MOS-II FINAL TERM

NAME: OWAIS USMAN

ID: 7897

SECTION: 'A'

SEMESTER: 4th

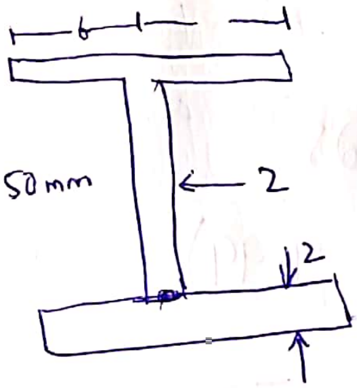
SUBMITTED TO: ENGR. SAQIB

DATE: 23-JUNE-2020

QUESTION #1

PART (a)

Determine the location of the shear center for the beams having the cross sectional dimensions shown in the fingure. All members are to be considered thin walled and calculations should be based on the centerline dimensions.



REQUIRED:

Location of the shear center.

SOLUTION:

As we know that :

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

and

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

Putting the values

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

$$I = 50026.66 + 20833.3$$

$$I = 70859.99 \ mm^4$$

Now

$$e = \frac{2(50)^2(25)^2}{4(70859.99)}$$

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

So

$$\boxed{\text{Shear center, } e = 11.02\,mm}$$

QUESTION #1
Part (b)

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

DATA:

$H = 26\ ft$

Assume the diameter $D = 22\ ft$

Tangential Stress $= 6000\ psi$

$= 600\ lb/ft^3$

$=$

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

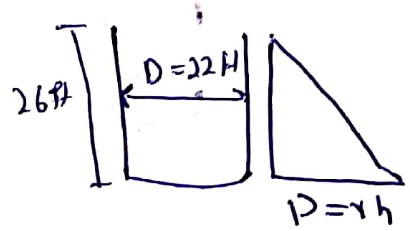
Thickness $= ?$

SOLUTION:

The pressure develope by water

$P. = \gamma h$

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



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

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

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

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

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

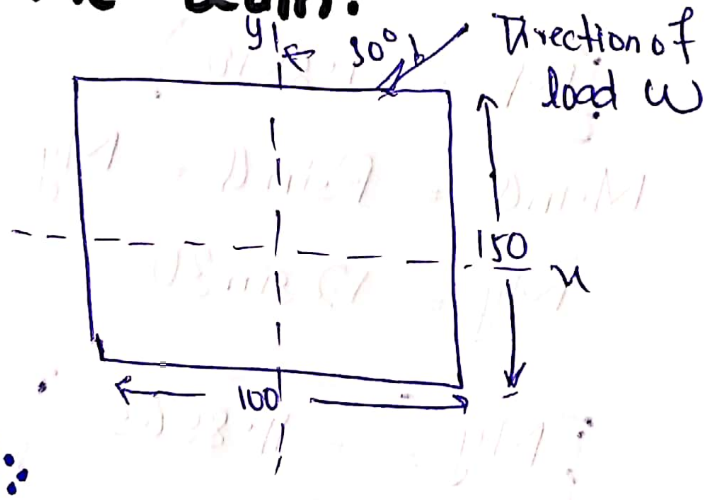
$$t = \frac{\frac{(6.24)}{(12)^3} \times (26 \times 12) \times (22 \times 12)}{6000 \times 2}$$

$$\boxed{t = 0.24 \text{ inch}}$$

QUESTION #2

Part (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.



SOLUTION:

Moment of inertia

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

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

Now

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

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

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

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

where

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

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

$$\boxed{M_z = 1.8510}$$

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

$$M_y = 12\sin 30$$

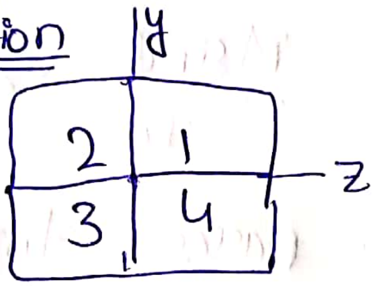
$$\boxed{M_y = -11.8563}$$

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

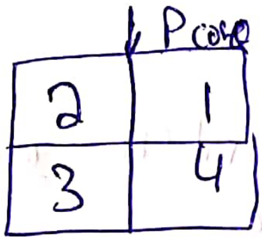
$$\sigma = \frac{1.851}{2.812 \times 10^{-3}} + \frac{(-11.8563)}{1.25 \times 10^{-5}}$$

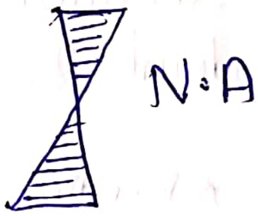
$$\boxed{\sigma = 882678\ \mathrm{Nm}^2}$$

Sign Convention

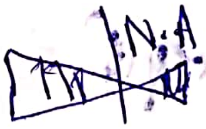


If we take compression as negative and tension as positive and the Beam is a simply supported.





