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Subject = Mos 2

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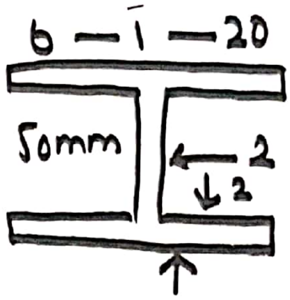
Question No # 1
Part (A)

Required:- Location of Shear centre

Sol:- As we know

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



and;

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

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

$$+ \left[\frac{2(50)^3}{12} + 0\right]$$

$$I = 50034.66 + 20833$$

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

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

So Shear Centre

$$e = \underline{11}.02 \text{ mm}$$

Question No 1
Part (b)

(2)

Data:-

$H = 26\,ft$

$\Rightarrow$ A assume diamete

$D = 22\,ft$

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

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

we have to find the thickness $= ?$

③

Solution:-

The pressure develope by water $P = \gamma h$

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

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

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

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

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

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

$$t = 0.24''$$

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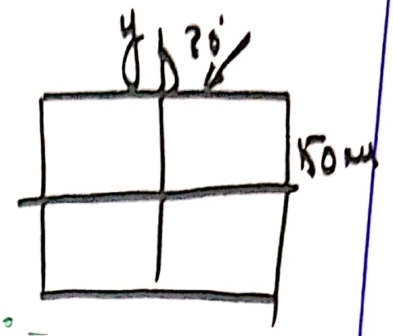
Question No # 2
Part (A) (4)



Moment of inertia:-

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

Now

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

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

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

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

where

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

$$M_z = \cancel{12}\cos 60^\circ = M_z = 1.8510$$

$M \sin Q = P \sin Q = M_y$

T5

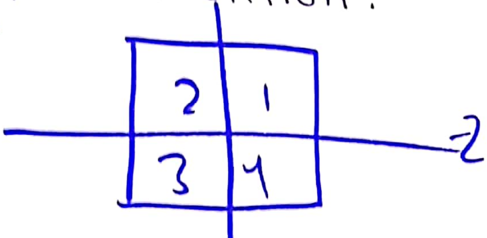
$M_y = 12 \sin 60°$

$M_y = -11.8563$

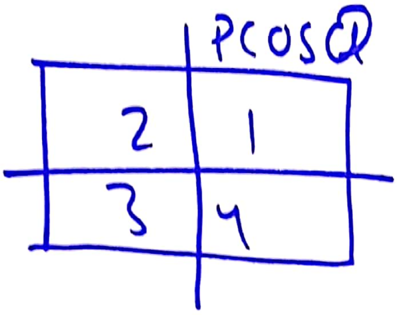
$$\sigma = \left(\frac{M_z}{I_z}\right) + \left(\frac{M_y}{I_y}\right)$$

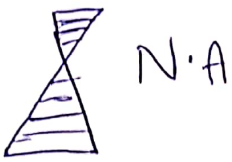
$$\sigma = \frac{1.851}{2.812 \times 10^{-5}} + \frac{(-11.8563)}{(1.25 \times 10^{-5})} = 882628 \ N.m^2$$

Sign Convention:-



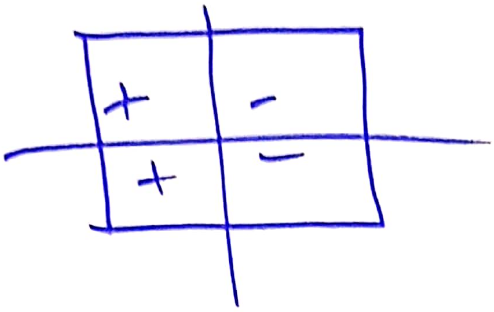
If we take compression as negative and tension as positive and the beam is a simply supported.

