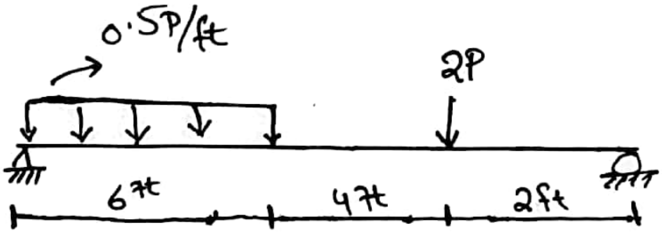
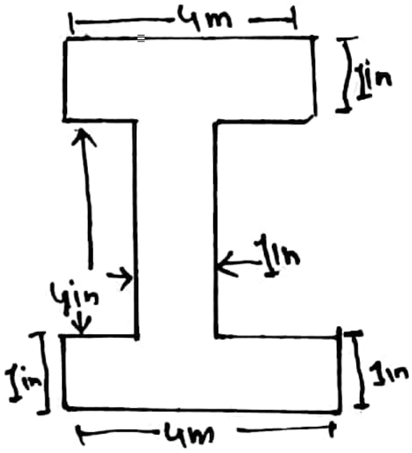
ID# 7493

Question :-





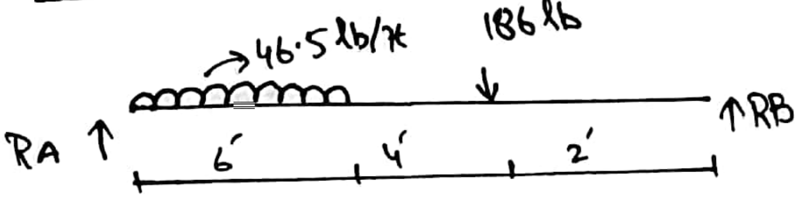
Solution :-

ID = 7493

$0.5P = 0.5 \times 93$
$= 46.5 \text{ lb}$

$2P = 2 \times 93$
$= 186 \text{ lb}$

Free body diagram :-



Support Reaction :-

$\Sigma M_A = 0$ (+↺)

$-(46.5 \times 6)(3) - (186)(10) + RB \times 12 = 0$

$RB = \dfrac{2697}{12}$ $\boxed{RB = 224.75 \text{ lb}}$

$\Sigma fy = 0 \quad \downarrow - \quad \uparrow +$

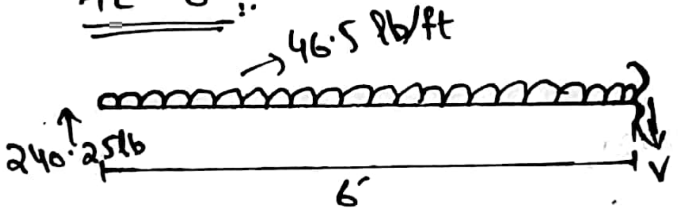
$RA - (46.5 \times 6) - 186 + 224.75 = 0$

$RA = 465 - 224.75$

$\boxed{RA = 240.25 \text{ lb}}$

Shear force at change Point of beam

At 6' :-



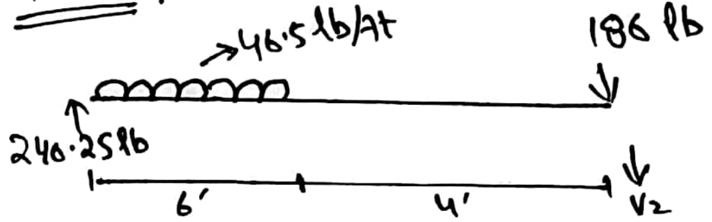
$\Sigma fy = 0 \quad \uparrow + \quad \downarrow -$

$-V + 240.25 - (46.5 \times 6) = 0$

$V = 240.25 - 279$

$V_1 = -38.75 \text{ lb}$

At 10' :-



$\Sigma fy = 0 \quad \uparrow + \quad \downarrow -$

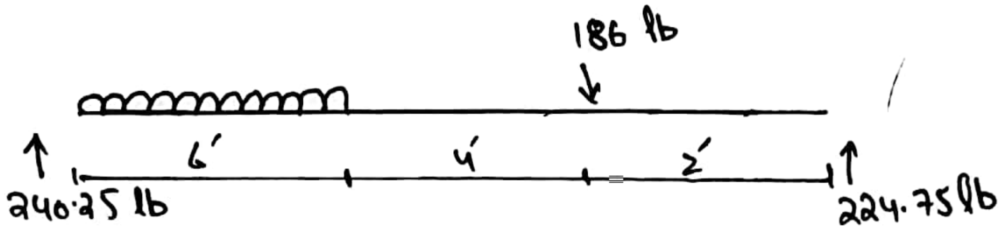
$-(46.5 \times 6) + 240.25 - 186 - V_2 = 0$

