Mechanics Of Solid

Name : M. Zahoor

ID : 7902

Sec : A

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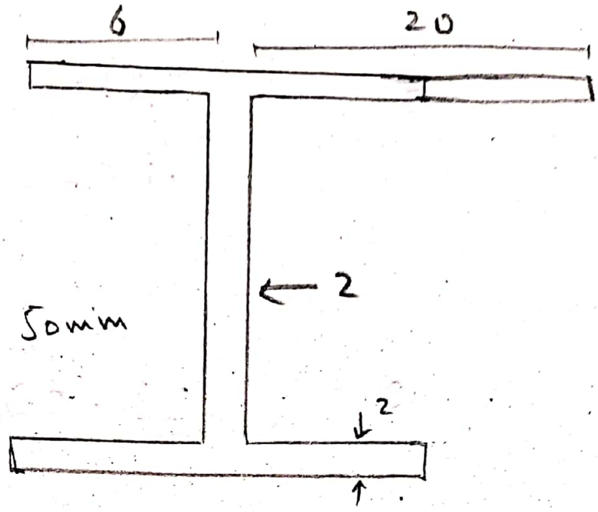
Q No 1

(Part – a)

Ans:-



Required:-

location of shear centre.

Sol:-

As we know.

$$e = \frac{h^2 b^2}{4I}$$

and

$$I = 2\left(\frac{bh^3}{12} + Ay^2\right) + \left(\frac{bh^3}{12} + Ay^2\right)$$

$$\Rightarrow 2\left(\frac{25(2)^3}{12} + (20 \times 2)(25)^2\right) + \left(\frac{2(50)^3}{12} + 0\right)$$

Scanned with CamScanner

$$I = 50034.66 + 20833$$

$$I = 70867.99 \ mm^4$$

$$e = \frac{2(50)^2 (25)^2}{4(70867.99)}$$

$$e = 11.02 \ mm$$

So sheer centre

$$e = 11.02$$

$$\boxed{e = 11.02 \ mm}$$

Ans.

Q No 1

(Part - b)

Ans :-

Given Data :-

Height = 26 ft

Tengential stress = 6000 psi

specific weight of water = 62.4 lb/ft^3

Required :

Thickness of wall of water tank = t = ?

Sol :

$$P = \gamma h$$

$$\sigma_t = \frac{PD}{2t} = \frac{\gamma h \times D}{2t}$$

$$t = \frac{\gamma h D}{2 \sigma_t}$$

Putting the value

$$t = \frac{\frac{62.4}{(12)^3}\,(26 \times D)}{2\,(6000)}$$

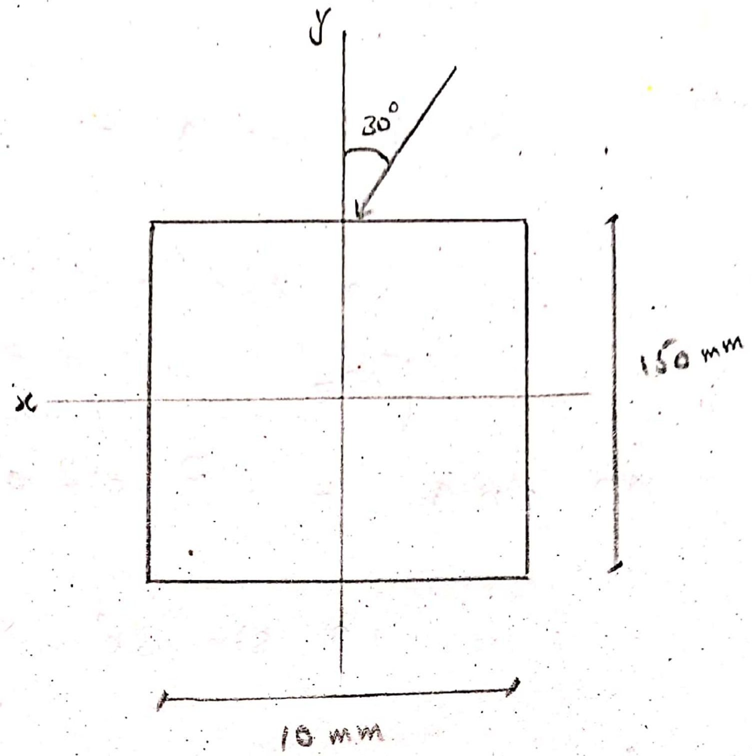
$$t = \frac{\frac{62.4}{(12)^3}\,(26 \times 12)\,(22 \times 12)}{2\,(6000)}$$

$$\boxed{t = 0.24 \text{ inch}}$$

Ans.

