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ID 7925

Section # A

Sub MOS 2

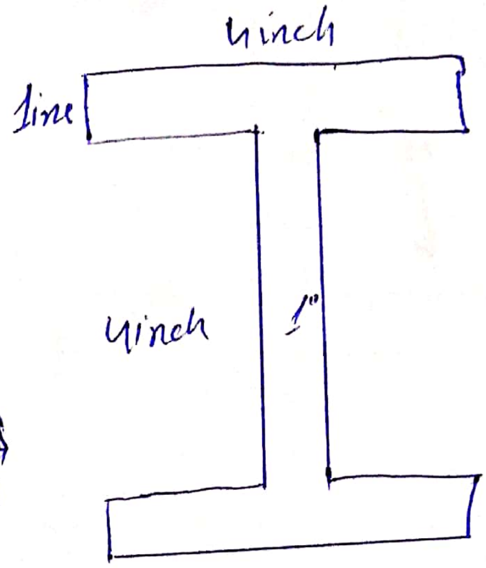
Semester 4th

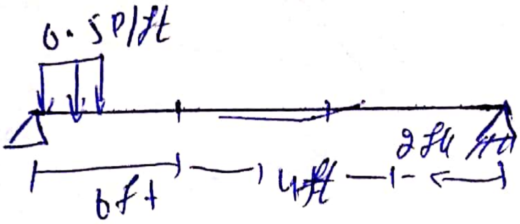
Degree BE civil

Instructor: Eng Saqib Khan

Question #1

Ans

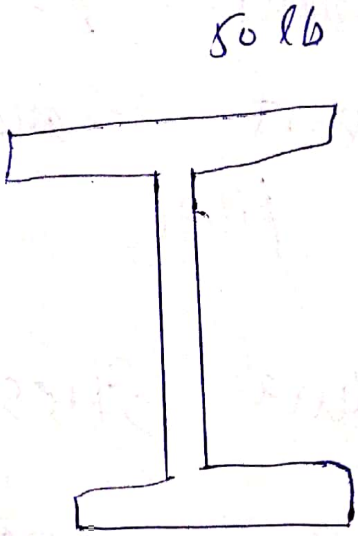


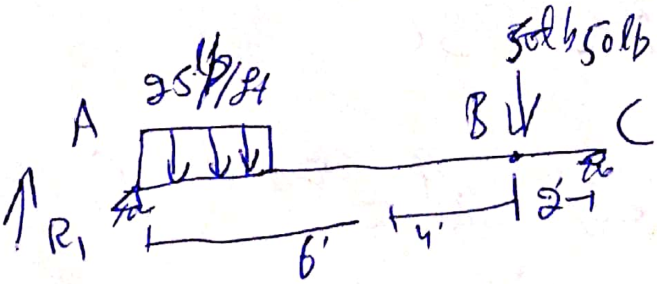


Here My class registration No 7925

So we have

$2p = 2 \times 25 = 50$





(2)

