paper:- MOS-II

final exam

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Sec-A

Subject:- Mechanics of Solids-II

Semester: 4th

instructure:- Sir SAQIB KHAN

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Q No. 01 (a)

Sol:-

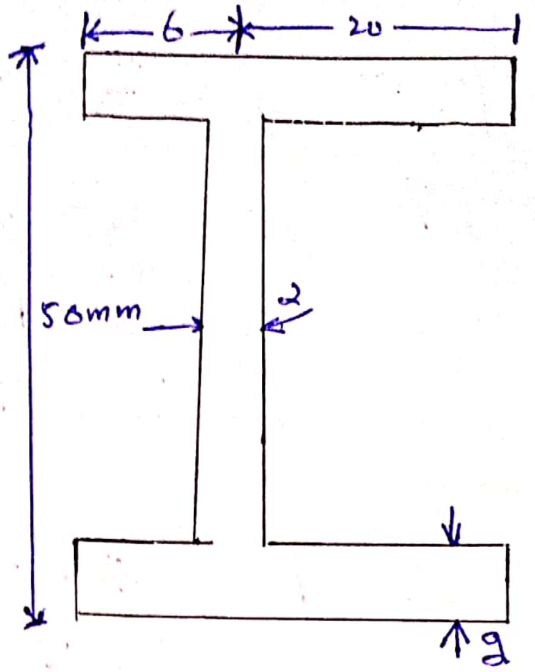
Given that;

height of Sec. $h = 50mm$

Thickness $= b = 20 + 6$

$\Rightarrow b = 26mm$

$T_f = 2mm$



Required;

Shear Center = ?

As we know that;

for unsymmerical members, the shear Center is some distance away from the geometrical center,

This distance is called ecentricity which is given as;

$\longrightarrow$

$$e = \frac{T_f h^2 b^2}{4I} \rightarrow ⓐ$$

Here I = moment of Inertia and is given as

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

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

$$I = 50034.66 + 20833$$

$$\boxed{I = 70867.99\,mm^4}$$

Now ~~question~~ eq ① $\Rightarrow$

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

$$\Rightarrow e = \frac{2\times(50)^2\times(25)^2}{4(70867.99)} = 11.0234\,mm$$

$$\boxed{e = 11.0234\,mm}$$

So Shear Center is 11.0234 mm away from geometrical center.

x ——————— x

Question No. 01 part (b)

Ans:-

Given Data;

Height = h = 26 ft

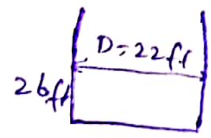
assumed diameter = 22 ft

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

Tengential Stress = 600 lb/ft = S_1

Required data;

Thickness of walls of water tank = ?



Sol:-

the pressure develop by water is given as

$$p = \gamma h$$

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

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

$$\Rightarrow 2t \times \delta_t = \gamma h D$$

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

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

~~put~~ put values

$$t = \frac{\left(\frac{62.4}{(12)^3}\right) \times (26 \times 12) \times (22 \times 12)}{600 \times 2}$$

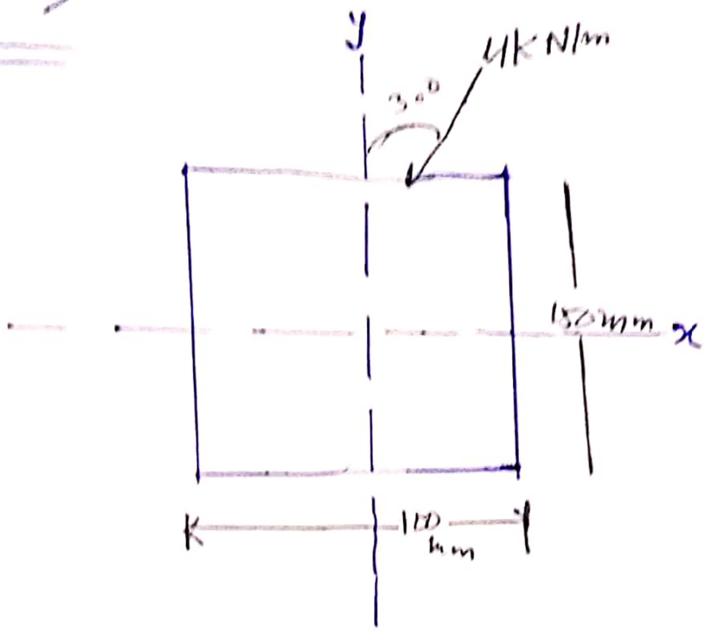
$$\Rightarrow t = \frac{270.4}{1200}$$

$$\Rightarrow \boxed{t = 0.2253''}$$

(5)

Question No. 02 (a)

Sol:-



Given that;

$b = 100\,mm$

$h = 150\,mm$

$load = p = 4KN/m$

Length of Beam = 3m

Required; Bending Stress = ?

N.A = ?