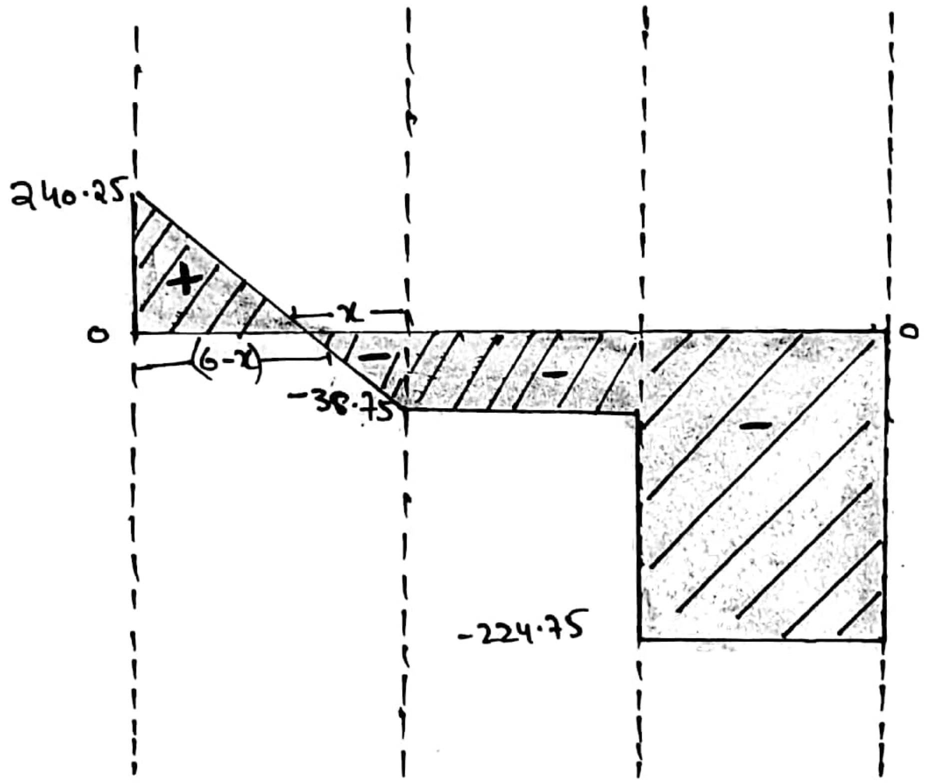
$V_2 = 240.25 - 279 - 186$

$V_2 = 240.25 - 465$

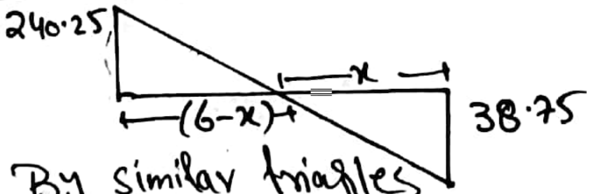
$V_2 = -224.75 \text{ lb}$

Shear Force diagram :-





Zero Shear Point



By similar triangles

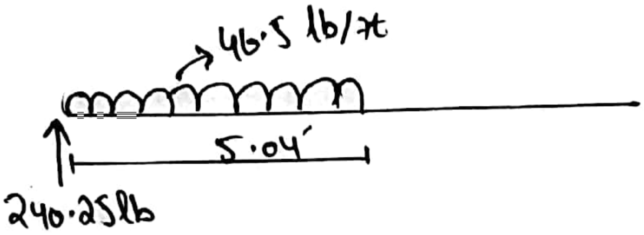
$$\frac{240.25}{(6-x)} = \frac{38.75}{x}$$

$$240.25x = 38.75(6-x)$$

$$x = \frac{232.5}{240.25}$$

$$\boxed{x = 0.96'}$$

Taking Section at 5.04 from left to end support



$\Sigma M_{5.04} = 0$ (+ ↺ −)

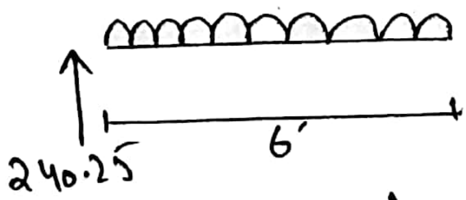
$-(240.25 \times 5.04) + 46.5\left(\frac{5.04}{2}\right) \times 5.04 + M_{5.04} = 0$

$= -1210.86 + 590.58 + M_{5.04} = 0$

$M_{5.04} = 1210.86 - 590.58$

$M_{5.04} = 620.28$ lb.ft.

