Name : M. Haseeb Khan

Id : 7916

Section : A

Subject : Mos. 2

Solution.

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

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

$$= 50034.66 + 20833$$

$$I = 70867.99 \ mm^4$$

$$e = 2(50)^2(25)^2$$

Tangential stress = 600 lb/ft³

Specific weight of water tank = 62.4 lb/ft³

We will find thickness = ?

Solution :-

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

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

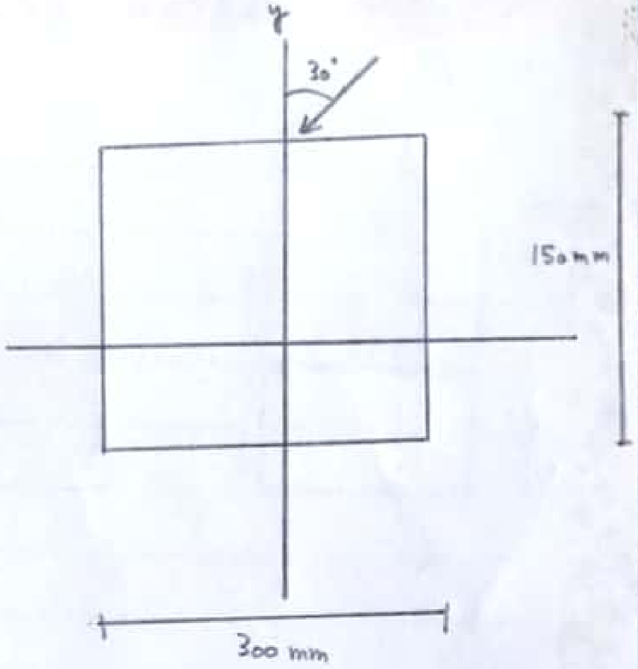
$$\sigma_t = \frac{PD}{2t} \Rightarrow \frac{\gamma h D}{2t}$$

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

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

$$t = 0.24''$$

Question 2 (A)



Moment of inertia

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

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

Now $\quad I_y = \dfrac{bh^3}{12}$

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

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

$$\sigma = \frac{M_z\,Y}{I_z} + \frac{M_y\,Z}{I_y}$$

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

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

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

$$M_z = 1.8510$$

$$M \sin\theta \Rightarrow P \sin\theta \Rightarrow M_y$$

$$= 12 \sin 30^\circ$$

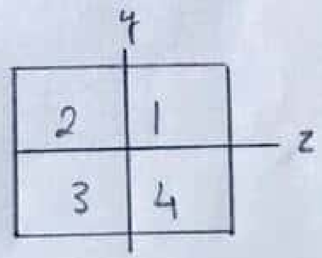
$$M_y = -11.8563$$

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

$$= \frac{1.851}{2.812 \times 10^{-5}} + \left(\frac{-11.8563}{1.25 \times 10^{-5}}\right)$$

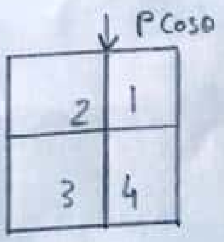
$$\sigma = 882678 \ N/m^2$$

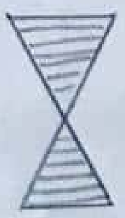
Sign Convention



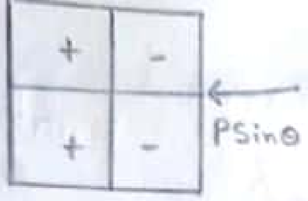
If we take compression as negative and tension as positive and the beam is simply supported

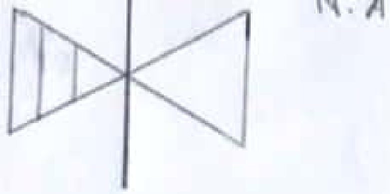
Quadrant 1.2 -ve
" 3.4 +ve





N.A





Quadrant 1.4 -ve
" 2.3 +ve

In case of unsymetric loading the neutral axis lies of an angle of 'α'. The principle axis and the algebric sum of stress at N. A is zero

