Mehanics of Solid

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Sec : A

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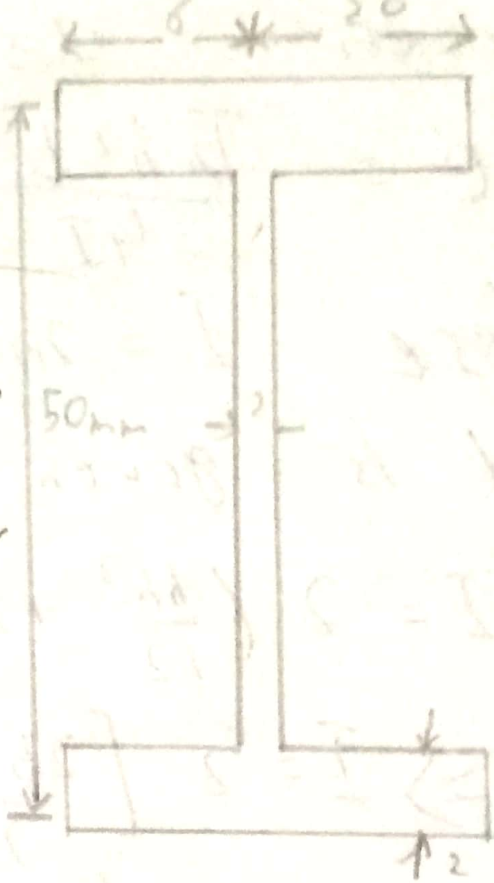
Question No 1 Part (A)

Ans:-

Given data:-



Height of Sec $h = 50mm$

Thickness $b = 20+6$

$b = 26mm$

$t_f = 2mm$

Required:-

Shear Center = ?

As we know that:

For Unsymmerical members, the shear center is some distance away from the geometrical center

This distance is called eccentricity which is given as

$$e = \frac{T_f h^2 b^2}{4I} \rightarrow (a)$$

Here I = moment of Inertia and is given as

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

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

$$I = 50034.66 + 20833$$

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

Now eq (1)

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

Scanned with CamScanner

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

$$= 11.0234 \text{ mm}$$

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

So shear center is 11.0234 mm away from geometrical center.

Q No ~~3~~ 1 (Past (B) (II))

Ans

Given data

Height = 26 ft

Tengential stress = 8000 psi

Specific weight of water = 62.4 lb/ft³

Required data

Thickness of wall of water tank = t = ?

Solution:

$$P = \gamma h$$

So

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

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

So by Putting values

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

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

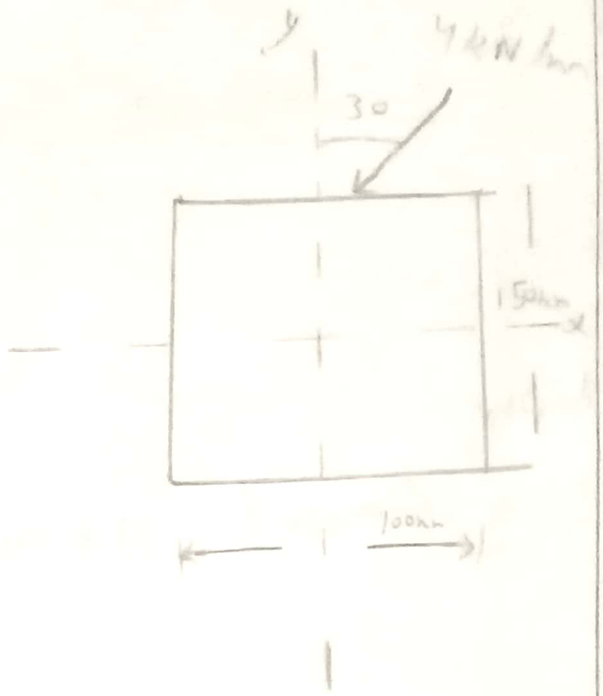
So

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

Required Ans

Question No 02 (a)

Sol^n



Given that:

$b = 100mm$

$h = 150mm$

load = $P = 4 kN/m$

Length of Beam = 3m

Required;

Bending stress = ?