First we find unknown reaction at the support applying equilibrium Equation

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

$\Sigma f y = 0$ $+\uparrow \downarrow$

$R_1 + R_2 = (25 \times 6)\ lb + 50$

$R_1 + R_2 = 150^{lb} + 50\ lb$

$\boxed{R_1 + R_2 = 200\ lb} \rightarrow (1)$

$R_2 \times 12 - 10 \times 50 - (25 \times 6) \times 3 = 0$

$12 R_2 - 500 - 450 = 0$

$12 R_2 = 500 + 450$

Divid 12 on both side

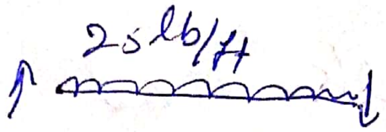
$R_2 = \frac{950}{12} = 79.166$

$R_1 + R_2 = 200 lb$

$R_1 = 200 - 79.166$

$\boxed{R_1 = 120.833}$

Now shear force at charge point of beat



at 6 ft

Shear force at 6 ft from support

$\Sigma f_y = 0, \; +\uparrow \downarrow$

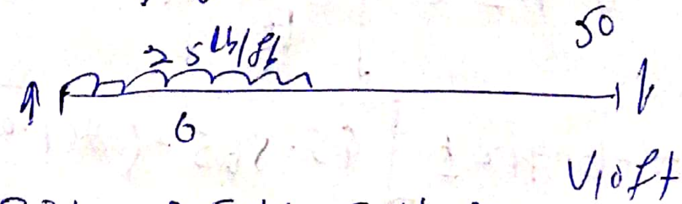
$120.834 - 25 \times 6 \; V_{6ft} = 0$

$-29.166 - V_{6ft}$

$V_{6ft} = -29.166$

Now shear force at 10 ft

$\Sigma f_y = 0 \; +\uparrow \downarrow$



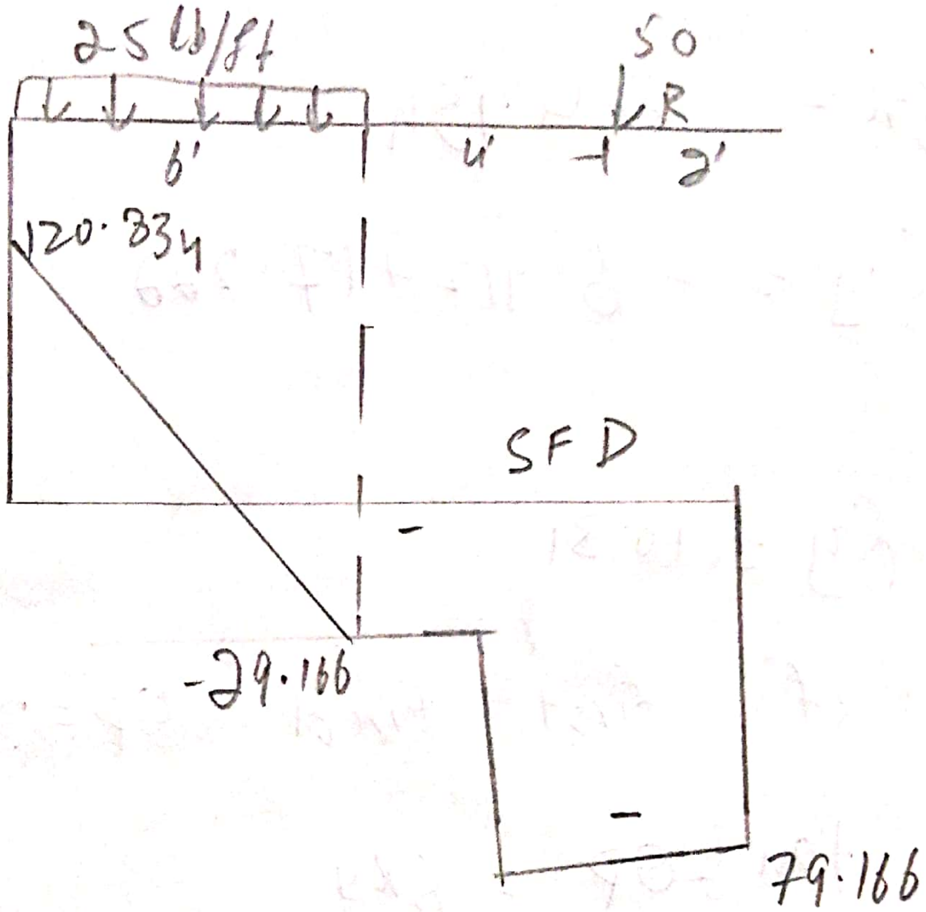
$120.834 - 25 \times 6 - 50 \, V_{10ft} = 0$

