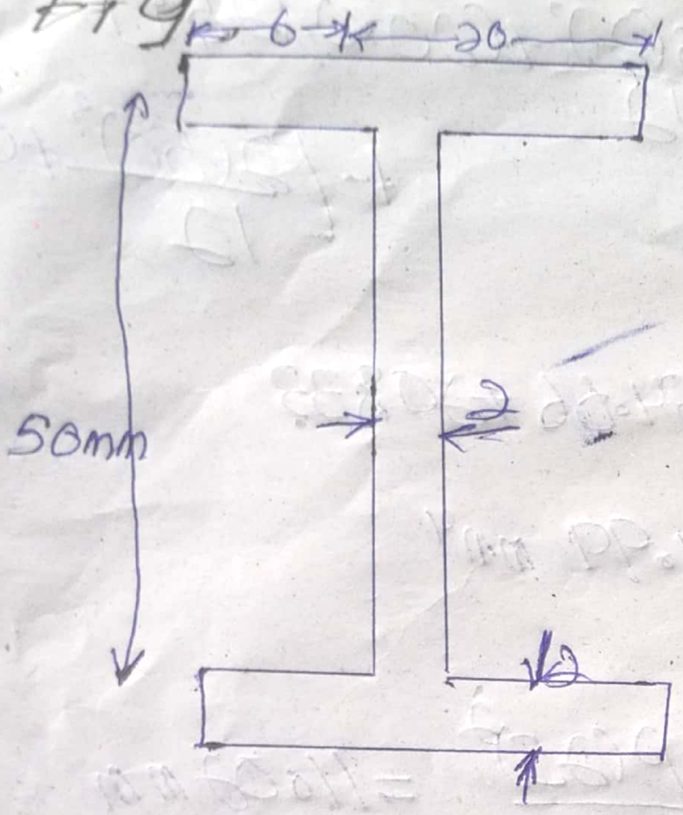
Q1
(a)

Fig



Required:-

location of shear centre

Sol:-

As we know that

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

and

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

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

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

$$I = 50034.66 + 20833$$

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

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

So,

shear centre $e = 11.02$ mm

Q Question NO 1 :-

Part (b) :-

Given Data :-

Height = h = 26 ft

D = 22 ft

tangential stress = 600 lb/ft

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

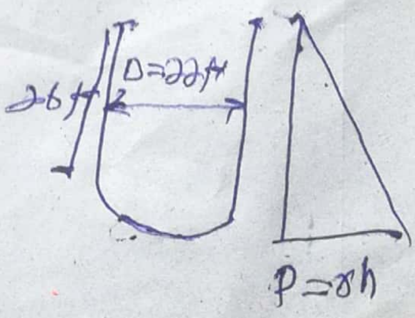
Required :-

To find the thickness = ?

Solution :-

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

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



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

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

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

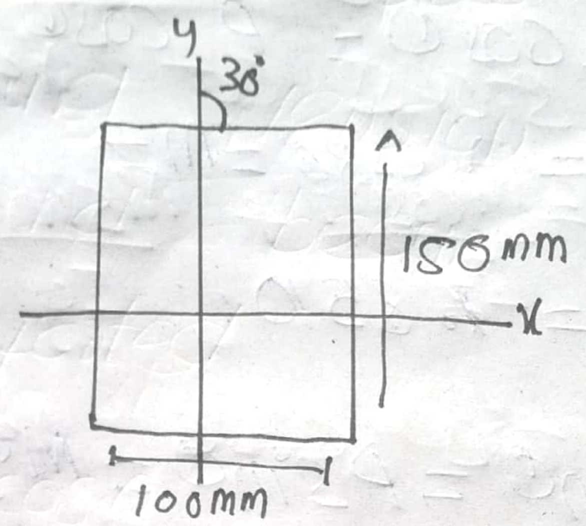
$$t = \frac{\gamma h D}{\sigma_t}$$

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

$$t = 0.24''$$

Question NO 2

(a)



