PAPER

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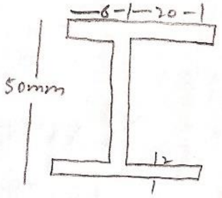
Q No (1)

Determine the location of the shear center for the beam having the cross sectional dimensions shown in the figure. All members are to be considered this walled and calkulation should be based on the centerline dimensions.



Sol: As we know

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

and

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

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

$$I = 50034.66 + 20833$$

$$I = 70867.99\ mm^4$$

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

So shear centre

$$e = 11.02mm$$

Question (1)

Part (b)

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

Data Required

=) $H = 26\,ft$

=) diameter = 22ft.

=) tangential stress = 600 lb/ft^3

=) specific weight of water tank = 62.4 lb/ft^3

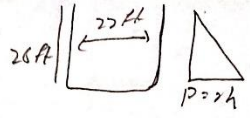
we have to find the thickness =?

Solution

The pressure develope by water

$p = \gamma h$

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



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

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

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

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

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

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

Assuming pressure disturbution to be uniform

$$T = \sigma_y A_t \quad 864000\,(th)$$

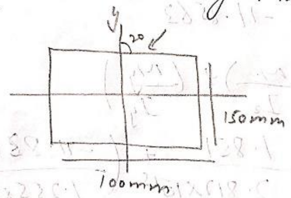
$$T = 864{,}000(1/2 \times 1/12)h$$

$$\boxed{T = 36{,}000h}$$

Question 2

Part 1

The 100 by 150mm wooden beam shown in figure 2 is used to support a uniformly beam distributed load of 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 interia

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

Now

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

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

$$6 = \frac{M_z y}{I_z} + \frac{M_y z}{I_y}$$

$$6 = \frac{M\cos\theta}{I_z} + \frac{M\cos\theta}{I_y}$$

where

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

$= 12 \cos 30° = M_z$

$M_z = 1.8510$

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

$M_y = 12 \sin 30$

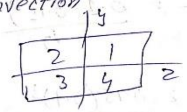
$M_y = -11.8563$

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

$$\sigma = \frac{1.851}{2.812 \times 10^{15}} + \left(\frac{-11.8863}{1.255 \times 10^{5}}\right)$$

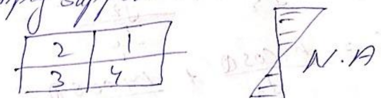
$= 882628 \ \mathrm{Nm}^{-}$

sign convection

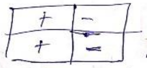


If we compression as negative and tension as postive and the Beam

is a simply supported



Quadrent 1, 2 -ve
Quadrant 3, 4 +ve



PsinΘ

Quad 1, 4 -ve
Quad 2, 3 +ve

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

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

In case N.A passes through z, y

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

let consider a point 'A' on NA lies in Quadrant, where

- Bending stress due to PcosΘ is compressive
  and
- Bending stress deu to PsinΘ is Tensive.

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

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

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

Now put values of I_z, I_y and θ in eq(1)

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

$\Rightarrow \tan\alpha = \frac{3.8125 \times 10^5 (\tan 30^0)}{1.25 \times 10^5}$

$\tan\alpha = -14.4124$

$\alpha = \tan^{-1}(-144129)$

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

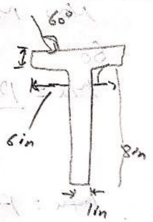
$\alpha = 1.5^0$

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

Q(2)

Part (b)

The T section shown in figure. is the cross section of a simply supported beam 16ft long that carries a central concentrated load inclined load 60 degree left ------- --- what is the maximum load that will not overstress the beam?



Given Data

$L = 16ft$

$I_x = 122.6 inch^4$

$I_y = 18.7 in^4$

$S_c = 12000 psi$

$S_t = 5000 psi$

Solution

By looking figer are can judge that maximum compression would accure on a and maximum tension as well a compression which effect of each other so we will calculate stress at A and C

so

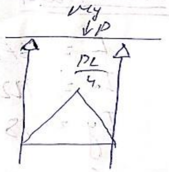
$$S_A = \frac{M_x y}{I_x} \pm \frac{M_y x}{I_y}$$

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

Now M_x and M_y

so

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



$\cancel{M_x} = \cancel{P\cos}$

$$M_x = 48\cos 60$$

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

$$M_y = 48\sin 60$$

Now

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

$$2)\quad 1200 = \frac{48P\cos 60^\circ \times 3.07}{112.6} +$$

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

Solving the equation

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

Now

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

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

Solving the equation.

$$\boxed{P = 2104.916}$$

So the maximum load P applied should

$$\boxed{1638.6\,lb}.$$

Question (3)

A 10ft long structure braced in the middle has rectangle section of 0.75 in by 2in. 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 axis parallel to 2in dimension. Determine the safe load P about using a factor of safety of 2 and $E = 10.3 \times 10^6$.

Ans **Given Data**

length "L" = 10ft

As bothsides are hinged

so $L_e = L$

$E = 10.3 \times 10^6$

factor of safety = 2

$b = 0.75$ inch.

$h = 2$ inch.

Required Data

Determine safe load?

Solution:- As

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

As we know that $I = Ar^2$

$I = Ar^2$

$r = \sqrt{I/A}$

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

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

$r = 0.216$ inch

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

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

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

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 columns

$$L_e = L/2 = 10/2$$

$$L_e = 5ft$$

$$P_{cr} = \frac{\pi^2 EA}{(L_e/r)^2} \Rightarrow \frac{(3.14)^2 \times ((10.3 \times 10^6)(1.5))}{\left(\frac{60}{2.16}\right)^2}$$

$$P_{cr} = 1.974.207$$

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

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

$$\boxed{987.103.}$$

Ans.