$120.834 - 150 - 50 \, V_{10ft} = 0$

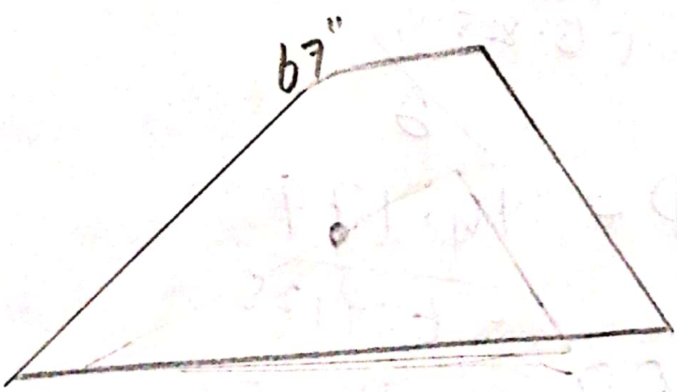
$120.834 - 200 - V_{10ft} = 0$

$-V_{10ft} = +79.166 \quad \Rightarrow \boxed{V_{10}ft = -79.166}$

Now draw Shear force and Bending Moment diagram we have



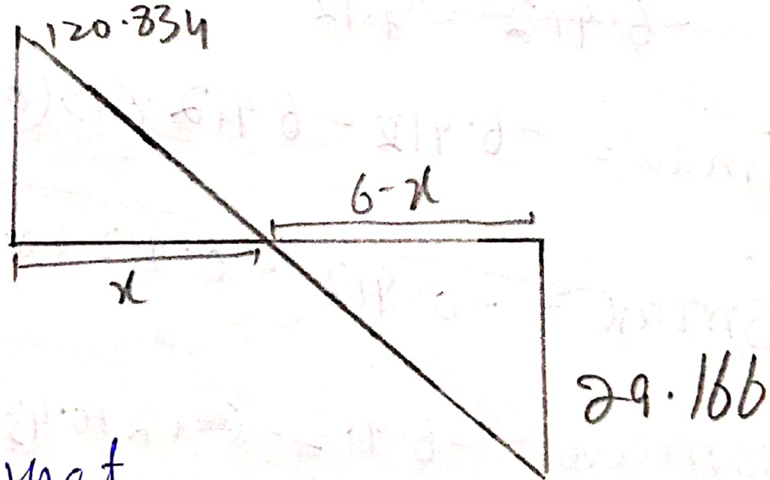
B.M.D



Point of Maximum Bending moment

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

from shear force diagram (SFD)