Now at 6' :-



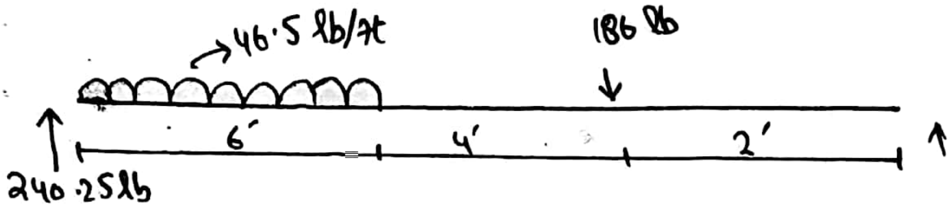
$\Sigma M = 0$ (+ ↺ −)

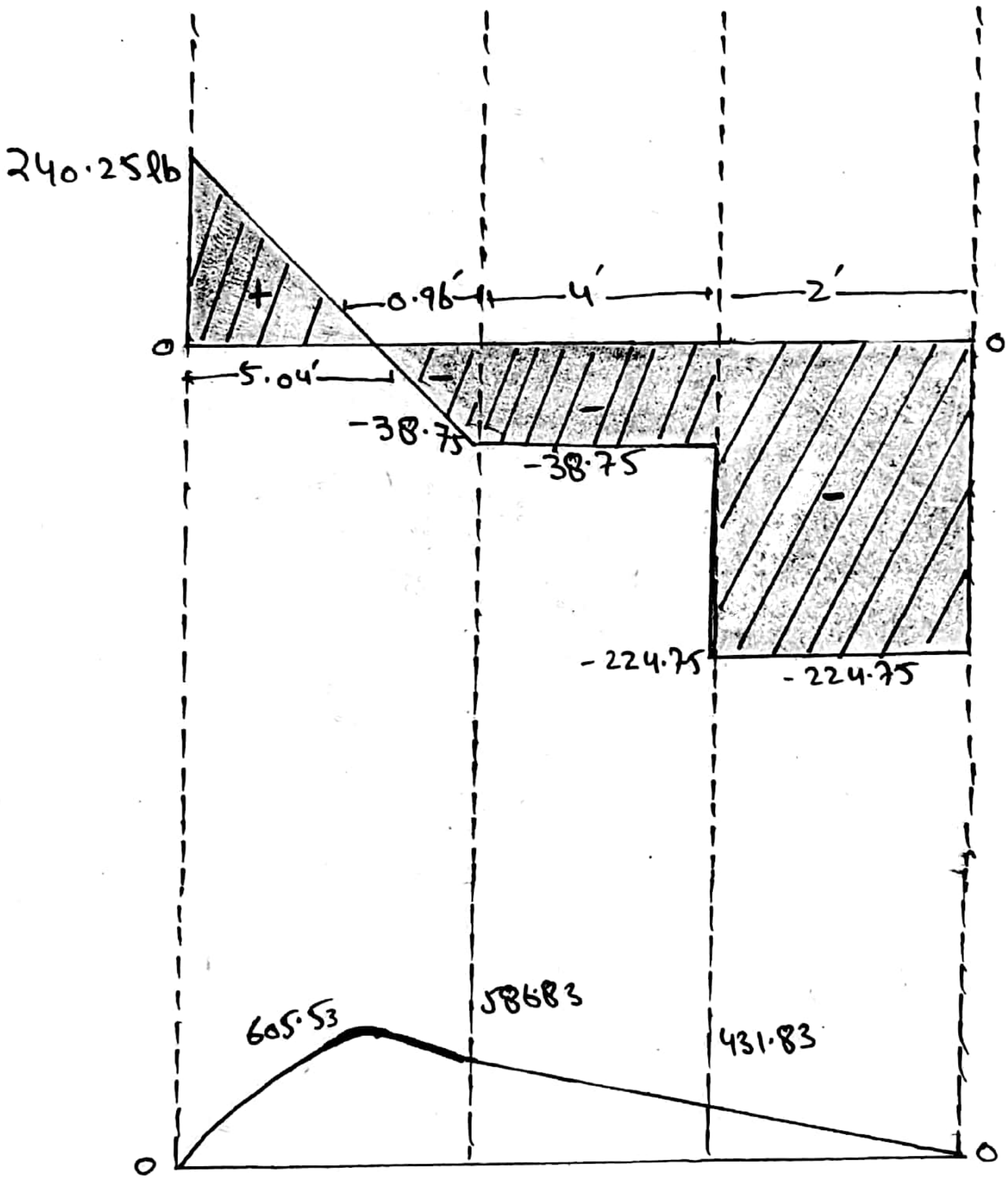
$M_6 = -(240.25 \times 6) + (46.5 \times 6)(3)$

$M_6 = 1441.5 + 837$

$M_6 = -604.5$

Shear Force and bending Moment diagram.



