Mechanics Of Solid ...

Name :- Afrasiyab

ID :- 7899

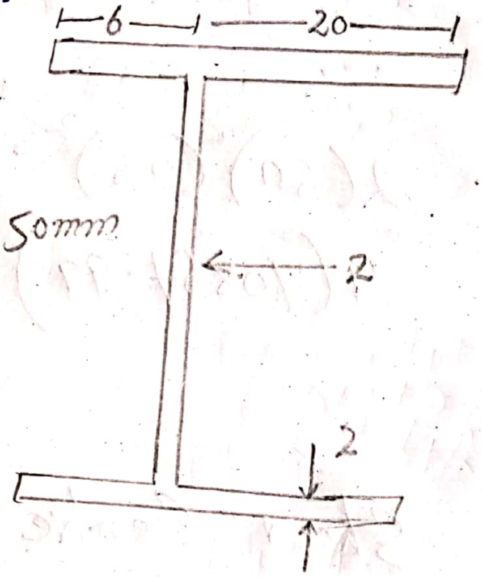
Sec :- A

Submitted to :- Engr Saqib

Date :- 23/6/2020

QNo 1 (part-a)

Ans:



Required: Location of shear Centre ?

Solution: As we know that

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

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

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

2

$$I = 50034.66 + 20833$$

$$I = 70867.99 \text{ mm}^4$$

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

$$\boxed{\text{So Shear Centre} \quad e = 11.02 \text{ mm}}$$

Ans

QNO1 (part B).

Ans :-

Given data

Height = 26 ft

Tengential stress = 6000 psi

Specific weight of water = 62.4 lb/ft³

Required data

Thickness of wall of water tank = t = ?

Solution

$$P = \gamma h$$

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

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

putting values

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

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

$$\boxed{\cancel{t = 0.001721296}}$$

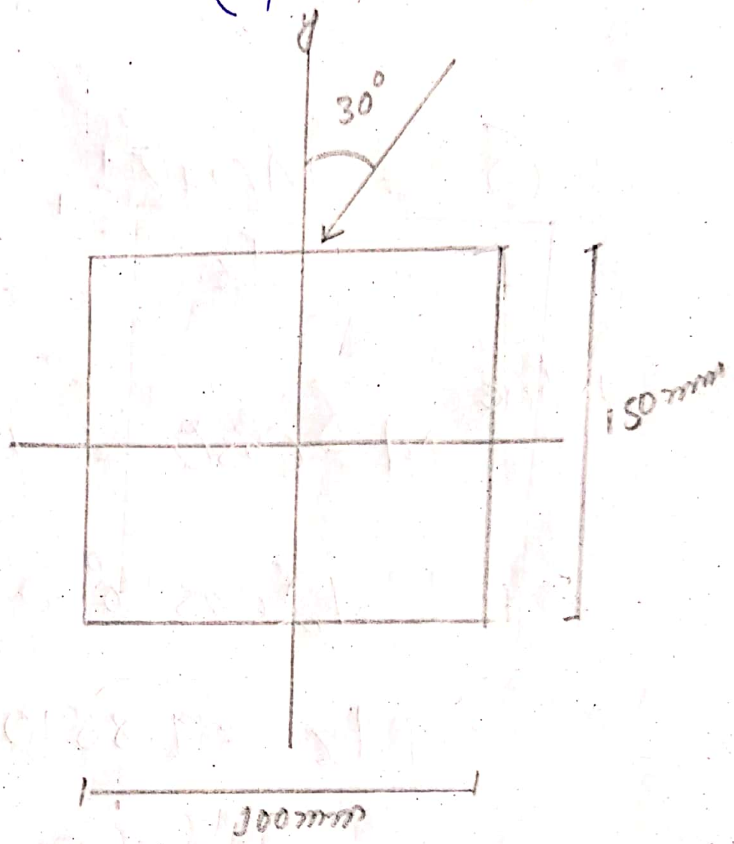
$$\boxed{t = 0.24 \text{ inch}}$$

Ans

QNo 2

(part — a)