Quadrant 1,2 ⇒ -ive
" 3,4 ⇒ +ive



Quad 1,4 ⇒ -ive
" 2,3 ⇒ +ive

In case of unsymmetrical loading the neutral axis lies at an angle of "α". The principal axis and the algebric sum of stress at N.A is zero

$$\sigma = \frac{M\cos\theta \cdot y}{I_z} + \frac{M\sin\theta}{I_y} \cdot z \rightarrow (1)$$

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

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

Let

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

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

So

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

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

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

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

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

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

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

$$\tan\alpha = -14.4129$$

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

$$\alpha = 1.5^\circ$$

$$\boxed{\alpha = 1^\circ 3' 5''}$$ Ans.

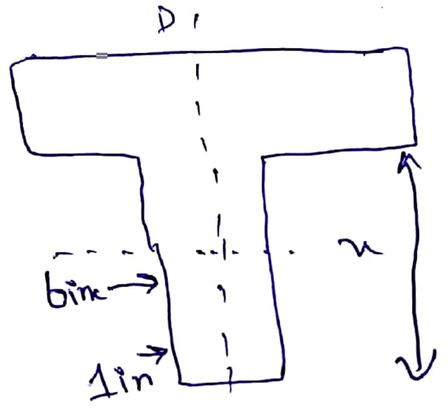
Scanned with CamScanner

① QUESTION#2

Part (b)

The T section shown in figure 3 is the cross section of a simply supported beam 16 ft long that carries a central concentrated load inclined 60 degree left to the y axis the centroid is 3·07 in below the top of the section $I_x = 112.6\ in^4$ and $I_y = 18.7\ in^4$ if compressive stress is limited to 12000 psi and tensile stress to 5000psi. what is the maximum load that will not overstress the beam?

SOLUTION:



Length of beam $= L = 16ft$

$I_x = 112.6\ in^4$

$I_y = 18.7\ in^4$

$S_c = 12000$ Psi

$S_t = 5000$ Psi

From figure, the maximum compression would occur on 'a' and maximum tension at B.

The tension and compression will reduce the effect of each other.

So, stress should be calculated at 'A' and 'C'.

So,

$$S_A = \frac{M_x y}{I_x} + \frac{M_y x}{I_y} \text{ (compression)}$$

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

So

$$M_x = \frac{P\cos(60^\circ)\,(16\times12)}{4}$$

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

$$M_y = \frac{P\sin(60^\circ)\,(16\times12)}{4}$$

$$\boxed{M_y = 48\sin 60^\circ}$$

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

$$\Rightarrow 1260 = \frac{48P\cos 60^\circ + 3.07}{112.6}$$

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

and

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

$$5000 = \frac{48P\cos 60^\circ \times (5.93)}{18.7}$$

$$\boxed{P = 2104.96}$$

So the maximum load (P) which can be applied should not be greater than 1638.6 lb.

QUESTION # 3

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 2in dimension and as a fixed ended column about an axis parallel to 2in dimension. Determine the safe load P about using a factor of safety of 2 and $E = 10.3 \times 10^6$ Psi.

GIVEN DATA:

Length 'L' = 10 ft

As bothsides are hinged

So

$L_e = L$

$E = 10.3 \times 10^6$ Psi

Factor of Safety = 2

$b = 0.75$ inch

$h = 2$ inch

REQUIRED:-

Determine Safe load = ?

SOLUTION:-

As

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

As we know that

$$I = Ar^2$$

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

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

$$r = \sqrt{\frac{b^2}{12}}$$

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

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

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

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

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

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

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

$$= \frac{853.8343}{2}$$

Safe load = 426.917

★ <u>For fixed ended column</u>

$$Le = L/2 = 10/2$$

$$\boxed{Le = 5\,ft}$$

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

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

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

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

$$\text{Safe load} = \frac{1974.207}{2}$$

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

THE END