Moment of Inertia

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

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

Now,

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

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

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

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

where

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

$= 2\cos 30° = M_z$

$M_z = 1.8510$

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

$M_y = 12\sin 30°$

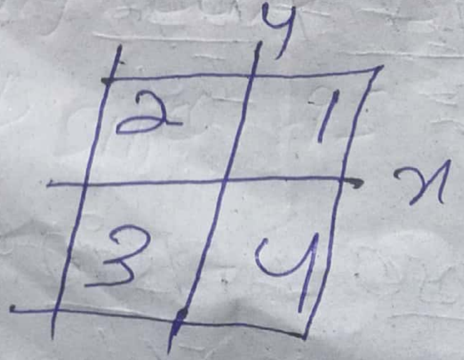
$M_y = -11.8563$

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

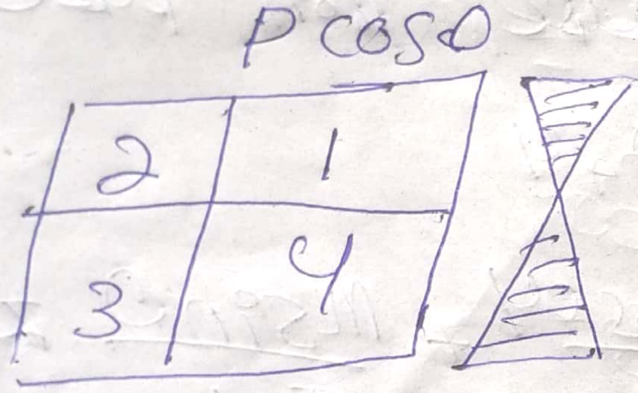
$$\sigma = \frac{1.851}{2.812\times10^{-5}} + \left(\frac{-11.8563}{1.25\times10^{-5}}\right) =$$

$882678\ Nm^3$

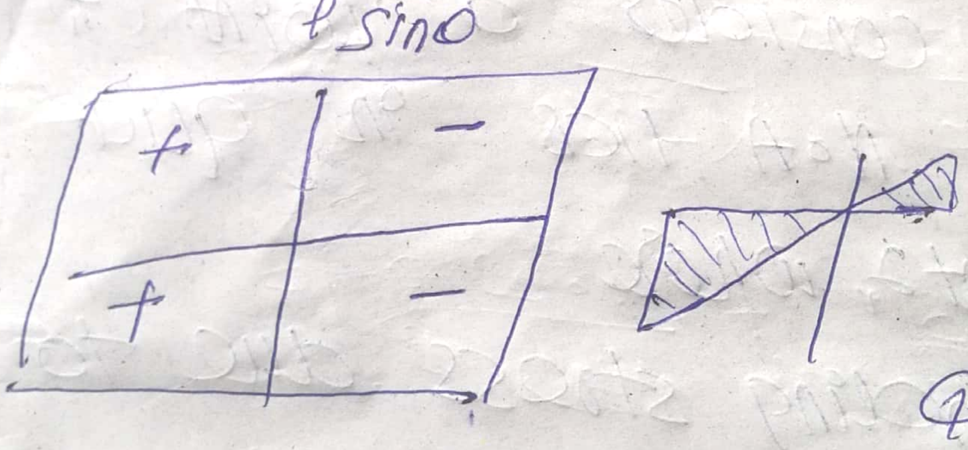
sign convention



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



quadrant 1, 2 -ive
3, 4 +ive



Qud 1, 4 -ve
2, 3 +ve

In case of unsymmetrical loading in neutral axis lies at an angle of (α) the principciple axis and the algebraic sum of stress at N.A is 0.

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

In this 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 N.A lies in quadrant 2, where

- Bending stress due to $P\cos\theta$ is compressive
- Bending and stress due to $P\sin\theta$ is tensile.

