Name:
Huzaifa Waseem

ID #:
7911

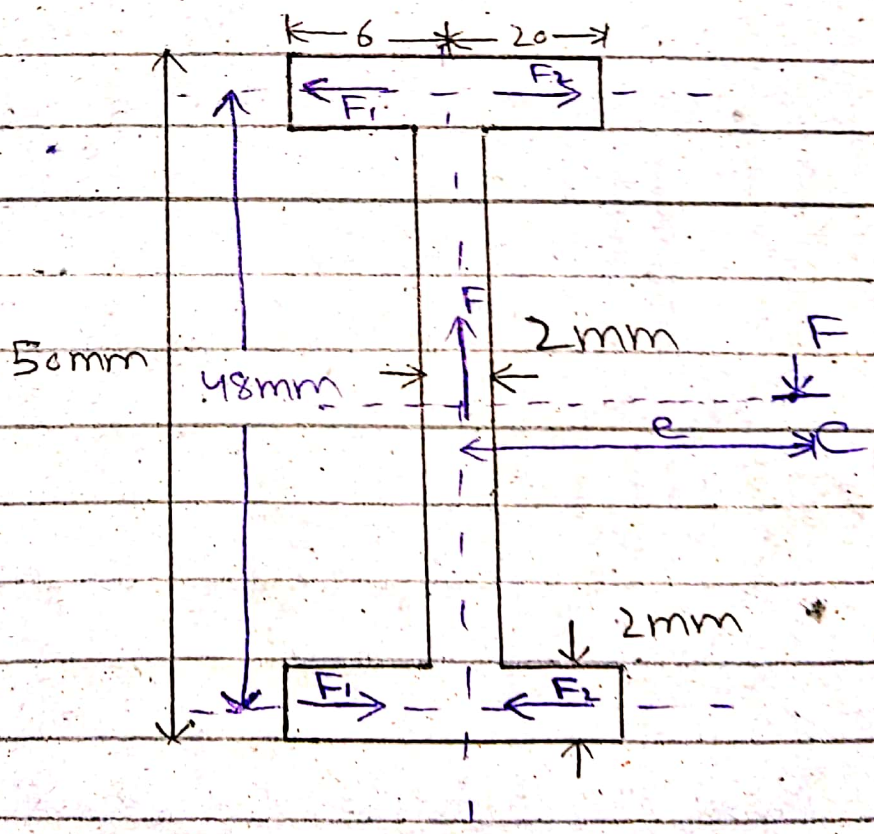
Section:
A

Subject:
MOS(II)

Date:
23-6-2020

1

Q1(a): Determine the location of shear centre for the beams having the cross-sectional dimensions shown in the figure 1. All members are to be considered thin walled and calculations should be based on the centreline dimensions



Solution:

Solution:

As we know that

$$e = \frac{t_f h^2 b^2}{4I} \quad \text{—— } (1)$$

where

h = height of section

b = flange length

t = thickness

Now moment of inertia is

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

$$I = \cancel{2}\ 50034.66 + 20833$$

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

Now put values in e.q (1)

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

So shear centre $\boxed{e = 11.02\,mm}$

Answer No 1 (b)

Given:

$H = 26 ft$

$D = 22 ft$

tangential stress = $600 \, lb/ft^3$

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

Thickness = ?

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

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

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

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

4

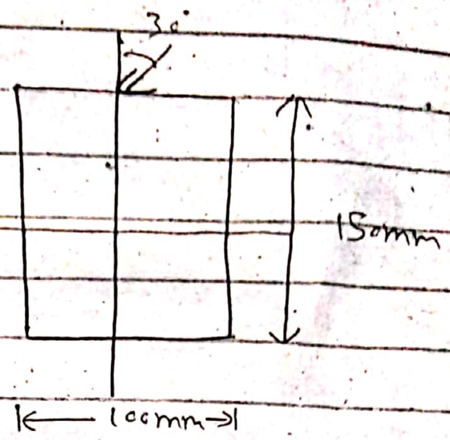
$$2t = \frac{\gamma h D}{\sigma_T}$$

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

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

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

Answer 2 (a)



Moment of ~~ind~~ inertia

$$I_x = \frac{bh^3}{12} = \frac{0.1(0.15)^3}{12} = 2.8125\times10^{-5}\,m^4$$

Now

$$I_y = \frac{bh^3}{12} = \frac{0.15(0.1)^3}{12} = 1.25\times10^{-5}\,m^4$$

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

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

~~where~~

$$\cancel{M = M\cos\theta = P\cos\theta = M_z}$$

$$\cancel{= 18\cos}$$

where

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

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

$M_z = 1.8516\,KN$

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

$M_y = 12\sin 30$

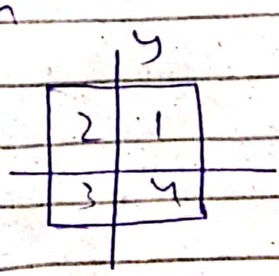
$M_y = -11.8563\,KN$

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

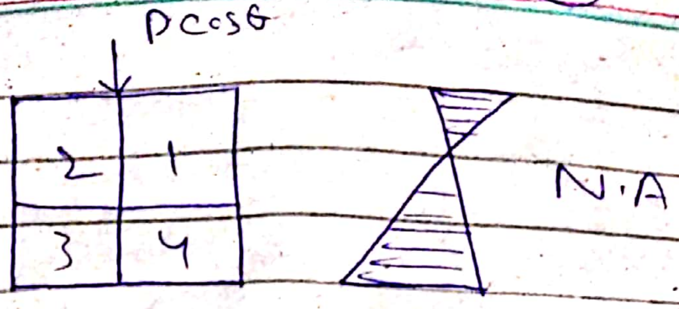
$$\sigma = \frac{1.851}{2.812\times10^{-5}} + \frac{(-11.8563)}{1.25\times10^{-5}}$$

