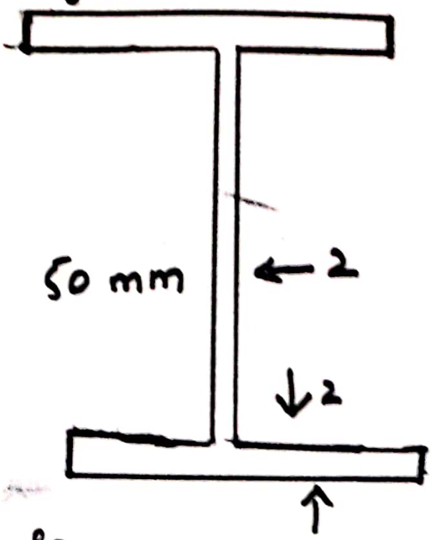
QUESTION : 1 :

PART : A

ANSWER : 6-1-20



Required :-

=> location of shear center.

As we know that

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

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

$$= 2\left[\frac{25(2)^3}{12} + (20\times2)(25)^2\right] + \left[\frac{2(50)^3}{12} + 0\right]$$

$$I = 50034.56 + 20833$$

$$I = 70867.99\,mm^4$$

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

So shear center $e = 11.02$ mm **ANSWER**.

QUESTION : 1 :

ANSWER :-

PART (B) :

Given data :-

$H = 26 ft$

I assume diameter = $D = 22 ft$

tangential stress = $6000 lb/ft^3$

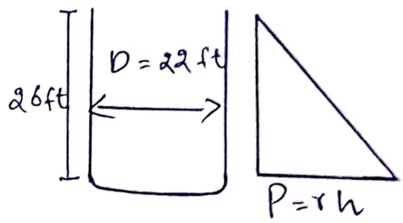
Specific weight of water tank = $62.4 lb/ft^3$

Now,

we have to find the thickness = ?

Solution :-

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



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

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

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

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

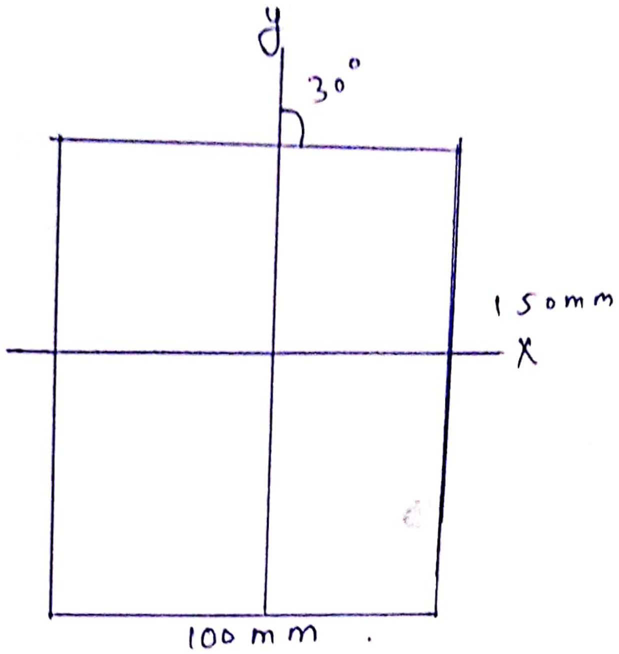
$$t = \frac{\left[\left(\frac{62.4}{(12)^3}\right) \times (26 \times 12) \times (22 \times 12)\right]}{6000 \times 2}$$

$t = 0.24''$ **ANSWER.**

QUESTION : 2 :

PART : A :

ANSWER :-



Moment of inertia :-

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

Now

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

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

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

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

where,

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

$$= 12\cos 0^\circ = M_z$$

$\Rightarrow$

$M_z = 1.8510$

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

$M_y = 12 \sin 30$

$M_y = -11.8563$

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

$$\delta = \frac{1.851}{2.812 \times 10^{-5}} + \left(\frac{-11.8563}{1.25 \times 10^{-5}}\right) = 882628 \, \mathrm{N/m^2}$$

Sign convention

y

2	1
3	4

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

2	1
3	4

N · A

Quadrant 1, 2 - ive

Quadrant 3, 4 + ive

+	−
+	−

$P \sin\theta$

N · A

Quadrant 1, 4 - ive

Quadrant 2, 3 +ve

Incase of unsymmetrical loading the Neutral axis lies of an angle of "α" the principal axis and the algebric sum of stress at N.A is zero.