We know that

$$\frac{120.834}{x} = \frac{29.166}{\cancel{x-6}\ 6-x}$$

$$6-x(120.834) = x(29.166)$$

$$725.004 - 120.834x = 29.166x$$

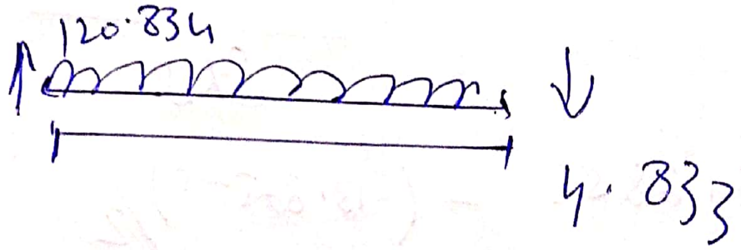
$$725.004 = 29.166x + 120.834x$$

$$725.004 = 150x$$

Dividing 150 on both sides

$\frac{725.004}{150} = x \Rightarrow 4.833\,ft$

Now Determine the value of moment at poin 4.833 ft



$M_{4.8333} - 120.834 \times 4.833 + (25 \times 4.833)$

$M_{4.833} - 583.990 + 120.825$

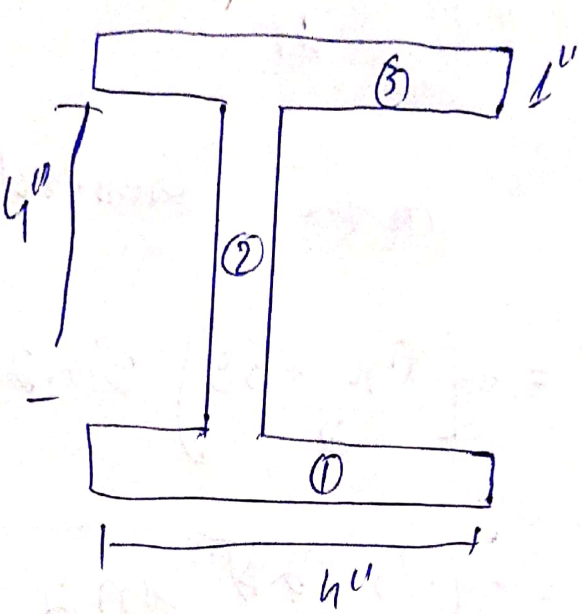
$M_{4.833} - 463.165$

$M_{4.833} = 463.165$

For shear stress we have

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

So first we have determine moment of Inertia I f the given section of Beam



As the give figure is symetrical along Both the axis

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

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

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

Centre of gravity

Extreme left and Bottom

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

" " " (2) $= 4 \times 1 = 4$ $inch^2$

" " " (3) $= 4 \times 1 = 4$ $inch^2$

Moment of Inertia about x-axis

(Centriod I) I_{xx}

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

let's

G_1, G_2, G_3 be in the Centre of gravity of point ① ② and ③

and k_1, k_2, k_3 be the distance b/w $\bar{y}$ and y_1, y_2, y_3 respectively

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

$k_2 = \bar{y} - y_2 = 3 - 3 = 0$ inch

$k_3 = \bar{y} - y_3 = 3 - \cancel{0.5} = \cancel{2.5\,inch}\; 2.5$ inch

So $I_{xx} = \frac{b_1 h^3}{12} + a_1 k_1^2 + \frac{b_2 h_2^3}{12} + a_2 k_2^2 + \frac{b_3 h_3^3}{12} + a_3 k_3^2$

$I_{xx} = \frac{4(1)^3}{12} + 4(2.5)^2 + \frac{4(4)^3}{12} + a_3(0)$

$+ \frac{4(1)^3}{12} + 4(2.5)$

$= \frac{4}{12} + 25 + \frac{64}{12} + \frac{4}{12}\; (25$

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

$I_{xx} = 56$ inch^4

Now

$$I_{yy} = \frac{b_1^3 h_1}{12} + \frac{b_2^3 h_2}{12} + \frac{b_3^3 h_3}{12}$$

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

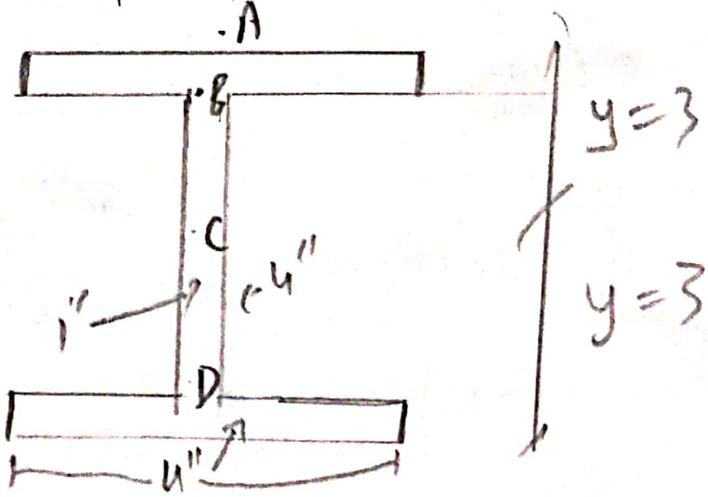
$$I_{yy} = \frac{64}{12} + 4/12 + 64/12$$

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

$$I_{yy} = \frac{132}{12} = 11 \text{ inch}^4$$

Next to find the shear stresses at various point we have

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



shear stress at point A

i.e at the top of fiber

$\tau = VQ/Ib$ $\therefore Q = A\bar{y}$

So

$V_{max} = 79.166\ lb$

I $56+11 = 67\ inch^4$

So $\tau = \dfrac{(79.166)(0)}{67(4)}$

Here $A = 0$ Beam no area of section or exist about point "A"

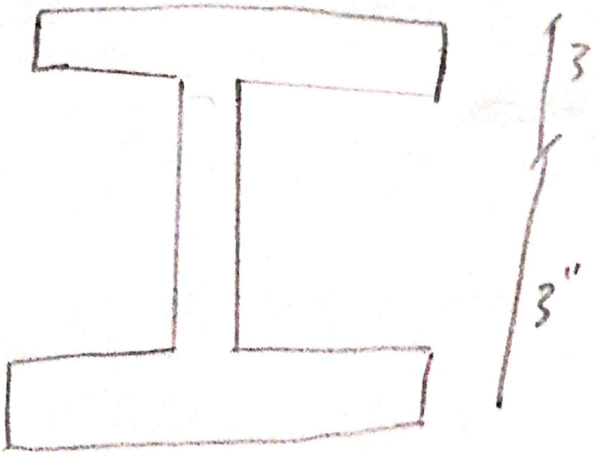
i.e. $Q = A\bar{y} = 0(\bar{y}) = 0$

$\tau = 0$

shear stress at point "B"