Q No = 2 (Part – 'a')

Ans :



Moment of Inertia

$$I_z = \frac{bh^3}{12} \Rightarrow \frac{0.1\,(0.15)^3}{12}$$

$$I_z \Rightarrow 2.8125 \times 10^{-5}$$

Now

$$I_y = \frac{bh^3}{12} \Rightarrow \frac{(0.15)\,(0.1)^3}{12}$$

$$I_y = 1.25 \times 10^{-5}$$

$$\sigma = \frac{M_z y}{I_z} + \frac{M_y z}{I_y}$$

$$\sigma = \frac{M\cos\theta}{I_z} + \frac{M\sin\theta}{I_y}$$

where

$$M = \cos\theta \Rightarrow P\cos\theta = M_z$$

$$= 12\cos 30^\circ$$

$$\boxed{M_z = 1.8510}$$

$$M\sin\theta = P\sin\theta = M_y$$

$$= 12\sin 30^\circ$$

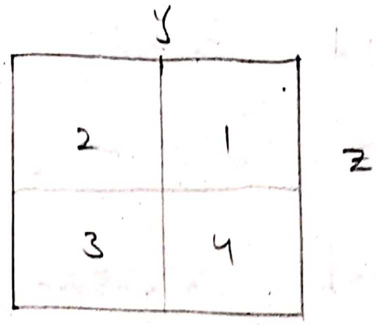
$$\boxed{M_y = -11.8563}$$

$$\sigma = \left(\frac{M_z}{I_z}\right) + \left(\frac{M_y}{I_y}\right)$$

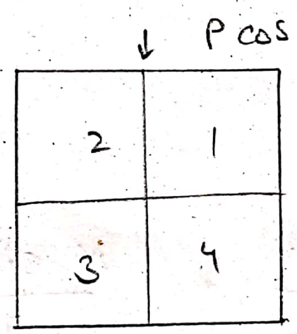
$$\sigma = \frac{1.851}{2.812 \times 10^{-15}} + \left(\frac{-11.8563}{1.25 \times 10^{-5}}\right)$$

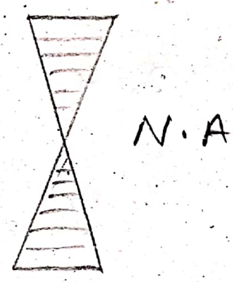
$$\boxed{\sigma = 882678 \ N/m^2}$$

Sign Convention



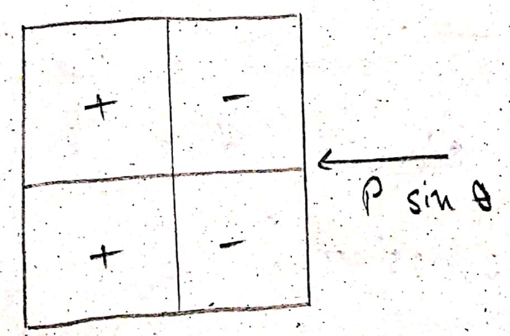
☆ If we take compression as negative and tension as positive and the Beam is simply supported.

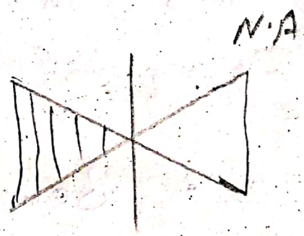




Quardant 1, 2 -ive

" 3, 4 +ive





Quardent 1, 4 -ive

" 2, 3 +ive

In case of Unsymetrical loading the Neutral axis lies of an angle of "x". The principle axis and the algebric sum of stress at N.A is zero.

$$\sigma = \frac{M\cos\theta \cdot y}{I_z} + \frac{M\sin\theta \cdot z}{I_y} \rightarrow (1)$$

In This case N.A passes through z, y

$$\sigma = \frac{M\cos\theta \cdot y}{I_z} + \frac{M\sin\theta \cdot z}{I_y}$$

Let consider a point "A" on N.A lies in Quardent z, where

- Bending stress due to $P\cos\theta$ is compressive.
- Bending stress due to $P\sin\theta$ is tensile.

