Mechnics Of Solid

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Sec :- A

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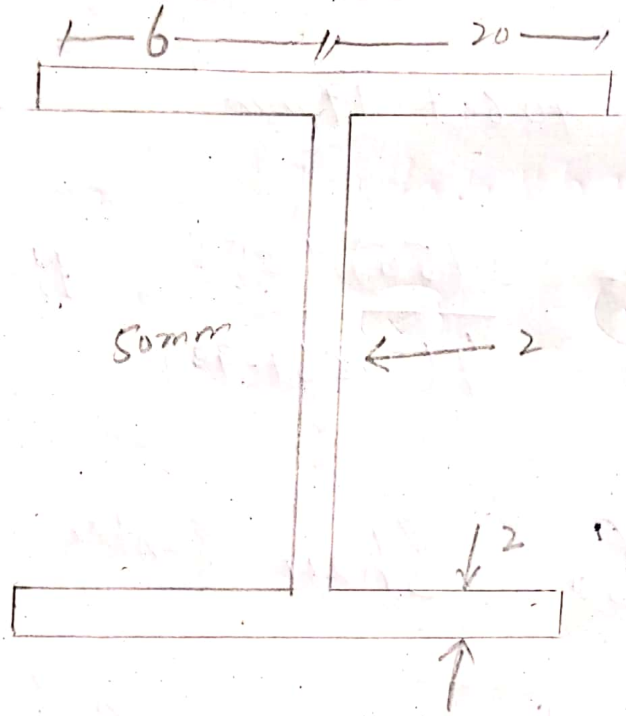
①

Q NO1 (Part- a)

Ans.



Required:
Location of Shear Center?

Solution: As we know that

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

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

$$\Rightarrow 2\left(\frac{25(2)^3}{12} + (20\times 2)(25)^2\right) + \left(\frac{2(50)^3}{12} + 0\right)$$

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②

Q NO 1 (part B).

Ans:

Given data

Height = 26ft

Tengential Stress = 6000psi

Specific weight of water = $62.4 \frac{lb}{ft^3}$

Required data:

Thickness of wall of water tank = t = ?

Solution:

$$p = \gamma h$$

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

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

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(3)

putting values

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

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

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

Ans

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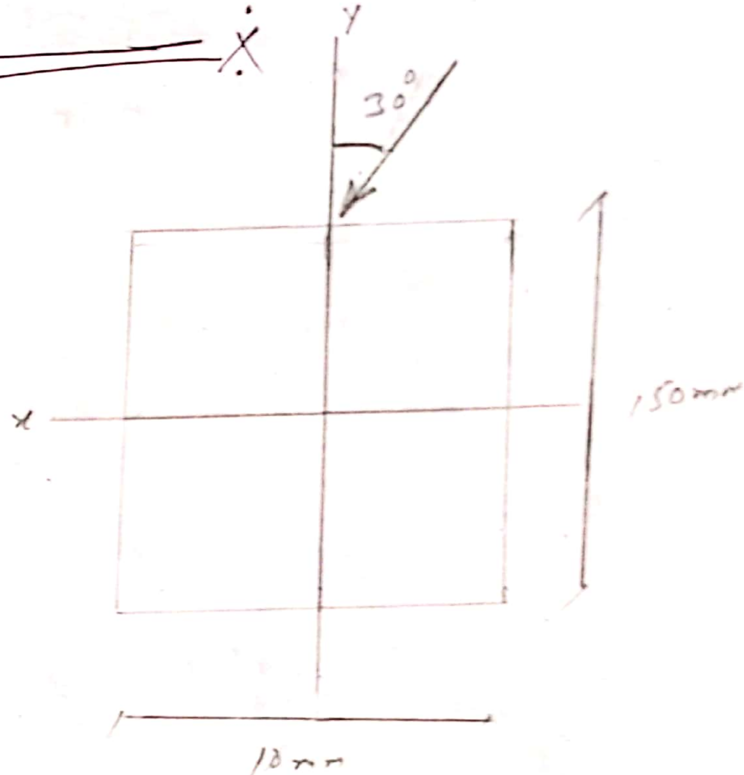
④

QNo2 (part-a)

Ans:-



Moment of Inertia.

