Mechanics Of Solid

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Name : M Zohaib

ID : 7909

Sec : A

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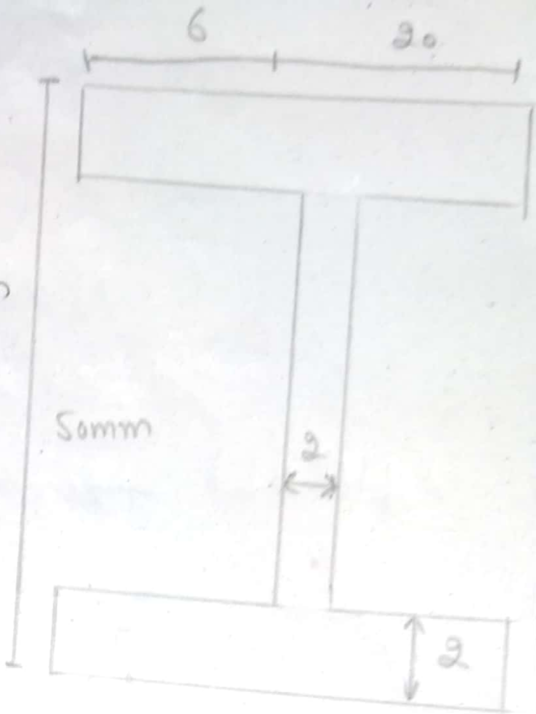
Q# 1 Part (A)



Given that

Height of Section h = 50mm

Thickness => b => 20+6

$b = 26\,mm$

$T_f = 2\,mm$

Required:-

Shear Center = ?

As we know that

For Unsymmetrical member, the Shear Center is some distance away from the Centre

=> This distance is called ecentricity which is given as

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

Here I= moment of Interia and

is given as

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

$$\Rightarrow I = 2\left(\frac{25(2)^3}{12} + (20\times2)(25)^2\right) + \left(\frac{2(50)^3}{12} + 0\right)$$

$$I = 50034.66 + 20833$$

$$\boxed{I = 70867.99\ mm^4}$$

Now equation ① ⇒

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

$$e = \frac{2\times(50)^2\times(25)^2}{4(7086.799)}$$

$$\boxed{e = 11.0234\ mm}$$

So, shear Center is 11.0234 mm away from geometrical Center.

Q#1:- Part B:-

Given data:-

Height = h = 267t

Tengential stress = 6000 Psi

Specific weight of water = 62.4 lb/ft^3

Required Data:-

Thickness of wall of water tank

= t = ?

Solution:-

As we know that

Presence is equal to

$$P = \gamma h$$

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

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

Putting the values, we get

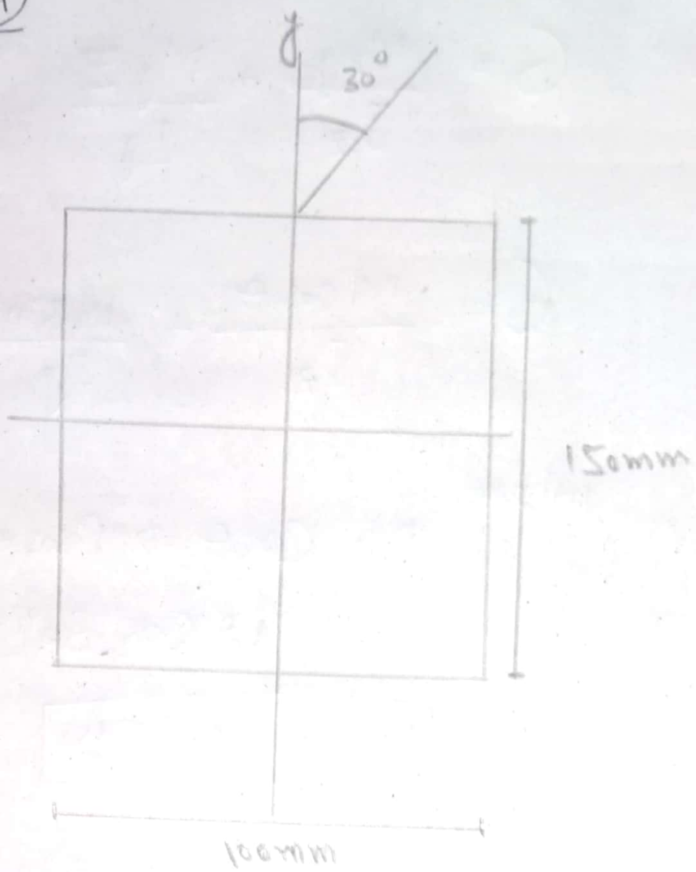
$$t = \frac{\frac{62.4 \times 26 \times D}{(12)^3}}{2(6000)}$$

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

$$\underline{t = 0.24 \text{ inch}} \quad \boxed{\text{Ans}}$$

Q# 2 :- Part (A)