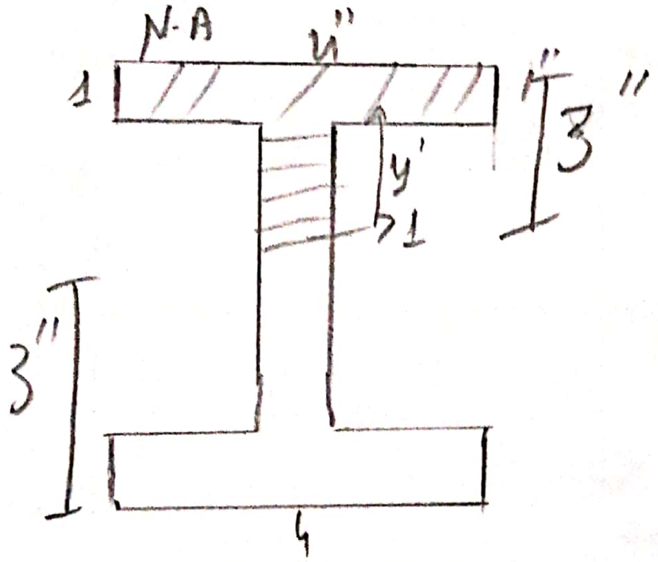
$\tau = VQ/Ib$ $= \dfrac{(79.166) \times (4 \times 1(3-0.5)}{67 \times 4}$

$$\tau = \frac{791.66}{268} = 2.951\ lb/in^2$$



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

iii) Shear stress at point C



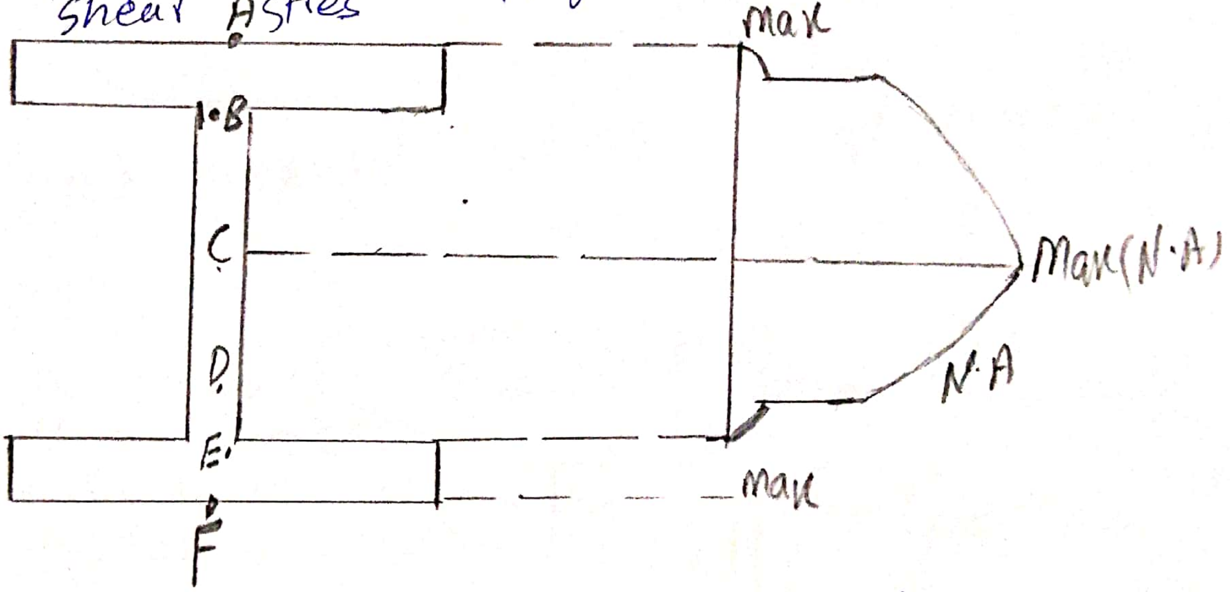
$$\tau = VQ/Ib = \frac{79.166[4 \times 1(3-0.5) + (1 \times 2(2-1)]}{67 \times 1}$$

$$= \frac{949.992}{67} = 14.1789\ lb/in^2$$

iv) Shear Strees at point D and E will be the Same because of the symetry

Note: The maximum shear stress value occure at the neutral axis and ~~ma~~ minimum value at the top of the Section

