stress

$\tau = 34.29$ psi is comprective Because point "c" lies in compression zone of Beam cross section

If point c lies below the centriod then stress would be tensile.



$\tau = 34.29$ psi

$\tau = 34.29$ psi

$\sigma_x = 18.92$ psi

Combine stress on 2d element.

Find it Principle stress:

we have also find

$\sigma_x = 18.92$

$\sigma_y = 0$

$\tau_{xy} = 34.29$

Principle stress equation

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

$$\sigma_{x,y} = -\frac{18.92 + 0}{2} \pm \sqrt{\left(\frac{-18.92 - 0}{2}\right)^2 + (34.29)^2}$$

$$\sigma_{x,y} = -9.46 \pm \sqrt{89.49 + 1175.80}$$

$$\sigma_{x,y} = -9.46 \pm \sqrt{1265.29}$$

$$\sigma_{x,y} = -9.46 \pm 35.57$$

$$\sigma_x = -9.46 - 35.57 = -45.03$$

$$\sigma_y = -9.46 + 35.57 = 26.11$$

or first find $\theta P = ?$

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

$$\tan 2\theta P = \frac{34.29}{(-18.92-0)/2}$$

$$\tan 2\theta P = -3.62$$

$$2\theta P = \tan^{-1}(-3.62)$$

$$\boxed{\theta P = -37.27}$$

Put in general equation

$\sigma_{max} = -\frac{18.92+0}{2} + \frac{-18.92+0}{2}$

$\cos 2(-37.27) + 34.29 \sin 2(-37.27)$

$\sigma_{P max} = -9.46 - 9.46 - 32.78$

$\sigma_{P max} = -51.7$

Max in plane shear stress

in this case

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

$\tan 2\theta_s = \frac{-(-18.92-0)/2}{34.29}$

$\tan 2\theta_s = 0.27$

$2\theta_s = \tan^{-1} 0.27$

$\theta_s = \frac{15.10}{2}$

$\theta_s = 7.55$

Put in these general equation

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

$\tau_{x'y'} = -\left(\frac{-18.92-0}{2}\right) \sin 2(7.55) + 34.29$

$\cos 2(7.55)$

$\tau_{x'y'} = (\cancel{9.46)(42.09})$

$\cancel{398.17}$ $\boxed{44.32}$

79.49
1175.80

(17)

To Draw Mohr's circle
centre co-ordinate

$$(h, k) = \left(\frac{\sigma x + \sigma y}{2}, 0\right)$$

$$\Rightarrow \left(\frac{-18.92 + 0}{2}, 0\right)$$

$$\Rightarrow (-9.46, 0)$$

Radius of Mohr's circle

$$r = \sqrt{\left(\frac{\sigma x - \sigma y}{2}\right)^2 + \tau^2 xy} = \sqrt{\left(\frac{-18.92 - 0}{2}\right)^2 + (34.29)^2}$$

$$\boxed{r = 1265.2941}$$

Scale
1Psi = 1cm