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

In this case N.A passes through 2,4

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

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

- Bending stress due to P.Cosθ is compressive
- Bending stress due to PSinθ is tencile

Equation (1)

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

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

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

$$\tan\alpha = \frac{I_z}{I_y} \tan\theta \longrightarrow (2)$$

Now put values of $I_z . I_y$ and θ in eq (2)

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

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

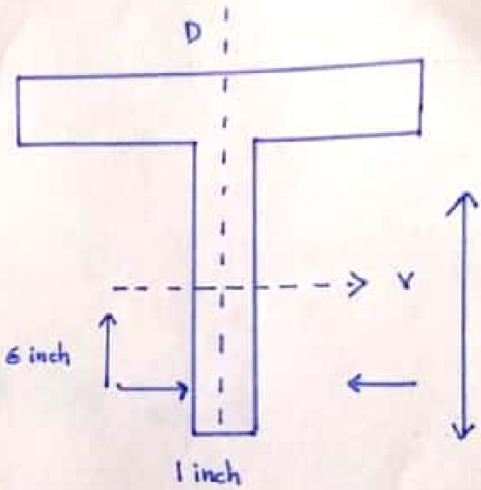
$$\tan\alpha = -14.4129$$

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

$$\alpha = 1.5^\circ$$

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

Question : 2 (B)



Given :-

$L = 16 \text{ ft}$

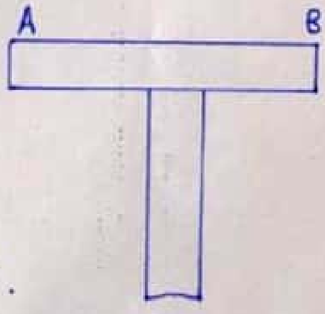
$I_x = 112.6 \text{ inch}^4$

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

$S_c = 12000 \text{ psi}$

$S_t : 500 \text{ Psi}$

Solution



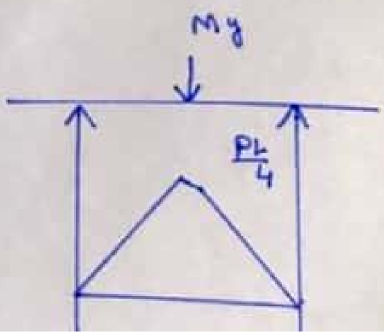
By observing figure we can judge that maximum compression would accure on a axial maximum tension C at B.

There will tension as well a compression which will reduce that effort of each other so we will calculate stress at A axial C

So
$$SA = \frac{M_x y}{I_x} + \frac{M_y x}{I_y} \quad \text{comp}$$

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

Now M_x & M_y



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

$M_x = 48 p \cos 60$

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

$M_y = 48 P \sin 60$

Now

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

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

$$= \frac{48 P \sin 60 \times 30}{18.7}$$

$P = 1638.6$ lb

Now

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

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

$P = 2104.916$

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

Question 3

Given data:

Length = 10 ft

$E = 10.3 \times 10^6$

$b = 0.75$

$h = 2$

factor of safety = 2

Required:

- Safe load at hinged = ?
- Safe load at fixed = ?

Solution:

(a) for hinged column

$L_e = L$

$$I = I_x = \frac{(0.75)(2)^3}{12} = 0.5 \text{ in}^4$$

$$P_{cr} = \frac{n^2 E I \pi^2}{L_e^2} = \frac{(1)^2(10.3 \times 10^6)(0.5)\pi^2}{(10 \times 12)^2}$$

$$P_{cr} = \frac{50776940}{14400} = 3526.176 \text{ lb}$$

$$P_{\text{safe load}} = \frac{P_{cr}}{\text{factor of safety}} = \frac{3526.176}{2} = 1763.088 \text{ lb}$$

For fixed end

$$L_e = L/2$$

$$L_e = 10/2$$

$$= 5 \text{ ft}$$

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

$$P_{cr} = \frac{n^2 E I \pi^2}{L_e^2} = \frac{(1)^2(10.3 \times 10^6)(0.07)(3.14)^2}{(5 \times 12)^2}$$

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

$$P_{cr} = 1974.658 \text{ lb}$$

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

$$= 987.3293 \text{ lb}$$