Shear Astres Diagram



flexural stress determination

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

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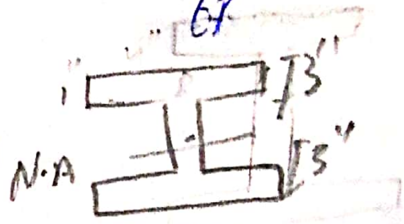
flexural stress at the top fiber point "A"

$S =$

$$= \frac{(463.165)3}{67} = \frac{1389.495}{67} = S = 20.738\ lb/in$$

ii) flexural stress at point "B"

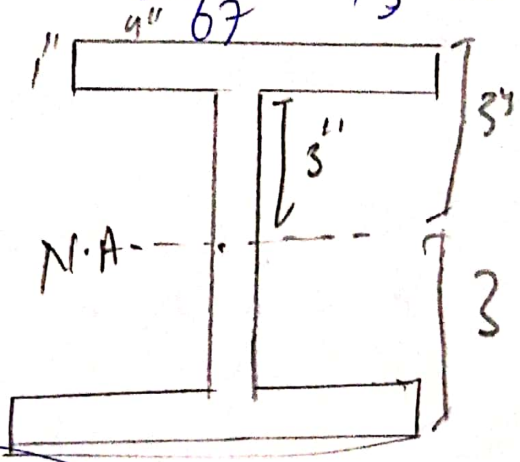
$$S = \frac{My}{I} = \frac{463.165 \times (3-0.5)}{67} = \frac{1167.912}{67}$$



$$S = 17.43\ lb/in^2$$

iii) flexural stress at point 'C'

$$S = \frac{463.165 \times (3-1)}{67} = \frac{926.33}{67} = 13.825\ lb/in^2$$



$$S = 13.825\ lb/in^2$$

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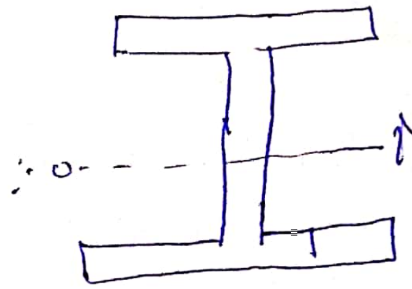
iv.) flexural stress of ~~Nauteral~~ Neutral axis (N.A)



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

$S = \frac{463.165(0)}{67} = 0\,lb/in^2$

flexural stress value at point E.F and G ~~ream~~ remain the same because of symetry the upper portion. Above the N.A. Shows Tension and below the N.A show compressive

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

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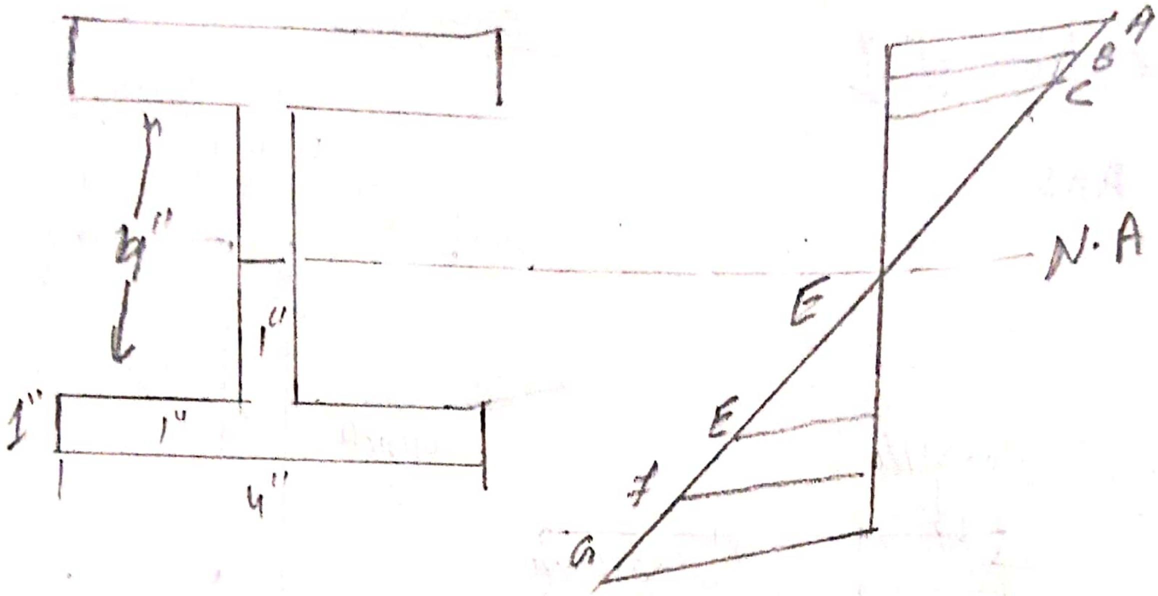