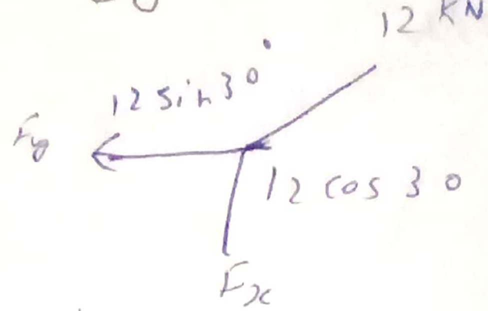
N·A = ?

Now we know that

$$S = \frac{M_z Y}{I_z} + \frac{M_y Z}{I_y} \quad \because M_x = M\cos\theta \quad M_y = M\sin\theta$$

Scanned with CamScanner

$$S = \frac{M\cos\theta}{I_z} + \frac{M\sin\theta}{I_y} \rightarrow \text{(a)}$$



$12\sin 30° = -11.8563$

Now $12\cos 30° = 1.8510$

Moment about x-axis

$M_z = -11.8563 \times 3$

$\Rightarrow M_z = -35.57\,N\cdot m$

$M_y = 6.851 \times 3$

$\Rightarrow M_y = 5.55\,N\cdot m$

We know

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

$\Rightarrow M\cos\theta = M_z$

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

$\Rightarrow M\sin\theta = M_y$

Hence eq (a) =>

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

Now moment of Inertia

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

$$= I_z = 2.8125 \times 10^{-5} \text{ inch}^4$$

$$I_y = \frac{hb^3}{12} = \frac{0.15(0.1)^3}{12}$$

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

eq (a) =>

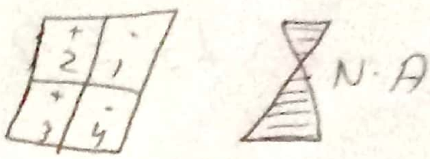
$$\delta = \frac{1.551}{2.812 \times 10^{-5}} + \frac{-11.8563}{11.85 \times 10^{-16}}$$

$$\delta = 882678 \ Nm^2$$

Natural axis (N.A) =

2	1
4	3

If we take Compression as negative and tension as positive, then beam is simply supported



in this case; Natural 2 and 4 Quadrents

in unsymmetrical loading case, the Neutral axis lies an angle of 'α' which is given by $\tan\alpha = \frac{I_z}{I_y} \tan\theta^\circ$

$$\Rightarrow \tan\alpha = \frac{2.8125\times10^{-5}}{1.25\times10^{-5}} (\tan 30^\circ)$$

$$\tan\alpha = 14.4129....$$

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

$$\Rightarrow \alpha = 1.5^\circ$$

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

Question No 2 (B)

Given data:-

$L = 1626$

$I_x = 112.6 in^4$

$I_y = 18.7 in^4$

$\delta c = 17000 psi$

$\delta t = 5000 psi$

Solution:-

By seeing to the figure, we can judge that maximum compression would occure on A & maximum compression tension at C

At B these well be taken as well as compression, which will reduce the effects of each other. So, we will calculate stresses at A and C

So,

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

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

Now M_x and M_y

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

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

$M_y = \frac{48 P\sin 60\ (16\times12)}{4}$

$M_y = 48 P\sin 60$

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

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

Now

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

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

Solving the equation

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

So the maximum load of P applied should be 1638.6lb

Question No 3.

Given data:

Length of column (l) = 10 ft

$E = 10.7 \times 10^6$

breadth (b) = 0.75

Height (h) = 2

Factor of safety = 2

Required:

Safe load = ?

when

Both end hinged

Both end fixed

So

$\Rightarrow$ For hinged column

effective length $L_e = L$

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

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

$$I_x = 0.5 inch^2$$

$$P_{critical} = \frac{h^2 E I \pi^2}{Le^2}$$

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

$$P_{cr} = \frac{50776940}{14400}$$

$$= 3526.176 lb$$

$$\text{Safe load} = P_{safe} = \frac{P_{cr}}{\text{Factor of Safety}}$$

$$= \frac{3526176}{2}$$

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

when Both ends fixed in this case $Le = \frac{L}{2}$

$$Le = 5.26$$

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

$$P_{cr} = \frac{n^2 E I \pi^2}{le^2}$$

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

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

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

So, safe load

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

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

Req Ans