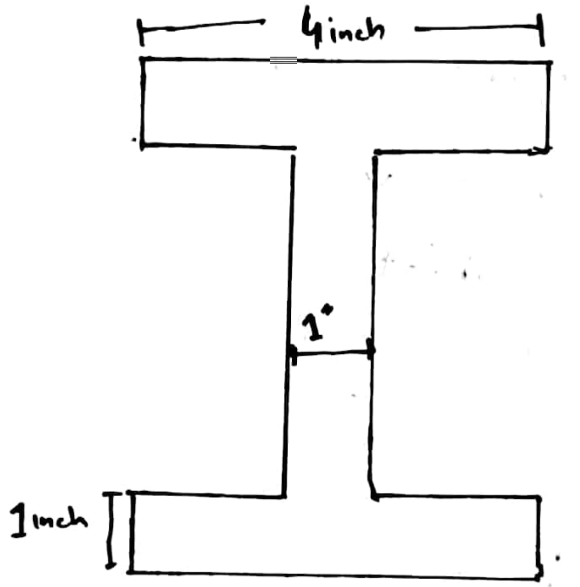


Now shear stress :-

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

Max shear force = 240.25

Moment of inertia :-



Formula For find centroid

$$\bar{y} = \frac{A_1 y_1 + A_2 y_2 + A_3 y_3}{A_1 + A_2 + A_3}$$

$A_1 = 4 \times 1 = 4$
$A_2 = 4 \times 1 = 4$
$A_3 = 4 \times 1 = 4$

$$\bar{y} = \frac{4 \times 0.5 + 4 \times 3 + 4 \times 5.5}{4+4+4}$$

$$\bar{y} = 3''$$

(Now "A")

No	A (in^2)	Ix (in)
1	4	$\frac{4\times(1)^2}{12} = 0.33$
2	4	$\frac{1\times(4)^3}{12} = 5.333$
3	4	$4\times(1)^3/12 = 0.333$

Now "d"

(1) $d = (\bar{y} - y^1) = (3 - 0.5) = 2.5$

(2) $d = (\bar{y} - y^2) = (3 - 3) = 0$

(3) $d = (3 - 5.5) = -2.5$

(Now Ad^2)

(1) $4\times(2.5)^2 = 25$

(2) $4\times(0)^2 = 0$

(3) $4\times(-2.5)^2 = 25$

$\Rightarrow \bar{I}x = Ix + Ad^2$

(1) $0.3335 + 25 = 25.33$

(2) $5.333 + 0 = 5.333$

(3) $0.333 + 25 = 25.333$

Combine Total

$\bar{I} = I_{x1} + I_{x2} + I_{x3}$

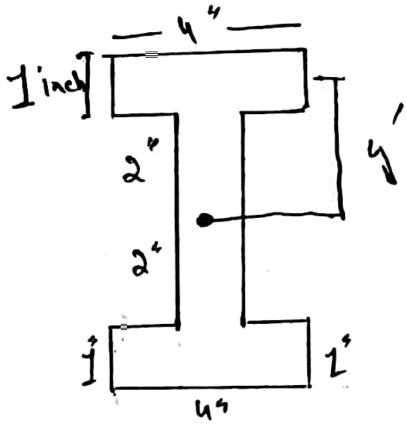
$\bar{I} = 25.333 + 5.33 + 25.33$

$\boxed{\bar{I} = 55.999 \text{ in}}$

Shear Stress :-

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

$V_{max} = 240.25 \text{ lb}$



$y' = 2 + 0.5 = 2.5$

$A = 1 \times 4 = 4$

$Q = 4 \times 2.5 = 10$

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

$= \frac{(240.25)(10)}{(55.996)(4)}$

$= \boxed{10.72}$ psi

Flexural Stress Analysis

$$\sigma = \frac{M y}{I}$$

$$M = 605.53$$

$$\sigma = \frac{(605.53)(2)}{55.996}$$

$$\boxed{\sigma = 21.62}$$

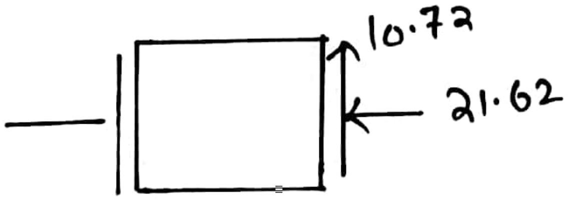
So shear streess at point "c".