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

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

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

let consider a point 'A' on N.A lies in Quadrant 2, where

- Bending stress due to $p\cos\theta$ is Tensile.

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

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

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

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

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

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

$$\Rightarrow \tan\alpha = \frac{3.8125 \times 10^{-5}}{1.25 \times 10^{-5}} (\tan 30^\circ)$$

$$\tan\alpha = -14.4129$$

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

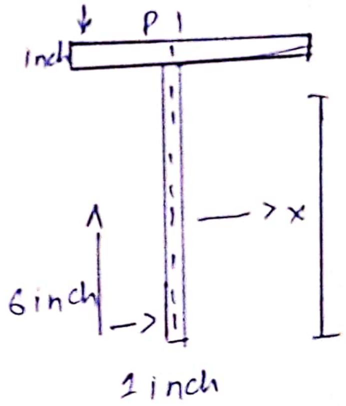
$$\alpha = 1.5^\circ$$

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

QUESTION : 2 :
PART : B

ANSWER :-

Given :



$L = 16\ ft$

$I_x = 112\ 6 inch^4$

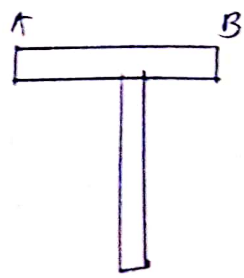
$I_y = 18.7\ in^4$

$S_c = 12000\ psi$

$S_t = 5000\ psi$

Solution :-

By looking the figure we can judge that maximum compression would accure on a and maximum tension co 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,

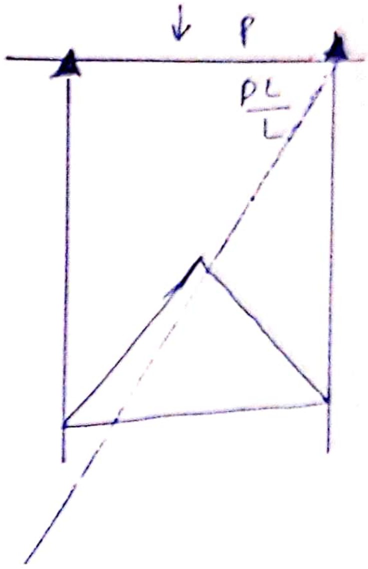
$$S_A = \frac{M_x y}{I_x} + \frac{M_y x}{I_y} \quad \text{comp}$$

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

Now M_x and 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

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

$$\Rightarrow 1200 = \frac{48\,p\cos 60^\circ \times 3.07}{112.6} + \frac{48\,P\sin 60 \times 30}{18.7}$$

Solving the equation

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

Now

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

$$5000 = 48\,p\cos 60 \times (593) + \frac{48\,p\sin 60 \times 0.5}{18.7}$$

Solving the equation.

$P = 2104.9$ lb

FOR CASE 1.

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

So the maximum load of P applied Should 1638.6 lb

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QUESTION : 3:
ANSWER :-

Given :-

length = 10 ft
$E = 10.3 \times 10^6$
$b = 0.75$
$h = 2$
Factor of safety = 2

Required :-

a) safe load at hinged = ?
b) safe load at fixed = ?

Solution :-

For hinged column

$L_e = L$

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

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

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

~~satisfied~~

$P \text{ safe led} = \frac{P_{cr}}{\text{Factor of safety}} = \frac{3526176}{2} = 1763.088$

3.1

R.

b) **Strut at column.**

$L_e = L/2$ (For fixed column)

$l_e = \frac{10}{2} = 5\ ft$

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

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

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

$P_{cr} = 1974658\ lb$

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

$= 987.3293\ lb$. **ANSWER.**