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Semester # 4th

Section # B

Subject # Mechanics of Solid (II)

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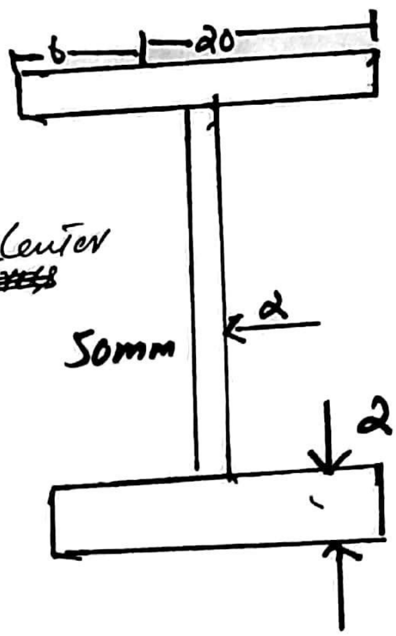
Q #01 (a)




**Required**

:- location of shear center

**Sol**: As we know

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

and

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

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

$$I = 50034.66 + 20833$$

$$I = 70867.99\ mm^4$$

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

$$\boxed{\text{So shear center } e = 11.02\ mm}$$

# Q # 01 (B)

## Data

$\Rightarrow H = 26ft$

$\Rightarrow D = 22ft$

$\Rightarrow$ Tangential Stress = ~~6000 lb/ft~~ 6000 PSI

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

## Required

We have find the Thickness = ?

## Solution

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

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

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

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

③

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

$$t = \frac{\frac{(62.4)(26\times12)\times(22\times12)}{(12)^3}}{6000\times 2}$$

$$\boxed{t = 0.24''}$$

Q#02 (a)

Given data

$\omega = 4 \, KN/m$

$L = 3m$

Required:

Maximum Bending stress = ?

Solution:- As the bending moment is maximum at extremes so we would find stresses at A, B, C, D as shown

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As we know

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

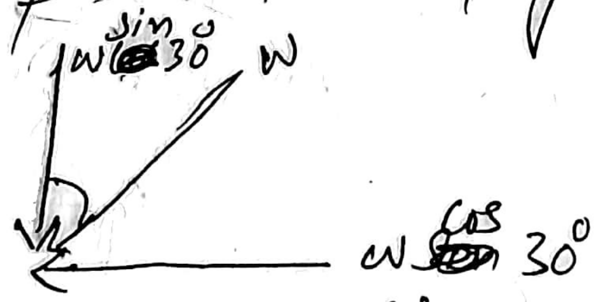
We have to find $M_x$ & $M_y$

As per Question the $M_x$ & $M_y$ should be found at the mid -

As per Simply Supported we have

$$M_{mid} = \frac{wl^2}{8} \rightarrow (1)$$

Now we have to find the components of $w$ in $x$ & $y$ directions




So $$M_x = \frac{(w \cos 30) \times l^2}{8}$$

$$M_x = \frac{(4 \times \cos 30) \times 3^2}{8}$$

$$\boxed{M_x = 3.9 \ KN}$$

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$$M_y = \frac{(4 \times \sin 30) \times 3^2}{8}$$

$$\boxed{M_y = 2.25 \text{ KN}}$$

$M_x$ is causing compression at A & B tension at C & D

$M_y$ is causing compression at B & D tension at A & C -

Now $I_x$ & $I_y$

$$I_x = \frac{bh^3}{12} = \frac{0.1 \times 0.15^3}{12} = 2.815 \times 10^{-5} m^4$$

$$I_y = \frac{hb^3}{12} = \frac{0.15 \times 0.1^3}{12} = 1.25 \times 10^{-5} m^4$$

Now stresses at extreme fibers

$$\sigma_x = \frac{M_x y}{I_x} = \frac{3.9 \times 0.075}{2.815 \times 10^{-5}}$$

$$\boxed{\sigma_x = 10390.7 \text{ KN/m}^2}$$

$$\sigma_y = \frac{2.25 \times 0.005}{1.25 \times 10^{-5}}$$

$$\boxed{\sigma_y = 9000 \ KN/m^2}$$

(Now taking Tension $+\uparrow$)

Stress at A $= \dfrac{M_x y}{I_x} + \dfrac{M_y x}{I_y}$

$= -10390.7 + 9000$

$= -1390.7 \ KN/m^2$ (comp)

at B $= \dfrac{M_x y}{I_x} + \dfrac{M_y x}{I_y}$

$= -10390.7 - 9000$

$\boxed{\sigma \text{ at } B = -19390.7 \ KN/m^2}$ (comp)

Now

Stresses at C $= \frac{M_x y}{I_x} + \frac{M_y x}{I_y}$

$= 10390.7 + 9000$

$= 19390.7$ KN/m (Tension)

Stresses at D $= \frac{M_x y}{I_x} + \frac{M_y x}{I_y}$

$= 10390.7 - 9000$

$= 1390.7$ KN/m$^2$ (Tension)

So the maximum stress are on B & C -

B is under compression of 19390.7 KN/m$^2$ & C is under Tension of the same value -

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Q # 02 (B)

**Given Data**

$L = 16 ft$

$I_x = 112.6 \, In^4$

$I_y = 18.7 \, In^4$

$\sigma_c = 12000 \, PSI$

$\sigma_t = 5000 \, psi$

Solution

By looking to the figure we can Judge that Maximum compression would occur on A & Maximum Tension at C at B there will be Tension as well compression