Ans :-



Moment of Inertia

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

$$I_z \Rightarrow 2.8125 \times 10^{-5}$$

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

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

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

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

Where

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

$= 12\cos 30^\circ$

$$\boxed{M_z = 1.8510}$$

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

$12\sin 30^\circ$

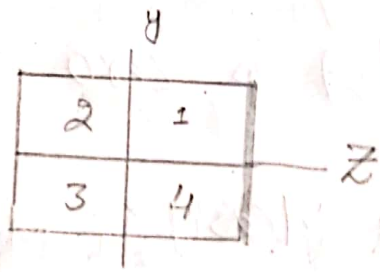
$$\boxed{M_y = -11.8563}$$

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

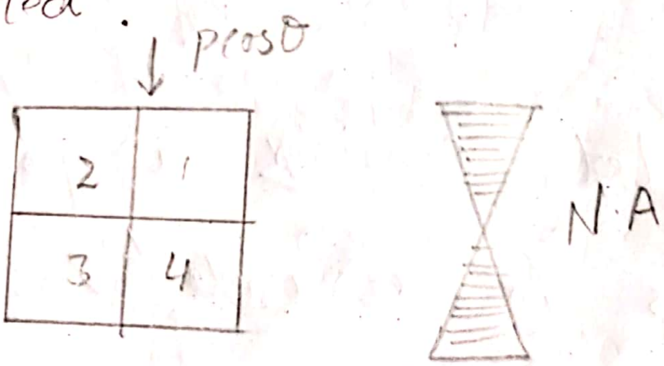
$$\sigma = \frac{1.851}{2.812\times10^{-5}} + \left(\frac{-11.8563}{1.25\times10^{-5}}\right)$$

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

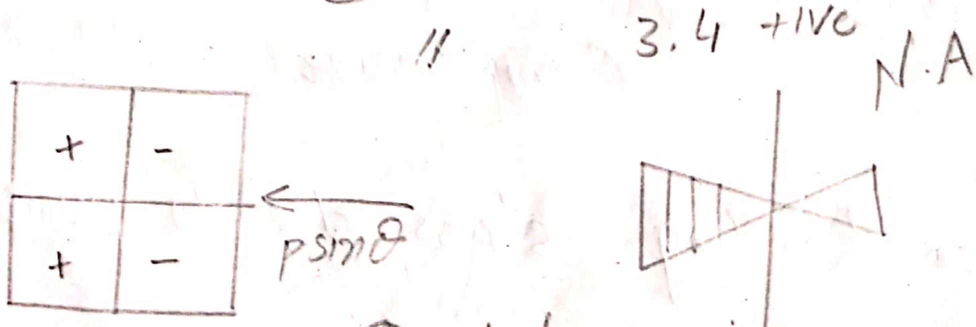
Sign Convention



* If we take Compression as negative and tension as positive and the Beam is simply Supported.



Quadrant 1, 2 – ive
" 3, 4 +ive



Quadrant 1.4 – ive
" 2.3 +ive

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

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

In this case N.A passes through 2, 4

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

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.

eq 1

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

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

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

$$\tan\alpha = \frac{I_z}{I_y}\tan\theta \quad \text{—— (2)}$$

Now put values of I_z, I_y and θ in eq 2

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

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

$$\tan\alpha = -14.4129$$

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

$$\alpha = 1.5^{\circ}$$

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

Ans.

QNo2 (part b)

Ans:-

Given data

Length of beam = 16 ft

Angle of inclination = 60°

$I_x = 112.6 \ in^4$

$I_y = 18.7$ "

$S_T = 5000 \ psi$

$S_c = 12000 \ psi$

Required data:

Maximum Load ?

Solution:

There are two forces Compression as well as tensile which will reduce the effect of of each other. So we will calculate stress at A and C so.

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

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

Now M_x and M_y

$$M_x = P\cos 60\,(\underbrace{16\times 12}_{=48})$$

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

$$M_y = P\sin\theta(60)$$

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

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

$$\delta_A = \frac{48 \cos 60^\circ \times 3.07 + 48 \sin 60 \times 3.07}{1126 + 18.7}$$

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

Now

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

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

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

Max Stress load => 1638.6 lb

Q No 3

Ans:. **Given data**

$L = 10 ft$

$E = 10.3 \times 10^6$

$b = 0.75$

Factor of safety $= 2$

$h = 0.75$

Required data

1) Safe load at hinged ?
2) " " at fixed ?

Solution

1) for Hinged

$le = L$

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

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

$$\Rightarrow \frac{(1)^2 (10.3\times10^6)(0.5)(3.14)^2}{(10\times12)^2}$$

$$\boxed{P_{cr} = 3526.176\ lb}$$

$$P\ \text{safe load} \Rightarrow \frac{P_{cr}}{\text{factor of safety}}$$

$$\Rightarrow \frac{3526.176}{2}$$

$$\boxed{\Rightarrow 1763.088\ lb}$$

2) For fixed

$$Le = L/2 = 5ft$$

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

$$P_{cr} = \frac{n^2 EI \pi}{2}$$

putting values

$$P_{cr} = \frac{(1)^2 (10.3\times10^6)(0.07)(3.14)^2}{(5\times12)^2}$$

$$\boxed{P_{cr} = 1974.658\ lb}$$

P safe load $\Rightarrow \frac{1974.658}{2}$

$\Rightarrow \boxed{987.3293\ lb}$

Ans