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Subject MOS 2

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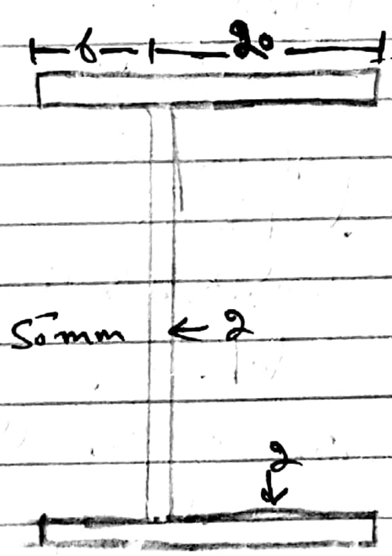
QNo1 "a" Determine the location of the shear center for the beams having the cross sectional dimension shown in the figure 1. All members are to be considered thin walled and calculation should be based on the center line dimensions.

Solution:-



As we know

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

and

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

$$I = 2\left[\frac{26(2)^3}{12} + (20\times2)(25)^2\right] + \left[\frac{2(50)^3}{12} + 0\right]$$

$$I = 50034.66 + 20833$$

$$I = 70867.99\ mm^4$$

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

So shear center

$e = 11.02$ mm

Q No 1 "b"

Determine the thickness of the wall of water tank constructed from steel plates filled to a height of 26 ft, the circumferential stress is limited to 6000 psi the specific weight of water is 62.4 lb/ft³

Given data

$H = 26\,ft$

assume diameter = 22 ft

= tangential stress = 600 lb/ft³

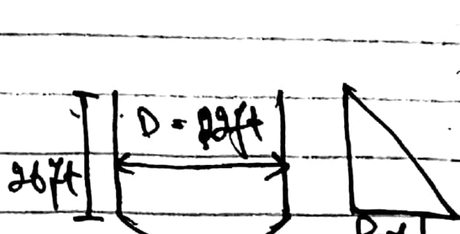
⇒ specific weight of water tank = 62.4 lb/ft³

we have to find the thickness = ?

Sol:

$$P = \gamma h$$

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



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

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

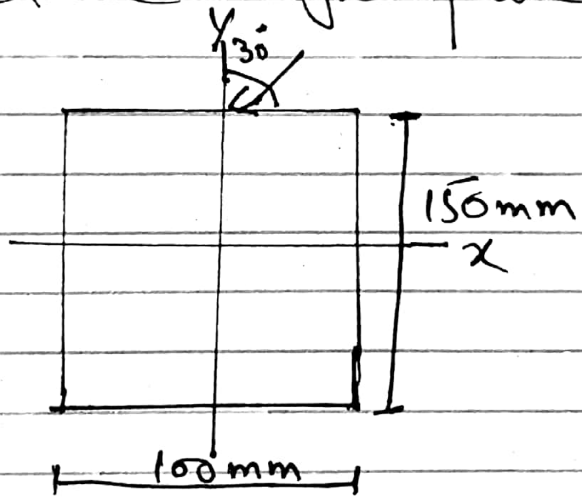
$$2t = \frac{\gamma h D}{\sigma_t}$$

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

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

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

Q No 2 "a" The 100 by 150mm wooden beam shown in figure 2 is used to support a uniformly distributed load of 4KN on a simply span of 3m. the applied load acts in a plane making an angle of 30 degree with vertical. calculate the maximum bending stress at mid span and for the same section locate the neutral axis. Neglect the weight of the beam.



moment of Inertia

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

Now

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

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

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

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

where

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

$$= 12\cos 60^\circ = M_z$$

$$M_z = 1.8510$$

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

$$M_y = 12\sin 60$$

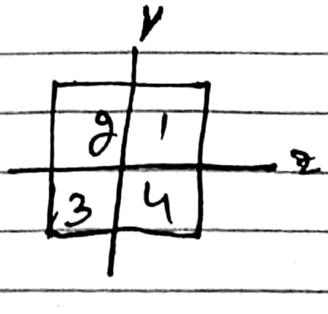
$$M_y = -11.8563$$

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

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

$$\delta = 882678\ Nm^2$$

Sign convention



A simple supported

2	1
3	4

1, 2 -ve
3, 4 +ve

in case of symetrical loading the neutral axis lies ~~of~~ on angle of α the principal axis and ~~the~~ algebric sum of stress at N.A is zero

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

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

So

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

let consider point "A" on N.A lies in Quadrant where.