=> Stress state =

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

flexural stress at point "C"

$\delta = 13.825$ Psi

shear stress at point C

$\tau = 14.178$ Psi

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considered point "C" is a planner elemen

[δ → sigma

13.825 psi

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

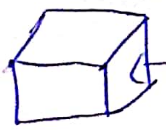
$\tau = 14.178$ psi is compreective

Because point "C" lies in compression zone of beam cross section

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

$T = 14.179$ Psi

$\tau = 14.179$ psi



$\sigma_x = 13.825$ Psi

Combine stress on 2-D element

we have also find

$\sigma x = 13.825$

$\sigma y = 0$

$\tau x^2 y = 14.179$

principle of stress eq

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

$$\sigma x = \frac{-13.825 + 0}{2} \pm \sqrt{\left(\frac{13.825 - 0}{2}\right)^2 + 14.179^2}$$

$$\sigma x, y = -6.912 \pm \sqrt{\frac{191.130}{4} + (14.179)^2}$$

$$= -6.912 \pm \sqrt{47.78 + (14.179)^2}$$

$$= -6.912 \pm \sqrt{248.324}$$

$$= -6.912 \pm 15.77$$

(18)

$\delta x = -6.912 - 15.77 = -22.682$

$\delta x = -6.992 + 15.77 = 8.858$

first find $\theta p = ?$

$$\tan 2\theta p = \frac{\delta xy}{\delta x - \delta y / 2}$$

$$\tan 2\theta p = \frac{14.179}{(-13.825) / 2}$$

$$\tan 2\theta p = \frac{14.179}{-6.912}$$

$\tan 2\theta p = -2.051$

$2\theta p = \tan^{-1}(-2.0.51)$

$$\frac{2\theta p}{2} = -64.007$$ Divid of both sides

$$\theta p = \frac{-64.007}{2}$$

$$\boxed{\theta p = -32.003}$$

put in General Equation

$$\delta max = \frac{-13.825+0}{2} + \frac{-13.825+0}{2}$$

$$\cos(-32.003) + 14.179 \sin 2(-32.003)$$

$$\delta max = -6.912 - 6.912 * 0.437 - 12.74$$

$$\boxed{\delta max = -26.36}$$

Max in plane shear stress

in this case

$$\tan 2\theta_s = -\frac{\left(\delta_x - \delta_y\right)/2}{\delta_{xy}}$$

$$\tan 2\theta_s = -\frac{\left(-13.825 - 0\right)/2}{14.825}$$

$$\tan 2\theta_s = \frac{13.825}{2} \Big/ 14.825$$

$$\tan 2\theta_s = 6.912 / 14.82$$

$$\tan 2\theta_s = 0.466$$

$$2\theta_s = \tan^{-1}(0.466)$$

$$2\theta_s = 24.98$$ Divid 2 on both sides

$$\theta_s \quad 24.98$$

$$\theta_s = 12.49$$

Put in the General sol equation

$$\tau xy = \left[\frac{\sigma x - \sigma y}{2}\right] \sin 2 (12.49) + 14.179$$

$$\tau xy = \left[\frac{\sigma x - \sigma y}{2}\right] \sin 2\theta + \tau xy \cos 2\theta$$