Ans :-



Moment of Interia

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

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

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

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

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

$$\boxed{M_z = 1.8510}$$

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

$$12\sin 30^\circ$$

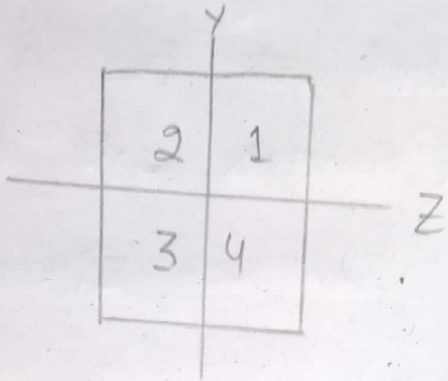
$$\boxed{M_y = -11.8563}$$

$$\sigma = \left(\frac{Mz}{Iz}\right) + \left(\frac{My}{Iy}\right)$$

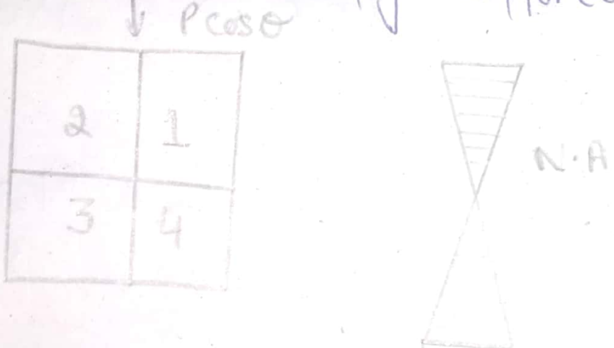
$$\sigma = \frac{1.851}{2.812\times10^{-5}} + \left(\frac{-11.8563}{1.25\times10^{-5}}\right)$$

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

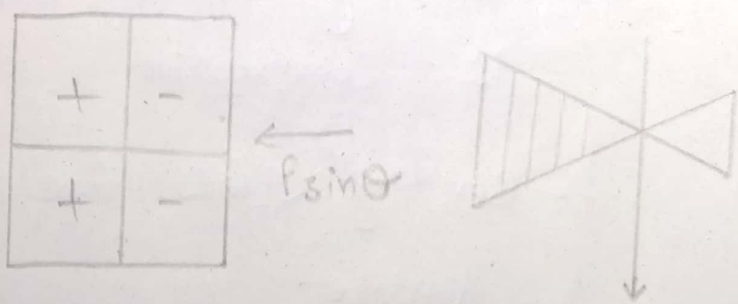
Sign Convention



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



Quardrant 1,2 -ve
Quardrant 3,4 +v



Quardrant 1,4 -ve
Quardrant 2,3 +ve

In case of unsymetrical loading the Neutral axis lies of an angle of "X" the ~~fac~~ Principle axis and the algebric Sum of stress at N.A is Zero.

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

In this case N.A passes throught 2,4

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

Let consider a point "A" on NA lies in Quardart Z, where

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

eq ①

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

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

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

$$\tan x = \frac{I_z}{I_y} \cdot \tan\theta \longrightarrow ②$$

Now Put values of $I_z \cdot I_y$ and θ in equ ②

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

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

$$\tan\alpha = -14.4129$$

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

$$\alpha = 1.50$$

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

Scanned with CamScanner

Q# 2 B Part:-

Given Data:-

$L = 16 ft$

$I_x = 112.6 \text{ in}^4$

$I_y = 18.7 \text{ in}^4$

$f_c = 12000 \text{ Psi}$

$f_t = 5000 \text{ Psi}$

Solution:-

By Seeing to the figure, we can Judge that maximom compression would occoure on A and maximom tension at C. At B there will be taken in well as compression which will reduce the effects of each other.

So, we will calculate stresses at A and C

So,

$$f_A = \frac{M_x y}{I_x} + \frac{M_y x}{I_y} \quad \text{Compression}$$

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

Now M_x and M_y

So

$$M_x = \frac{P\cos 60 \times 16 \times 12}{4}$$

$$M_x = 48 P\cos 60^\circ$$

$$M_y = \frac{48 \; P\sin 60 (16 \times 12)}{4}$$

$$M_y = 48 \; P\sin 60$$

Now

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

$$12000 = \frac{48 \; P\cos 60^\circ \times 3.07}{1126} + \frac{48 \; P\sin 60^\circ \times 3}{18.7}$$

By Solving the equation

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

Now

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

$$5000 = \frac{48P \cos 60 \times (5.93)}{112.6} + \frac{48 \sin 60 \times 0.5}{18.7}$$

Solving the equation

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

So the maximum load of P applied should ~~be~~ be 1638.6 lb

Q# 3:-

Given Data:-

Lengthy of Column = L = 10ft

$E = 10.3 \times 10^6$

Breadth = B = 0.75

Height = h = 2

Factory of safety = 2

Required:-

Safe load = ?

When

Both end hinged

Both end fixed

So

=> For hinged column

Effective length $L_e = L$

$$I = I_X = \frac{bh^3}{12}$$

$$= \frac{0.75(2)^3}{12}$$

$$\boxed{I_x = 0.65 \text{ inch}^2}$$

$$P\ critical = \frac{n^2 EI \pi^2}{Le^2}$$

$$= \frac{(1)^2 (10.3 \times 10^6)(1.5)\pi^2}{(10 \times 12)^2}$$

$$Pcr = \frac{50776940}{14400}$$

$$= \boxed{3528.176\ lb}$$

$$\text{Safe Load} = P_{safe} = \frac{Pcr}{\text{factor of safety}}$$

$$= \frac{3528176}{2}$$

$$\Rightarrow \boxed{P_{safe} = 1763.088\ lb}$$

When Both ends fixed in this Case $Le = l/2$

$$Le = 586$$

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

$$P_{cr} = \frac{n^2 EI \pi^2}{Le^2}$$

$$= \frac{(1)^2 (10.3 \times 10^6)(0.07)(3.14)^2}{(5 \times 12)^2}$$

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

$$P_{cr} = \frac{1974.658}{2}$$

So, Safe load

$$P_{safe\ load} = \frac{1974.658}{2}$$

$$\boxed{P_{safe} = 987.3293\ lb}$$ Ans