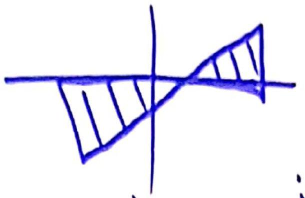




Quadrant 1,2 ⇒ -ive

Quadrant 3,4 ⇒ +ive





Quad 1,4 −ive
Quad 2,3 +ive

In case of unsymmetrical loading the neutral axis lies at an angle 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

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

Let consider a point "A" on N.A lies Quandrant 2, where

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

and

- Bending stress due to $P\sin\theta$ is Tensile.

(7)

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

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

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

$$\frac{y_A}{z_A} = \frac{I_z \sin\theta}{I_y \cos\theta} \Rightarrow \tan\alpha = \frac{I_z}{I_y}\tan\theta \quad \text{—(ii)}$$

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

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

$$\Rightarrow \tan\alpha = \frac{3.8125\times10^{-5}}{1.25\times10^{-5}}(\tan 30^\circ)$$

$$\tan\alpha = -14.4129$$

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

$$\alpha = 1.5^\circ$$

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

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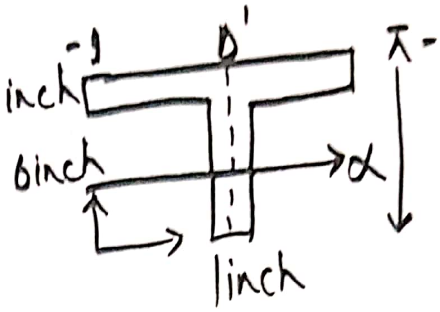
Question No # 2

Part (B)

Given:-



$L = 16\,ft$

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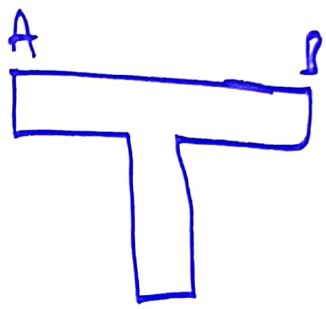
$I_x = 112.6\ inch^4$

$I_y = 18.7\ inch^4$

$S_c = 12000\ psi$

$S_t = 5000\ psi$



Solution:-

By looking the figure we can judge that maximum compression would accure on "a" and maximum tension c at B. There will tension as well a compression which will reduce that effect of each other so we will calculate stress at A & C.

So,

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

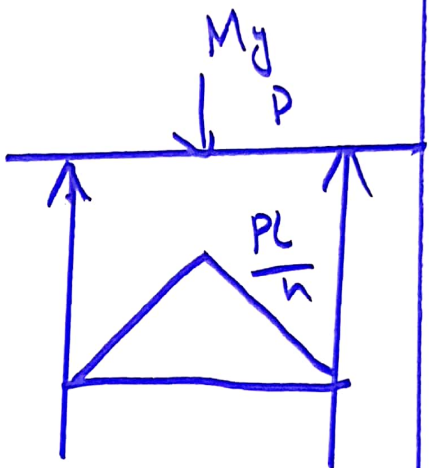
a

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

Now M_x and M_y

So

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



$$M_x = 48 \, P \cos 60$$

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

$$M_y \; 48 P \sin 60$$

Now

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

$$\Rightarrow 1200 = \frac{48 P \cos 60^\circ \times 3.07}{112.6} + \frac{48 P \sin 60 \times 30}{18.7}$$

Solving the equation

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$P = 1638.6$ 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.

$P = 2104.9$ lb

For Case 1

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

So the maximum load of P applied should 1638.6 lb

Question No #3

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

$$L_e = L$$

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

$$P_{cr} = \frac{n^2 E I \pi^2}{L_e^2} = \frac{(1)^2 (10.3 \times 10^6)(0.5)\pi^2}{(10 \times 12)^2}$$

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

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(12)

$$P_{safe\ load} = \frac{P_{cr}}{\text{factor of Safety}} = \frac{3526.176}{2} = 1763.088\ lb$$

(b) fixed Column:-

$L_e = L/2$ (for fixed ended)

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

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

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

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

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

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

$$= 987.3293\ lb$$