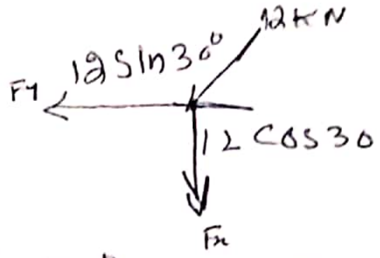
Now we know that

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

$\because M_x = M\cos\omega$

$M_y = M\sin\omega$

$$\Rightarrow S = \frac{M\cos\omega}{I_z} + \frac{M\sin\omega}{I_y} \longrightarrow (a)$$



$12 \sin 30° = -11.8563$

$12 \cos 30° = 1.8510$

Now;

moment about x-axis

$$M_z = -11.8563 \times 3$$

$$\Rightarrow M_z = -35.57 \, N \cdot m$$

$$M_y = 1.851 \times 3$$

$$\Rightarrow M_y = 5.55 \, N \cdot m$$

We know

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

$$\Rightarrow \cancel{M_z}.\ M \cos\theta = M_z$$

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

$$\Rightarrow M \sin\alpha = M_y$$

Hence eq (a) $\Rightarrow$

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

NOW moment of inertia.

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

$$\Rightarrow I_z = 2.8125 \times 10^{-5} \text{ inch}^4$$

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

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

eq(a) $\Rightarrow$

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

$$\boxed{\delta = 882678 \text{ Nm}^2}$$

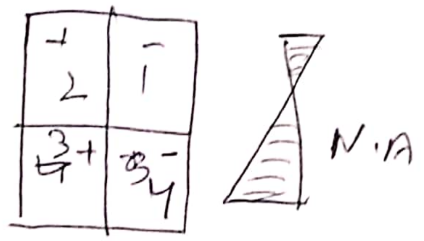
Natural axis (N.A):-

Sign Convections are

2	1
4	3

$\rightarrow$

- If we take Compression as negative and tension as positive, then beam is Simply Supported.



in this Case; Natural axis passes 2 and 4 Quadrants.

in unsymmetrical loading case, the Neutral axis lies on angle of 'α' which is given by:

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

$$\Rightarrow \tan\alpha = \frac{2.8125\times10^{-5}}{1.25\times10^{-5}}(\tan 30^\circ)$$

$$\tan\alpha = 14.4129$$

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

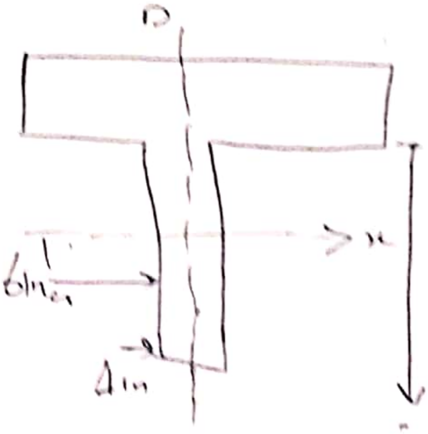
$$\Rightarrow \alpha = 1.5^\circ$$

$$\Rightarrow \boxed{\alpha = 1^\circ 30' 5''}$$

Question No. 02 (b)

Sol:-

Given data:



Length of beam = $L = 16ft$.

$I_x = 112.6 \, in^4$

$I_y = 18.7 \, in^4$

$\delta_c = 12000 \, Psi$

$\delta_t = 5000 \, Psi$

from given figure, the maximum Compression would occur on 'A' and maximum tension at B.

the tension and Compression will reduce the effect of each other.

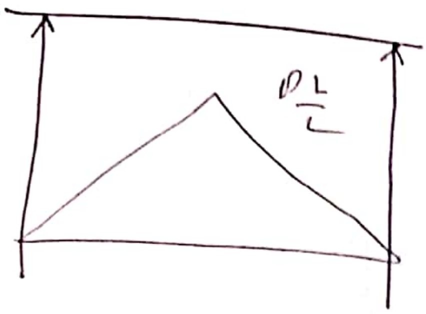
So stress should be calculated at

at 'A' and 'C'.

so; $\delta_A = \frac{M_x y}{I_x} + \frac{M_y x}{I_y}$ (compression)

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

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



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

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

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

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

$\Rightarrow 1200 = \frac{48P\cos 60^\circ + 3.07}{112.6}$

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

and

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

$$\Rightarrow 5000 = \frac{48 P \cos 60^\circ \times (5.97)}{18.7}$$

$$\Rightarrow P = 2104.916$$

So the maximum load 'P' which can be applied should not be greater than 1638.6 lb

C X

Question No. 03

Sol:- Length of ~~Beam~~ Column $= L = 10ft$

Given $E = 10.3 \times 10^6$

breadth $= b = 0.75$

height $= h = 2$

factor of safety $= 2$

Required; Safe load $= ?$

when
- both ends hinged.
- both ends fixed.

So;
- for hinged Coloumns

effective length $= L_e = L$

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

$$P_{critical} = \frac{n^2 EI \pi^2}{L_e^2} = \frac{1^2(10.3\times10^6)(0.5)\pi^2}{(10\times12)^2}$$

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

$$\Rightarrow P_{cr} = 3526.176 \text{ lb}$$

$$\text{Safe load} = P_{safe} = \frac{P_{cr}}{\text{factor of safety}} = \frac{3526176}{2}$$

$$\Rightarrow \boxed{P_{safe} = 1763.088 \text{ lb}}$$

- when both ends fixed

in this case $L_e = \frac{L}{2}$

$$\Rightarrow L_e = 5 \text{ ft.}$$

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

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

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

$$\Rightarrow P_{cr} = 1974.658 \text{ lb} \longrightarrow$$

⇒ So, Safe load
⇒

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

$$\Rightarrow \boxed{P_{safe} = 987.3293\ lb}$$

THE END