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

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

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

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

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

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

$$\Rightarrow \tan\alpha = \frac{2.8125 \times 10^{-5}}{1.25 \times 10^{-15}} (\tan 30^\circ)$$

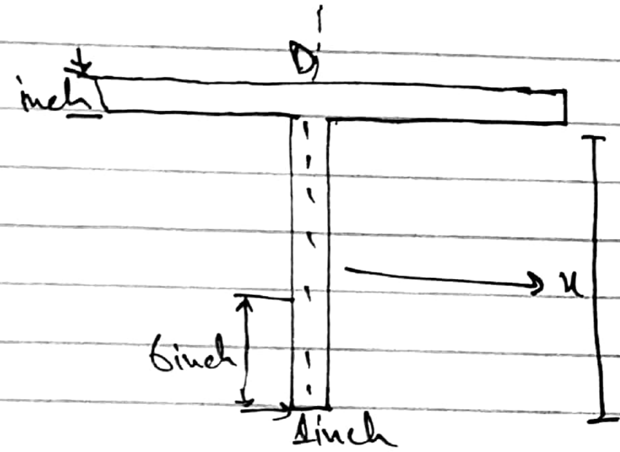
$$\tan\alpha = -14.4129$$

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

$$\alpha = 1.5^\circ$$

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

Q No 2
"B"



Given data

$L = 16\ ft$

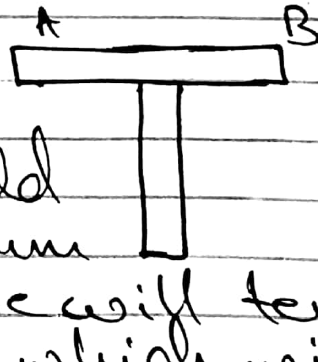
$Ix = 112.6\ inch^4$

$Iy = 18.7\ in^4$

$Sc = 12000\ psi$

$St = 5000\ psi$

Solution



we can Judge that maximum compression would accure on a and maximum tension e at B. there will tension as well a compression which will reduce that effect of each other

So.

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

$$S_A = \frac{M_x y}{I_X} + \frac{M_y x}{I_Y} \quad \text{(compression)}$$

Now M_x and M_y

So

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

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

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

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

Now

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

$$1200 = \frac{48P\cos 60^\circ \times 3.07}{118.6} + \frac{48P\sin 60 \times 30}{18.7}$$

Solving the equation

$\Rightarrow P = 1636.6\ lb$

Now

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

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

solving the equation

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

So the maximum load should be 1638.6 lb

Q No3 A 10ft long strut braced in the middle has a rectangular section of 0.75 in by 2 in. A bolt through each end secures the strut so that it acts as a hinged column about an axis perpendicular to the 2 in dimension and as a fixed ended column about an axis ~~perpendi~~ parallel to 2 in dimension. Determine the safe load P about using a factor of safety of 2 and $E = 10.3 \times 10^6$

Solution:-

Case 1

Strutt act as a hinged

As we know

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

$$I = Ar^2$$

$$I = Ar^2$$

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

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

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

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

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

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

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

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

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

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

For fixed ended column

$$le = L/2 = 10/2$$

$$le = 5 \text{ ft}$$

$$P_{cr} = \frac{\pi^2 EA}{(le/r)^2} \Rightarrow \frac{(3.14)^2 \times (10.3 \times 10^6)(1.5)}{(60/0.216)^2}$$

$$P_{cr} = 1974.207$$

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

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

$$\boxed{\text{Safeload} = 987.103}$$ Ans.