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ID: 7395 SEC: A

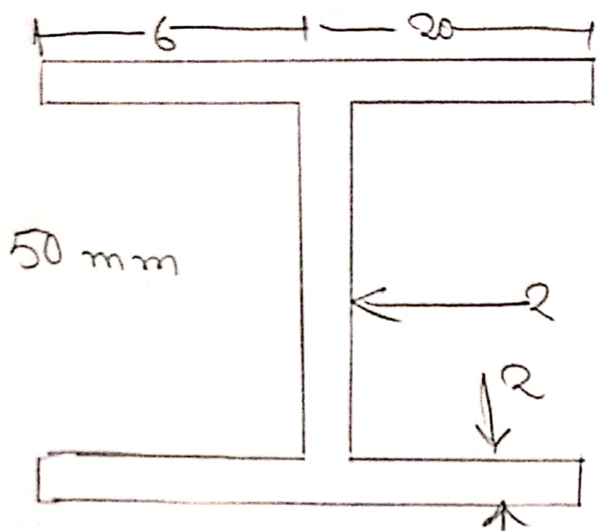
SUBJECT: MOS-II

INSTRUCTOR:

ENGR M. SAQIB.

DATE: 23rd-JUNE-2020.

Question No (1)(a):



Required location of shear centre:

Sol: As we know.

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

and

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

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

$$I = 50034.66 + 20833$$

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

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

So shear centre $= e = \underline{11}.02$ mm.

Question No 1(b):

Data:

$H = 26\,ft$

=> I assume diameter

$D = 22\,ft$

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

=> Specific weight of water tank

$= 62.4\,lb/ft^3$

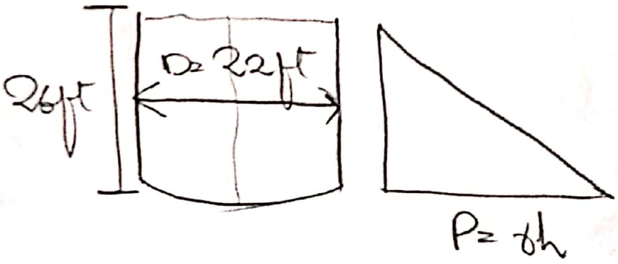
we have to find the thickness = ?

Solution:

The pressure develops by water $= P = \gamma h$

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

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



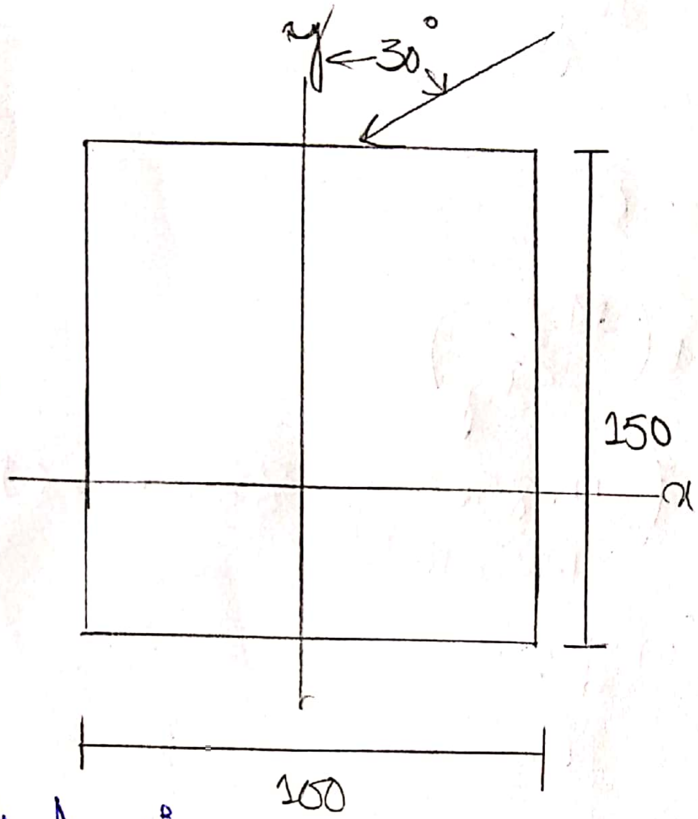
$2t \times \sigma_t = \gamma h D$

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

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

$t = \frac{\frac{(62.4)}{(12)^3} \times (26 \times 12) \times (22 \times 12)}{6000 \times 2} = t = 0.24''$ Ans.