$\sigma = -882678\,Nm^2$

Sign Convention

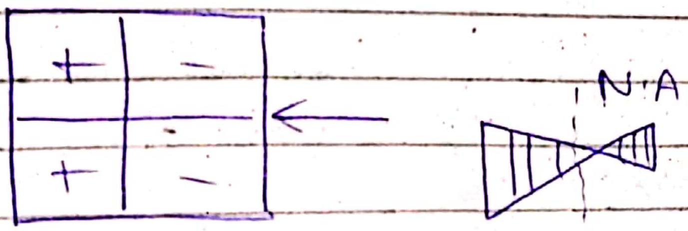


If we take compression as negative and tension as positive and the beam is simply supported



Quadrant 1,2 (-ive)

Quadrant 3,4 (+ive)



Quadrant 1,4 (-ve)

Quadrant 2,3 (+ive)

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

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

In this case, neutral axis 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 neutral axis lies in quadrant 2 where

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

Eq ① becomes

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

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

$$\Rightarrow \tan\alpha = \frac{I_z}{I_y} \tan\theta \quad \text{— (II)}$$

Now putting values of I_z, I_y and θ in eq (II)

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

9

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

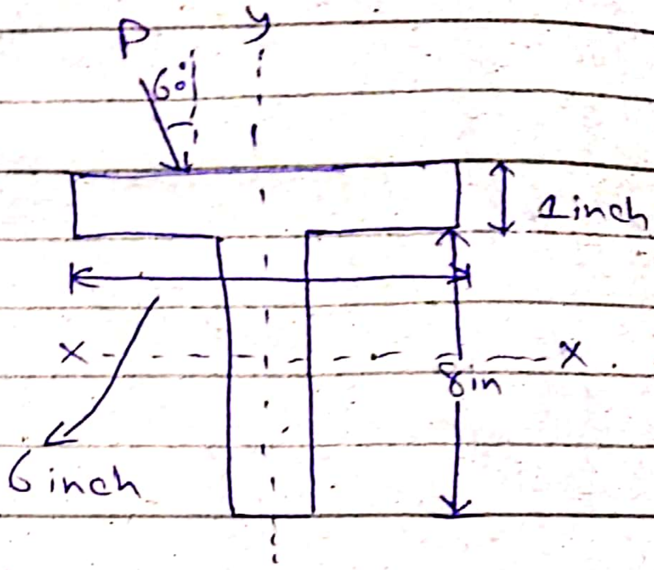
$$\tan\alpha = -14.4129$$

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

$$\alpha = 1.5^\circ$$

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

Answer 2 (b)



Given:

$L = 16 ft$

$I_x = 112.6 \ inch^4$

$I_y = 18.7 \ inch$

$\delta_C = 12000 \ psi$

$\delta_T = 5000 \ psi$

Solution:

If we look at the figure we can judge maximum compression would that occur on an axial maximum tension C and at B. There will be tension as well as compression which will reduce that effect of each other so we will calculate stress at A and C

$$\delta_A = \frac{M_x y}{I_x} + \frac{M_y x}{I_y} \quad (comp)$$

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

Now M_x and M_y

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

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

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

$$M_y = 48P\sin 60$$

Now

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

$$1200 = \frac{48P\cos 60^\circ \times 3.07}{112.6} + \frac{48P\sin 60 \times 3}{18.7}$$

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

Now

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

$$S_{000} = \frac{48 p \cos 60^\circ \times (5.93)}{112.6} + \frac{48 p \sin 60^\circ \times 0.5}{18.7}$$

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

Answer 3

Given:

Length = L = 10 ft

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:

Safe load = ?

Solution.

As

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

As we know that

$$I = A r^2$$

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

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

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

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

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

$$P_{cr} = \frac{(3.14)^2 (10.3 \times 10^8)(1.5)}{\left(\frac{10}{0.216}\right)^2}$$

$$P_{cr} = 853.8343$$

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

$$\text{Safe load} = \frac{853.8343}{2}$$

$$\text{Safe load} = 426.917$$

For fixed ended Column

$$Le = \frac{L}{2} = \frac{10}{2}$$

$$Le = 5ft$$

$$P_{cr} = \frac{\pi^2 EA}{\left(\frac{Le}{r}\right)^2} = \frac{(3.14)^2 \times (10.3 \times 10^6)(1.5)}{\left(\frac{10}{0.216}\right)^2}$$

15

$P_{cr} = 1974.207$

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

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

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