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

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

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

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

Now put values in eq(ii)

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

$\tan\alpha = -14.4124$

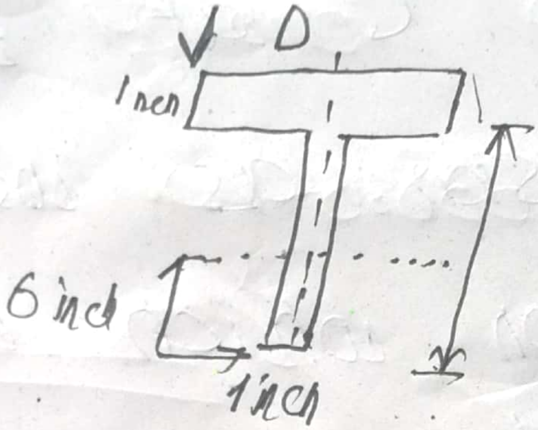
$\alpha = \tan^{-1}(-14.4129)$

$\alpha = 105^\circ$

$\alpha = 1305''$

Q2

Part B



$L = 16 ft$

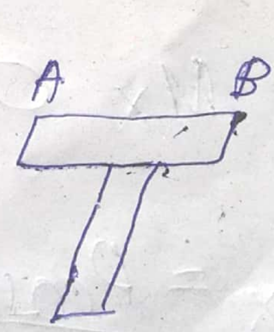
$I_x = 112.06 inch$

$I_y = 18.7 in$

$S_c = 12000$ PSI

$S_t = 5000$ PSI

Sol:-



By looking fig we can judge that max compression accure on a maximum tension C at B. There will tension as well as compression which will reduce that effect of each other so we will calculate stress at A and C.

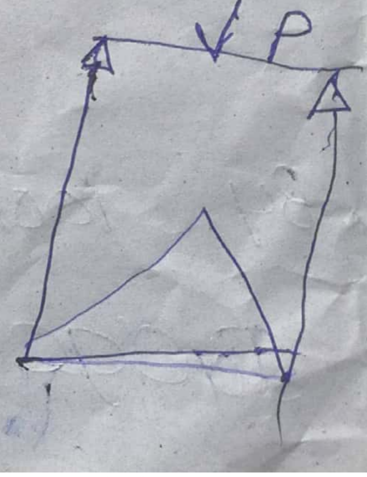
$$S_A = \frac{M_x y}{I_x} + \frac{M_y x}{I_y} \text{ compression}$$

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

Now M_x and M_y.

so

$$M_x = \frac{P\cos 60 \times (10 \times 12)}{40}$$



$\cancel{My} = M_x = 98 P\cos 60$

ten-
wall
mpre-
e
others
ces
ssion
P

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

$$M_y = 48P \sin 60$$

Now

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

$$\Rightarrow 1200 = \frac{48P \cos 60 \times 3.07}{112.6}$$

$$= \frac{48P \sin 60 \times 3}{18.7}$$

Solving eq.

$$\Rightarrow P = 1638.8 \text{ lb}$$

Now

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

$$5000 = 48P \cos 60 \times (5.93) + \frac{48P \sin 60 \times 0.5}{18.7}$$

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

So, the maximum load P applied sould be 1638.6 lb.

Q3(c)

Given:-

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 = ?

sol:-

(a) safe load at hinged:-

$L_e = L$

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

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

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

$$P_{cr} = \frac{50776990}{14400} = 3526.176\ lb.$$

$$P\ safe = \frac{P_{cr}}{\text{factor safety}} = \frac{3526.176}{2}$$

$$= 1763.088\ lb$$

(b) =

$L_e = \frac{L}{2}$ (for fixed

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

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

$$P_{cr} = \frac{n^2 E I \pi^2}{I_{e}^2} = \frac{(1)^2(10.3\times10^6)(0.07)(3.14)^2}{(5\times12)^2}$$

$$P_{cr} = \frac{\cancel{\quad}\,71087716}{(60)^2}$$

$$P_{cr} = 19746.58\ lb$$

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

$$= 987.3293\ lb$$