Question No 2(a):



Moment of Inertia:

$I_z = bh^3/12 = 0.1(0.15)^3/12 = I_z = 2.8125\times10^{-5}$

Now

$I_y = hb^3/12 = 0.15(0.1)^3/12$

$I_y = 1.25\times10^{-5}$

$\sigma = M_z y/I_z + M_y z/I_y$

$\sigma = M\cos\theta/I_z + M\sin\theta/I_y$

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

$= 12\cos 30° = M_z$

$M_z = 1.8510$

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

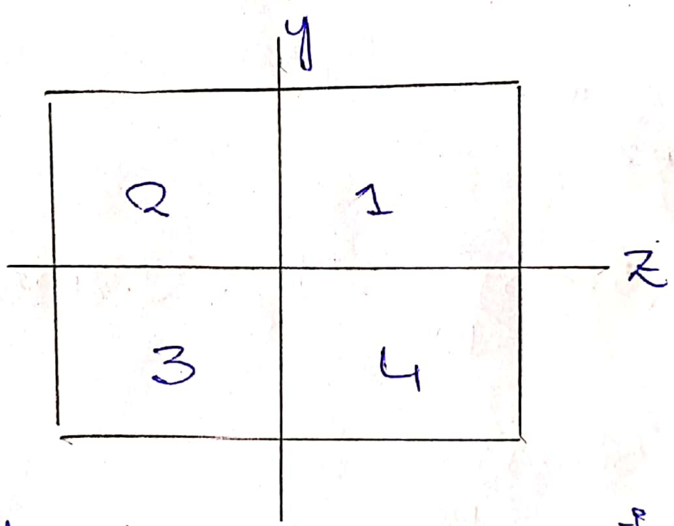
$M_y = 12 \sin 30$

$M_y = -11.8563$

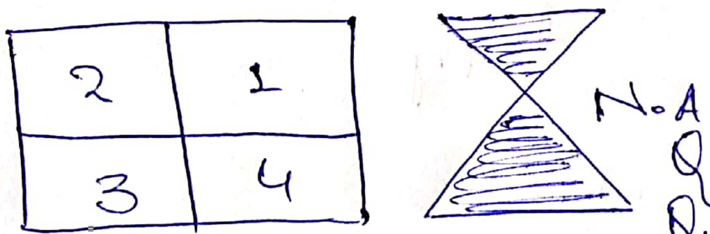
$$\sigma = \left(\frac{M_z}{I_z}\right) + \left(\frac{M_y}{I_y}\right)$$

$$\sigma = \frac{1.851}{2.812\times10^{-5}} + \left(\frac{-11.8563}{1.25\times10^{-5}}\right) = 882628\,Nm^{2}$$

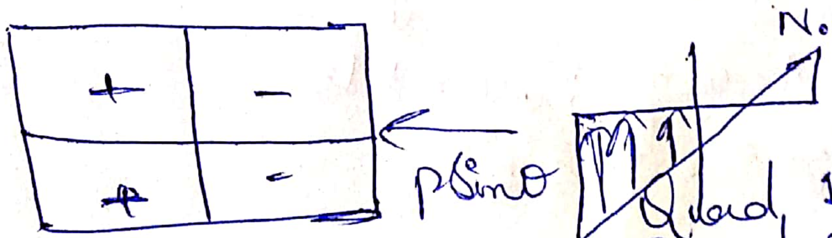
Sign conventions :



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



Quadrant 1,2 -ve
Quadrant 3,4 +ive



Quad 1,4 -ve
Quad 2,3 +ive

Incase of unsymmetrical loading. The neutral axis lies at an angle of 'α'. The principal axis and the algebraic sum of stress at N.A is zero.

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

in this case N.A passes through 2,4, 30.

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

Let consider a point 'A' on N.A lies in Quadrant, where Bending stress due to $P\cos\theta$ is compressive Bending and stress due to $P\sin\theta$ is tensile.

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

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

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

$$\frac{y_A}{z_A} = \frac{I_z}{I_y} \cdot \frac{\sin\theta}{\cos\theta} \Rightarrow \tan\alpha = \frac{I_z}{I_y} \tan\theta \quad \text{--- (11)}$$

