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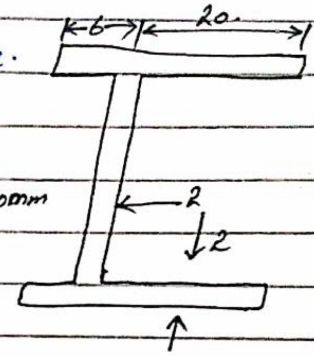
Paper: Mechanics of Solid II. (MOS II).

Qno 1A:- Determine the location - - - - - - - - - - - - - - - - - dimensions.

Required:-

Location of shear centre.



Sol:-

As we know

$$e = \frac{6 t h^2 b^2}{4I}$$

and

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

$$2\left(\frac{26(2)^3}{12} + (20)(2)(25)^2\right) + \left(\frac{2(50)^3}{12} + 0\right)$$

$$I = 50034.66 + 20833.$$

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

$$e = \frac{2(50)^2(25)^2}{4(70867.99)} = 11.02 \text{ mm}$$

$$\boxed{\text{So shear centre} = 11.02 \text{ mm}}$$

Q No: 1 B: Determine the thickness . . . . water is 62.4 lb/ft³.

Given data!

⇒ $H = 26\,ft$.

⇒ I assume diameter. $D = 22\,ft$

tangential stress $= 600\ lb/ft^3$

Specific weight of water tanks $= 62.4\ lb/ft^3$.

Required :-

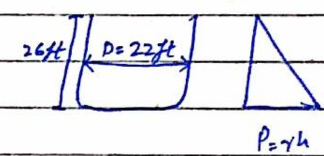
find the thickness $= ?$

Solution:-

The pressure develope by water.

$= P = \gamma h$.

$$\sigma t = \frac{PD}{2t}.$$



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

$$2t \times \sigma t = \gamma h D.$$

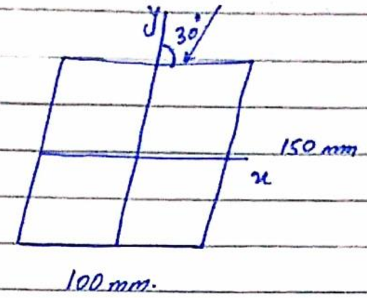
$$2t = \frac{\gamma h D}{\sigma t}.$$

$$t = \frac{\gamma h D}{\sigma t \times 2} \Rightarrow \frac{\frac{(62.4) \times (26 \times 12) \times (22 \times 12)}{(12)^3}}{6000 \times 2}.$$

$$\boxed{t = 0.24''}$$

Q.No:2: A:- The 100 by 150mm wooden beam.....
.... weight of the beam.

Solution:-



Moment of Inertia.

$$I_z = \frac{bh^3}{12} = \frac{0.1\,(0.15)^3}{12} = 2.8125 \times 10^{-5}$$

Now:

$$I_y = \frac{hb^3}{12} = \frac{0.15\,(0.1)^3}{12} = 1.25 \times 10^{-5}$$

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

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

where:

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

$$= 12\, \cos 60° = M_z.$$

$$M_z = 108510.$$

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

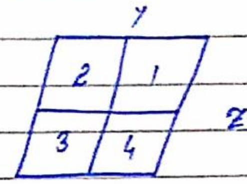
$$M_y = 12\, \sin 6a.$$

$$M_y = -11.8563.$$

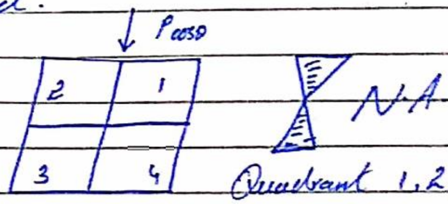
$$\sigma = \left(\frac{Mz}{Iz}\right) + \left(\frac{My}{I \cdot y}\right).$$

$$= \frac{1.851}{2.812\times10^{-5}} + \frac{(-11.8563)}{1.25\times10^{-5}} = 882678 \ N/m^2.$$

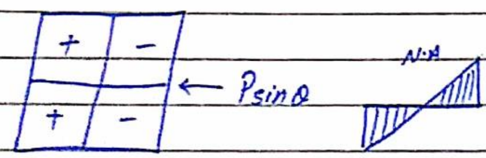
Sign Convention.



if we take compression as negative and tension as positive and the beam is a simply supported.



Quadrant 1,2, ~~posit~~-ive.
Quadrant 3,4, Positive.



Quadrant 1,4 Negative
Quadrant 2,3 Positive.

In case of unsymmetrical loading the Neutral axis lies at an angle of "α" the principal axis and the algebric sum of stress at N.A = 0.

$$\sigma = \frac{M\cos\theta}{Iz} + \frac{M\sin\theta}{Iy} - 2 \longrightarrow ①.$$

In this case, N.A passes through 2, 4. so.

$$\sigma = \frac{M\cos\theta \ y}{Iz} + \frac{M\sin\theta \ z}{Iy}.$$

Let consider a point "A" on N.A lies in quadrants 2. where.

Bending ~~stress~~ stress due to $P\cos\theta$ is compressive.