$$\tau xy = \left[\frac{13.825 - 0}{2}\right] \sin 2 (12.49) + \cos 2 (12.49)$$

$$\tau x, y = \left(\frac{13.825}{2}\right) \sin (24.98) + \cos (24.98) (14.479)$$

$$\tau x, y = 6.912 (0.422) + 14.179 (0.904)$$

$$\tau x, y = 2.91 + 12.85$$

$$\tau, x, y = 15.76$$

To Draw Mohr's circle

Centre co-ordinate

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

$$\Rightarrow \left[\frac{-13.825+0}{2}, 0\right]$$

$$(h,k) \Rightarrow (-6.912, 0]$$

Radius of Mohr's circle

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

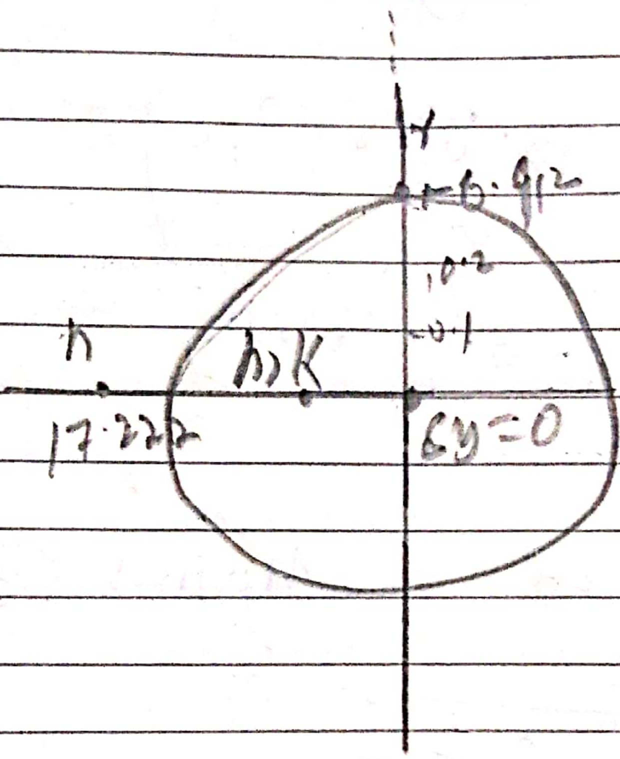
$$= \sqrt{\left(\frac{-13.825}{2}\right)^2 + (14.179)^2}$$

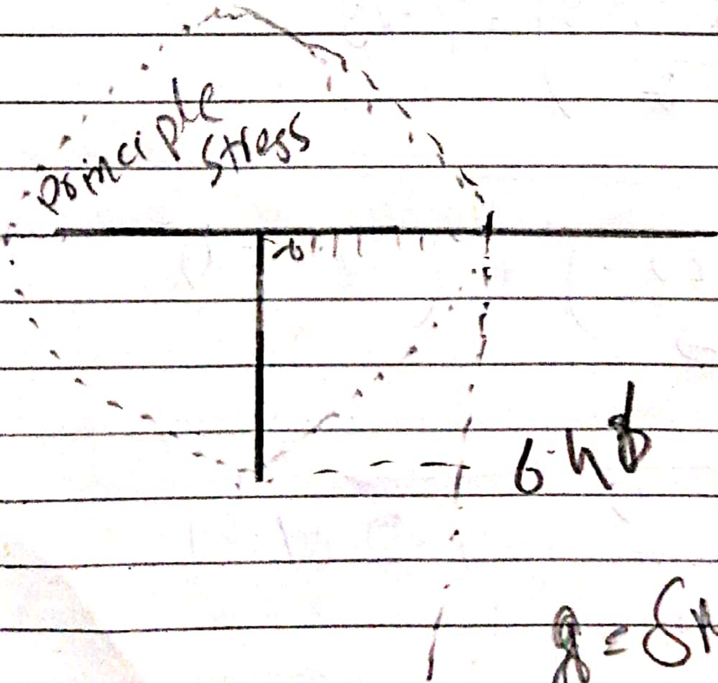
$$= \sqrt{\frac{191.13}{4} + 201.04}$$

$$= \sqrt{47.78 + 201}$$

$= \sqrt{296.009}$

$\boxed{r = 17.222}$





$g = 6xy$