$$I_z = \frac{bh^3}{12}$$

$$\Rightarrow 0.1\,(0.15)^3 \Rightarrow 2.8125\times10^{-5}$$

$$I_z = 2.8125\times10^{-5}$$

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

$$I_y = 1.25\times10^{-5}$$

P.T.O

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

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

Where

$M = \cos\theta \Rightarrow p\cos\theta = M_z$

$= 12\cos 30^\circ$

$$\boxed{M_z = 1.8510}$$

$M\sin\theta = p\sin\theta = M_y = 12\sin 30^\circ$

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

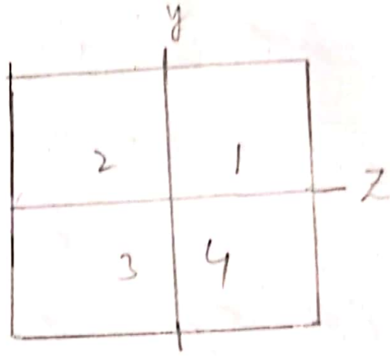
$$\sigma = \left(\frac{M_z}{I_z}\right) + \left(\frac{M_y}{I_y}\right)$$

P.T.O

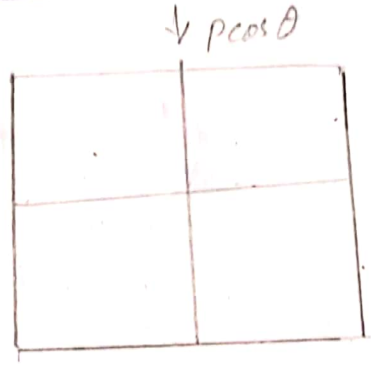
$$\sigma = \frac{1.851}{2.812\times10^{-5}} + \left(-\frac{11.8563}{1.25\times10^{-5}}\right)$$

$$\boxed{\sigma = 882678\ N/m^2}$$

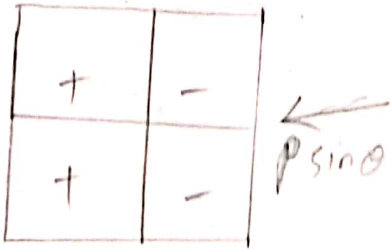
Sign Convention

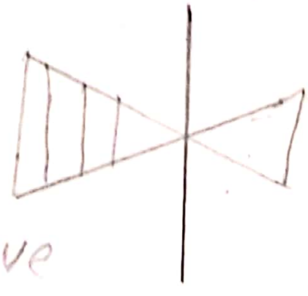


* If we take compression as negative and tension as positive and the Beam is Simply Supported.



Quadrant 1, 2 – ve
" 3 4 +ve





Quadrant 1, 4 – ve
" 2 – 3 +ve

In Case of unsymmetrical loading the Neutral axis lies of an angle of "x" the principle axis and the algebric Sum of Stress at N.A is zero

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

In this case N.A passes through z, y

$$0 = \frac{M\cos\theta \cdot y}{I_z} + \frac{M\sin\theta \cdot z}{I_y}$$

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.

eq (1)

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

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

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

$$\tan\alpha = \frac{I_z}{I_y}\tan\theta \longrightarrow (2)$$

Now, put values of I_z, I_y and θ

In eq (2)

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

$$\Rightarrow \frac{2.8125\times10^{-5}}{1.25\times10^{-5}}\tan 30^\circ$$

P.T.O

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$\tan\alpha = -14.4129$

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

$\alpha = 1.5^\circ$

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

Ans

Q No 3 (Part-a)

Given data:

Length = 10 ft

$E = 10.3 \times 10^6$

$b = 0.75$

$h = 2$

Factor of Safety = 2

Required:

a) Safe load at hinged = ?

b) Safe load at fixed

Solution

a) For hinged columns

$L_e = L$

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

N.A

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

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

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

1763.088 lb

(Part - b): Start act colums.

$$l_e = \frac{L}{2} \quad (\text{For fixed ended})$$

$$l_e = \frac{10}{2} = 5 \text{ ft}$$

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

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

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

$$P_{cr} = 1974658 \text{ lb}$$

$$P_{safe\ load} = \frac{1974.658}{2} = \boxed{987.329 \text{ lb}}$$

Q NO 2 part - b

Given data

Length is beam = 16 ft

Average of inclination = 60°

$I_x = 102.6\ in^4$

$I_y = 18.7\ in^4$

$\sigma_t = 5000\ psi$

$\sigma_c = 12000\ psi$

Required: maximum load = ?

Sol:

There will be tension as well as compression which will reduce the effect of each other.

So we will calculate Stress at A and C so

$$\sigma_A = \frac{M_x y}{I_x} + \frac{M_x y}{I_y} \quad \text{(in compression)}$$

$$\sigma_c = \frac{M_x y}{I_x} + \frac{M_x y}{I_y} \quad \text{(tension}$$

Now M_x and M_y

$M_x = P\cos 60\ (16 \times 12)$

$M_x = 48\ P\cos 60$

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

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

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

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

Now

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

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

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

Maximum Stress load = 1638.6 lb

Ans