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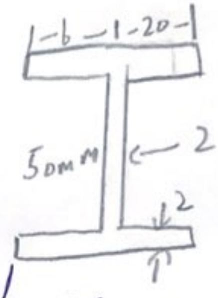
ID - 7978

Subject - MOS - 2

To,

ENGR Saqib Khan.

Q1- Part - A:



Required:

Location of shear stress

Solution:

As we know

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

and,

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

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

$$I = 50034.66 + 20833$$

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

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

So shear centre

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

Q No 1- Part - B:

Data:

$H = 26\ ft.$

Assume diameter

$D = 22\ ft$

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

Specific weight $= 62.4\ lb/ft^3$

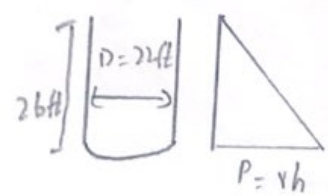
We have to find thickness = ?

Solution:

The pressure develop by water

$P = \gamma h$

$\sigma_t = \dfrac{PD}{2t}$



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

$2t \times \sigma_t = \gamma h D$

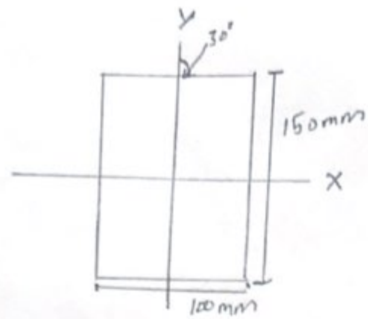
$$2t = \frac{\gamma h D}{\sigma_t}$$

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

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

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

Q2- Part A:



Moment of inertia

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

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

Now,

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

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

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

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

Where,

$$M = \cos\theta = P\cos\theta = M_z = 12\cos 30^\circ$$

$$M_z = 1.8510$$

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

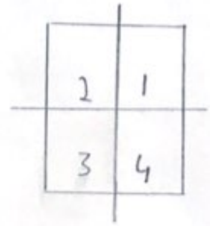
$$M_y = 12\sin 30$$

$$M_y = -11.8563$$

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

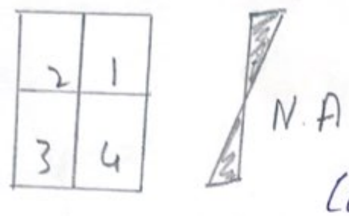
$$\sigma = \frac{1.851}{2.812\times10^{-5}} + \frac{(-11.8563)}{1.25\times10^{-5}}$$

$$\sigma = 882678\ N_{m^2}.$$



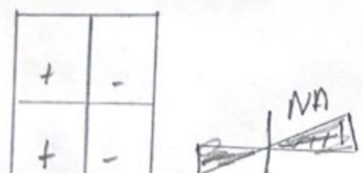
If we take compression as negative and tension as positive and the beam is a

Simply spported



Co-ordinate 1, 2 -ve

Co-ordinate 3, 4 -ve



Co-ordinate 1, 4 -ve

Co-ordinate 2, 3 +ve

In case of symetrical loading the neutral axis as of an angle of 'α' The principle axis (i) and the algebric sum of stress at NA is zero.

$$\sigma = \frac{M\cos\alpha}{I_z} y + \frac{M\sin\alpha}{I_y} z \quad -①$$

In this case NA passes through 2, 4, So

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

Consider point A on N.A lies in Quadrant 2, where

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

$$eq\ (1) \Rightarrow 0 = -\frac{M\cos\theta}{I_z} y_A + \frac{M\sin\theta}{I_y} z_A$$

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

$$\frac{y_A}{z_A} = \frac{I_z}{I_y}\frac{\sin\theta}{\cos\theta} \Rightarrow \tan\alpha = \frac{I_z}{I_y}\tan\theta \quad (2)$$

Now put values of I_z, I_y and θ in eq (11)

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

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

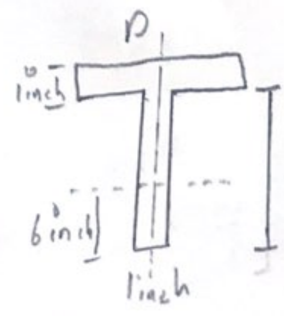
$$\tan \alpha = -14.4129$$

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

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

Part-B

Given:



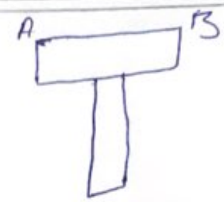
$L = 6 ft$

$I_x = 112.6 inch^4$

$I_y = 18.7 in^4$

$\delta_c = 12000$ Psi

$\delta_t = 5000$ Psi

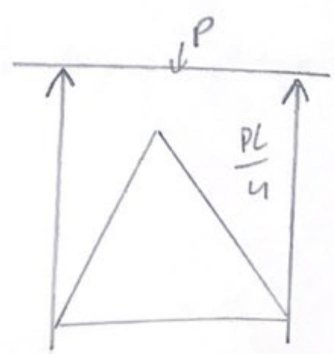


Solution:

By looking figure we can judge that maximum compression would occure on A and maximum tension c at B. There will tension as well a compression which will reduce that effect of each other, so we will calculate stress at A & C,

$$\delta A = \frac{M_x y}{I_x} + \frac{M_y x}{I_y} \text{ (comp)}$$

$$\delta c = \frac{M_x y}{I_x} + \frac{M_y x}{I_y} \text{ (tension)}$$



Now M_x & M_y,

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

$$\boxed{M_y = 48p \sin 60}$$

Now

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

$$\Rightarrow 1200 = \frac{48p \cos 60^\circ \times 3.07}{112.6} + \frac{48p \sin 60 \times 3}{18.7}$$

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

Now,

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

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

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

So the maximum load P applied should 1638.6 lb.

Q No 3:

Given:

Length $(L) = 10\,ft$

As both sides are hinged

So,

$L_e = L$

$E = 10.3 \times 10^6$

Factor of safety $= 2$

$b = 0.75$ inch

$h = 2$ inch

Required:

Determine safe load?

Solution:

As

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

As we know that $I = Ar^2$

$$I = A r^2$$

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

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

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

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

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

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

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

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

$$\text{Safe load} = \frac{853.8342}{2}$$

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

* For fixed ended column

$$Le = \frac{L}{2} = \frac{10}{2}$$

$$Le = 5ft$$

$$P_{cr} = \frac{\pi^2 EA}{(Le/r)^2} = \frac{(3.14)^2(10.3 \times 10^6)(1.5)}{(10/0.216)^2}$$

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

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

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

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