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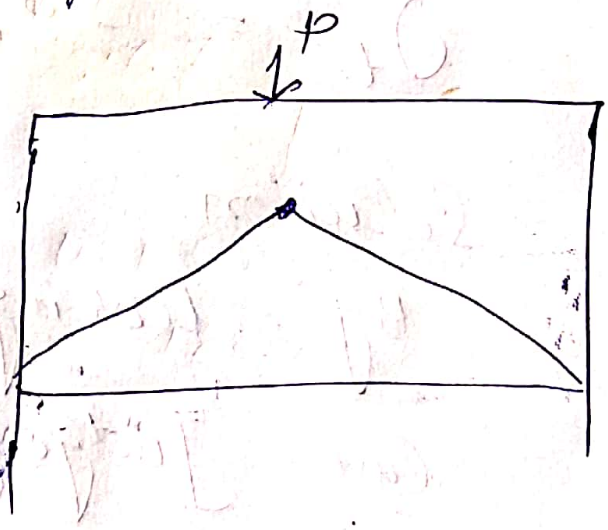
which will reduce that effects of each other so we will Calculate Stresses at A & C.

So

$$\sigma_A = \frac{M_x y}{I_x} + \frac{M_y x}{I_y} \text{ (comp)}$$

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

Now $M_x$ & $M_y$




So

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

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

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

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

Now

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

$$12000 = \frac{48 P \cos 60^\circ \times 3.07}{112.6} + \frac{48 P \sin 60^\circ \times 3}{18.7}$$

solving the equation

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

Now

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

$$5000 = \frac{48\, p \cos 60 \times (5.93)}{112.6} + \frac{48 \sin 60 \times 0.5}{18.7}$$

Slowing the equation

$$\boxed{p = 2104.9 \text{ lb}}$$

So the maximum load p applied should be 1638.6 lb.

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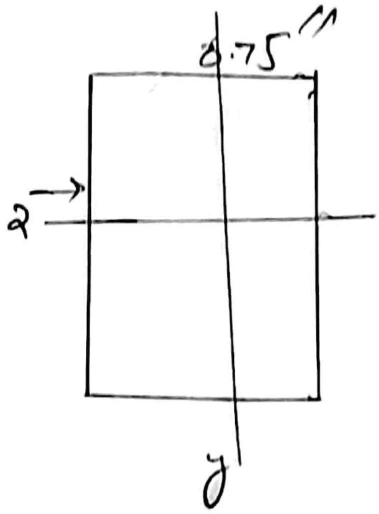
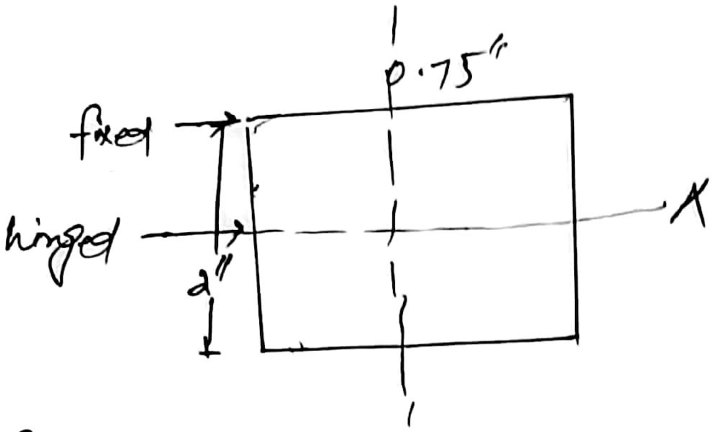
## Q # 3




## Given Data :-

Length, $L = 10 ft$

Breadth, $b = 0.75''$

height, $h = 2''$

factor of safety $= 2$

$E = 10.3 \times 10^6$

## Required Data

Safe load, $P_{safe} = ?$

**Solution :-** Case I

Strut column act as

hinged Column about an axis perpendicular to the 2 in dimension Then,

$$I = I_x = (3/4)(2)^3 = 0.5\ In^4$$

$L_e = L$ (for hinged ended column)

$\cancel{P_{cr} = (1)^2 (10.3 \times 10^6)(0.5)(3.1}$

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

$$\Rightarrow P_{cr} = \frac{(1)^2 (10.3 \times 10^6)(0.5)(3.14)^2}{(10 \times 12)^2}$$

$$\boxed{\Rightarrow P_{cr} = 3526.17}$$

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

$$P_{safe} = \frac{3526.17}{2}$$

$$\boxed{P_{safe} = 1763.08}$$

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Case II

column act as a fixed end about axis parallel to 2in i.e y-axis

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

$$I_y = 0.07\ In^4$$

Now for fixed ended $le = L/2$

$$P_{cr} = \frac{(1)^2 (10.3 \times 10^6)(0.07)(3.14)^2}{120/2}$$

$$P_{cr} = 1974.65\ lb$$

For $P_{safe}$

$$P_{safe} = \frac{P_{cr}}{\text{Factor of safety}}$$

$$P_{safe} = \frac{1974.65}{2}$$

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$P_{safe} = 987.32\ lb$

In both cases we take smaller value of safe -

$$\boxed{P_{safe} = 987.32 < 1763.07}$$