$$\boxed{t = 10.72}$$

Flexural stress at point "c"

$$\boxed{\sigma = 21.62}$$

Combine Stress on 2D



→ Find stress state consider at Point "c" at a degree of 20°

Given:

$\sigma_x = -21.62$

$\sigma_y = 0$

$\tau_{xy} = 10.72$

Sol:

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

for $\sigma_{x'}$

$$\sigma_{x'} = -\frac{21.62}{2} + -\frac{21.62}{2} \cos(2(-20)) + (10.72)\sin(2(-20))$$

$$\boxed{\sigma_{\bar{x}} = -25.98} \text{ psi}$$

For $\sigma_{y'}$

$$\sigma_{y'} = -\frac{21.62}{2} - \frac{(-21.62)}{2} \cos(2(-20)) - (10.72)\sin(2(-20))$$

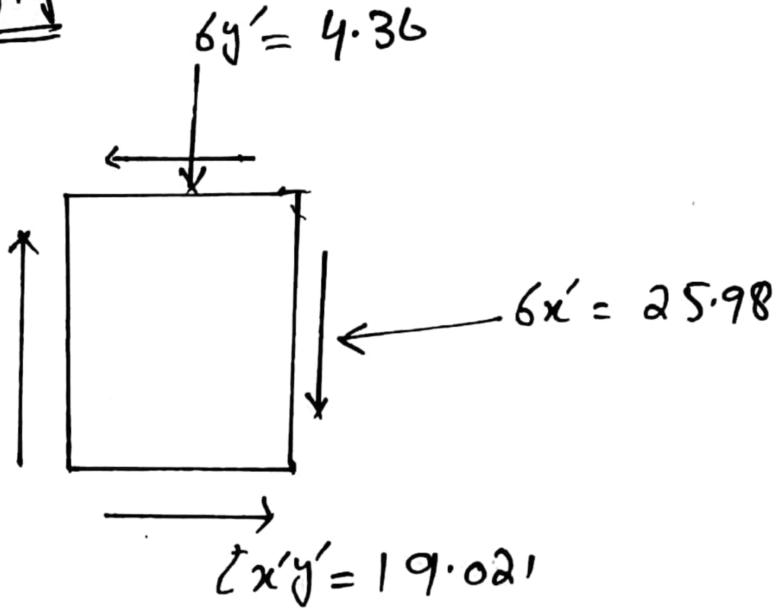
$$\boxed{\sigma_{y'} = 4.36}$$

For $\tau_{\bar{x}y'}$

$$\tau_{x'y'} = -\left(-\frac{21.62}{2}\right) - 0 \sin(2(-20)) + 10.72 \cos(2(-20))$$

$$\boxed{\tau_{x'y'} = 19.021}$$

Now the new stress state after 20°
Shown in fig



Principle stress :-

$$\sigma_{12} = \frac{-21.62+0}{2} \pm \sqrt{\left(\frac{-21.62-0}{2}\right)^2 + (10.72)^2}$$

$$\sigma_{12} = -10.81 \pm \sqrt{116.85 + 114.9}$$

$$\sigma_{12} = -10.81 \pm \sqrt{231.75}$$

$$\sigma_{12} = -10.81 \pm 15.22$$

$$\sigma_y = \sigma_1 = -10.81 + 15.22 = 4.41$$

$$\sigma_x = \sigma_2 \quad -10.81 - 15.22 = -26.03$$

Max in plane Shear stress

$$\tau_{xy} = \sqrt{\left(\frac{6x - 6y}{2}\right)^2 + (10.72)^2}$$

$$\tau_{xy} = \sqrt{\left(\frac{-21.62 - 0}{2}\right)^2 + (10.72)^2}$$

$$\boxed{\tau_{xy} = 15.22}$$

Mohar circle:

The condition of circle can be find by

$$\left(\frac{6x + 6y}{2}, 0\right)$$

$$(h, K) = \left(-\frac{21.62}{2}, 0\right)$$

$$= (-10.81, 0)$$

Find Radius Mohar circle

$$r = \sqrt{\left(\frac{6x - 6y}{2}\right)^2 + \tau_{xy}^2}$$

P.T.O

$$r = \sqrt{\left(-\frac{21.62}{2}\right)^2 + (10.72)^2}$$

$$\boxed{r = 15.22}$$