eq → 1

$$0 = \frac{-M\cos\theta\, y_A}{I_z} + \frac{M\sin\theta\, z_A}{I_y}$$

$$\frac{M\cos\theta\, y_A}{I_z} = \frac{M\sin\theta\, z_A}{I_y}$$

$$\frac{y_A}{z_A} = \frac{I_z}{I_y}\frac{\sin\theta}{\cos\theta}$$

$$\tan\alpha = \frac{I_z}{I_y}\tan\theta \longrightarrow (2)$$

Now

Put values of I_z, I_y and θ in eq (2)

$$\tan\alpha = \frac{I_z}{I_y}\tan 30$$

$$\Rightarrow \frac{2.8125 \times 10^{-5}}{1.25 \times 10^{-5}}\tan 30^\circ$$

$$\tan\alpha = -14.1429$$

$$\alpha = \tan^{-1}(-14.4129)$$

$$\alpha = 1.5^{\circ}$$

$$\boxed{\alpha = 1^{\circ}\ 30'\ 5''}$$

Ans.

Q No 2

(Part - B)

Given Data :

Length of beam = 16 ft

Angle of inclimation = 60°

I_x = 112.6 in^4

I_y = 18.7 in^4

δ_t = 5000 PSI.

δ_c = 12000 PSI

Required :-

maximum load = ?

Sol :-

There will be tension as well as compression which will reduce the effect of each other. So, we will calculate stress at A and C so,:

$$\delta_A = \frac{M_x \, y}{I_x} + \frac{M_y \, x}{I_y} \text{ (incompression).}$$

$$\delta_c = \frac{M_x y}{I_x} + \frac{M_x y}{I_y} \quad (\text{Tension}).$$

Now M_x and M_y.

$$M_x = P \cos 60 \; (16 \times 12)$$

$$M_x = 48 \; P' \cos 60.$$

$$M_y = \frac{P \sin 60 \; (16 \times 12)}{4}$$

$$\boxed{M_y = 48 \, P \sin 60.}$$

$$\delta_A = \frac{48 \; P \cos 60^\circ \times 3.07 + 48 \, P \sin 60 \times 3.07}{1126 + 18.7}$$

$$\boxed{P = 1638.6 \text{ lb}}$$

Now

$$\delta_c = \frac{M_x y}{I_x} + \frac{M_y x}{I_y}$$

$$5000 = 48 \; P \cos 60 + 593 + \frac{48 \, P \sin 60 \times 0.5}{18.7}$$

$$\boxed{P = 2104.9 \text{ lb}}$$

Maximum stress load = 1638.6 lb

Ans

Q No 3

Given Data

Length = 10 ft

$E = 10.3 \times 10^6$

$b = 0.75$

$h = 2$

Factor of safety = 2

Requird:-

a) safe load at hinged = ?

3) saf load at Fixed = ?

solv:-

a) For hinged column.

$L_e = L$

$$I = I_x \frac{(0.75)(2)^3}{12} = 0.5 \text{ in}^4$$

$$P_{cr} = \frac{n^2 E I \pi^2}{L_e^2} = \frac{(1)^2(10.3\times10^6)(0.5)\pi^2}{(10\times12)^2}$$

$$P_{cr} = \frac{50776940}{14400} = 3526.176 \text{ lb}$$

$$P \text{ safe load} = \frac{P_{cr}}{\text{Factor of safety}}$$

$$\frac{3526176}{2} = \boxed{1763.088 \text{ lb}}$$

b, Strut act column.

(For fixed ended)

$$Le = L/2$$

$$Le = \frac{10}{2} = 5 ft.$$

$$I = I_y = \frac{2 \times (0.75)^3}{12} = 0.07 \text{ in}^4$$

$$P_{cr} = \frac{n^2 EI \pi^2}{Le^2} = \frac{(1)^2 (10.3 \times 10^6)(0.07)(3.14)^2}{(5 \times 12)^2}$$

$$P_{cr} = \frac{7108771.6}{(60)^2}$$

$$P_{cr} = 1974.658 \text{ lb}$$

$$P \text{ safe load} = \frac{1974.658}{2}$$

$$= \boxed{987.3293 \text{ lb}}$$

Ans,