Bending stress due to $P\sin\theta$ is Tensile.

eq ① ⇒ $0 = -\frac{M\cos\theta\, y_A}{I_z} + \frac{M\sin\theta}{I_y} z_A$

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

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

$$\frac{y_A}{z_A} = \frac{I_z}{I_y}\frac{\sin\theta}{\cos\theta} \Rightarrow \tan\alpha = \frac{I_z}{I_y}\tan\theta \quad \text{eq (ii)}$$

Now put values of I_z, I_y and θ in eq (ii).

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

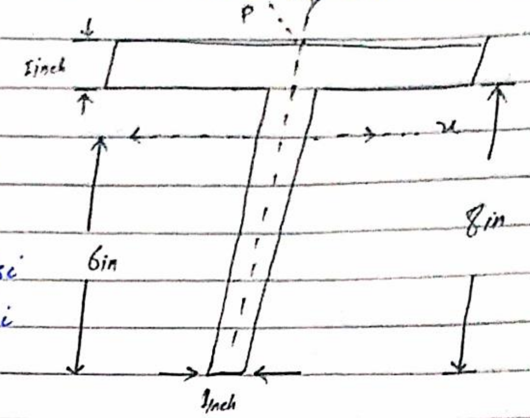
$$\Rightarrow \tan\alpha = \frac{2.8125\times 10^{-5}}{1.25\times 10^{-5}}(\tan 30^\circ).$$

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

$$\alpha = \tan^{-1}(-14.4129) \Rightarrow 1.5^\circ.$$

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

Q2B:- The T section shown in . . . . . .
. . . . the beam.



Given data!

$L = 16\ ft$

$I_x = 112.6\ in^4$

$I_y = 18.7\ in^4$

$\sigma_c = 12000\ psi$

$\sigma_t = 5000\ psi$

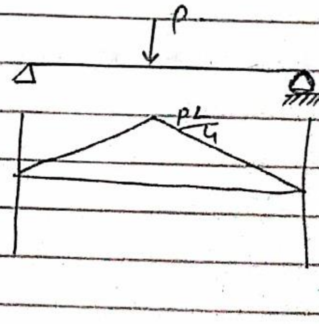
Solution:-

By looking to the figure, we can judge that maximum compression would occure on A & maximum tension at C at B there will be tension as well as compression which will reduce the effect of each other so we will calculate stresses at A & C.

So:

$$\sigma_A = \frac{M_x y}{I_x} + \frac{M_y x}{I_y} \quad (comp.)$$

$$\sigma_c = \frac{M_x y}{I_x} + \frac{M_y x}{I_y} \quad (Tension).$$



Now M_x & M_y.

So:

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

$$\boxed{M_x = 48 P \cos 60^\circ}$$

$$M_y = \frac{P \sin 60 (16 \times 12)}{14}$$

$$\boxed{M_y = 48 P \sin 60^\circ}$$

Now: $\dfrac{M_x y}{I_x} + \dfrac{M_y x}{I_y}$.

$$\Rightarrow \quad 12000 = \frac{48 P \cos 60^\circ \times 3.07}{112.6} + \frac{48 P \sin 60^\circ \times 3}{18.7}$$

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

Now.

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

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

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

So that maximum load P applied should be 1638.6 lb.

Q No:3:- A 10ft long strut braced........
.............and $E = 10.3 \times 10^6$.

Given data:

Length "L" = 10ft.

As bothside are hinged.

So $L_e = L$.

$E = 10.3 \times 10^6$

factor of safety = 2.

$b = 0.75$ inch.

$h = 2$ inch.

Requird:-

Determine safe load.

Solution:-

As

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

As we know that $I = Ar^2$

$$r = \sqrt{I/A}$$

$$r = \sqrt{\frac{\frac{hb^3}{12}}{bh}} \Rightarrow \sqrt{\frac{b^2}{12}}$$

$$r = \frac{b}{2\sqrt{3}} \Rightarrow \frac{0.75}{2\sqrt{3}}$$

$$\boxed{r = 0.216 \text{ inch}}$$

$$P_{cr} = \frac{\pi^2 EA}{(L_e/r)^2}$$

$$\frac{(3.14)^2 (10.3 \times 10^6)(1.5)}{(10/0.216)^2}$$

$$\boxed{P_{cr} = 853.8343}$$

$$\text{Safe load} = \frac{\text{Crippling load}}{\text{factor of safety.}}$$

$$\Rightarrow \frac{853.8343}{2}$$

$$\boxed{\text{Safe load} \Rightarrow 426.917}$$

for fixed ended column.

$$L_e = \frac{L}{2} = 10/2.$$

$$L_e = 5ft.$$

$$P_{cr} = \frac{\pi^2 EA}{(L_e/r)^2} = \frac{(3.14)^2 \times (10.3 \times 10^6)(1.5)}{(60/02.16)^2}$$

$$\boxed{P_{cr} = 1974.207}$$

$$\text{Safe load} = \frac{P_{cr}}{\text{factor of saftey.}}$$

$$= \frac{1974.207}{2}$$

$$\boxed{\text{Safe load} = 987.103}$$

Ans.