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

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

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

$$\tan\alpha = -14.4124$$

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

$$\alpha = 1.5^\circ$$

$$\alpha = 1^\circ 30' 5''.$$

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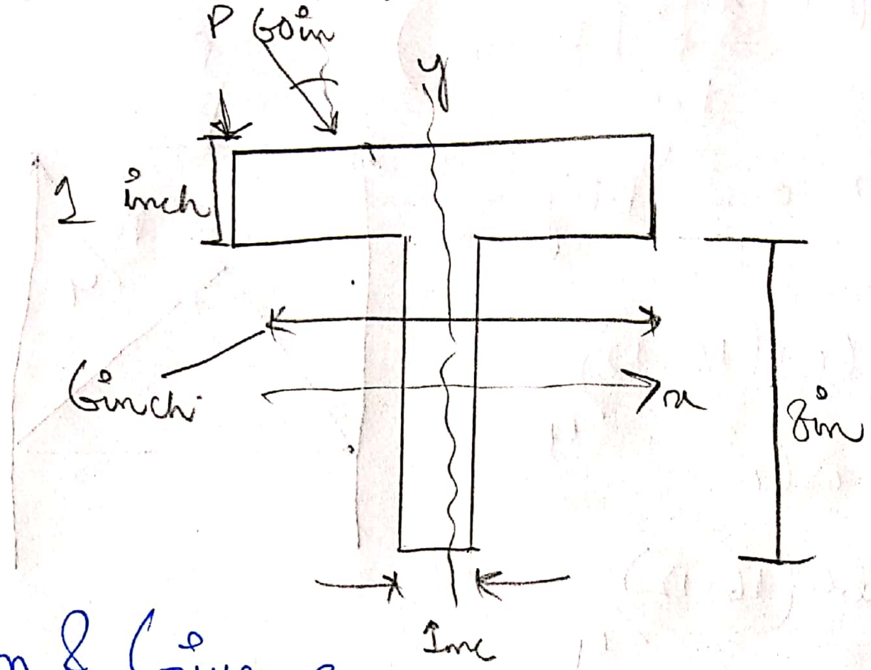
Question No (2)(b):



Solution & Given:

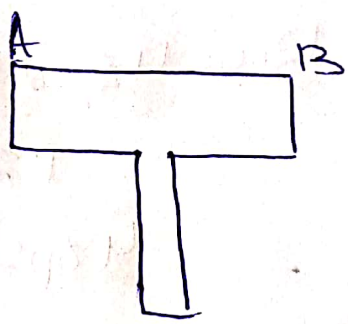
$L = 16ft$

$I_x = 112.6 inch^4$

$I_y = 18.7 in^4$

$\delta_c = 12000$ psi

$\delta_t = 5000$ psi

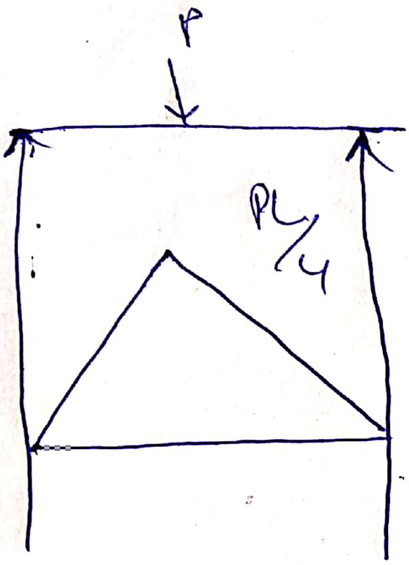


By looking figure we can judge that maximum compression would occur on a and maximum tension C at B. There will tension as well a compression which will reduce that effect of each other so we will calculate stress at A and C

so

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

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



Now M_x and M_y

So

$M_x = P\cos 60 \times (16\times 12)/4$

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

$M_y = P\sin 60\,(16\times 12)/4$

$M_y = 48p\sin 60$

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

$1200 = \frac{48p\cos 60^\circ \times 3.07}{112.6}$

$= 48p\sin 60 \times 30/18.7$

Solving the equation

$\Rightarrow P = 1638.6$ lb

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

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

Solving the equatn

$P = 2104.9$ lb

So the maximum load P applied should 1638.6 lb.

Question No (3):

Given Data:

length 'L' = 10ft

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 Data:

Determine safe load = ?

Solution: As

$$P_{cr} = \pi^2 EI / l_e^2$$

As we know that.

$$I = Ar^2$$

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

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

$$r = \frac{b}{2\sqrt{3}} = \frac{0.75}{2\sqrt{3}} = r = 0.216 \text{ inch}$$

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

$\Rightarrow (3.14)^2 (10.3\times10^6)(1.5) / (10/0.216)^2$

$P_{cr} = 853.843$

Safe load = crippling load / factor of safety.

$\Rightarrow 853.8343/2$

Safe load = 426.917.

* for fixed extended column

$Le = L/2 = 10/2$

$Le = 5ft$

$$P_{cr} = \frac{\pi^2 EA}{(Le/r)^2} = \frac{(3.14)^2 \times (10.3\times10^6)(1.5)}{\left(\frac{60}{0.216}\right)^2}$$

$P_{cr} = 1974.207$

Safe load = P_{cr} / factor of safety.

$= 1974.207/2$

$= 987.103$

Ans.