1

NAME ZARAK REHMAN

SECTION "C"

ID # 7666

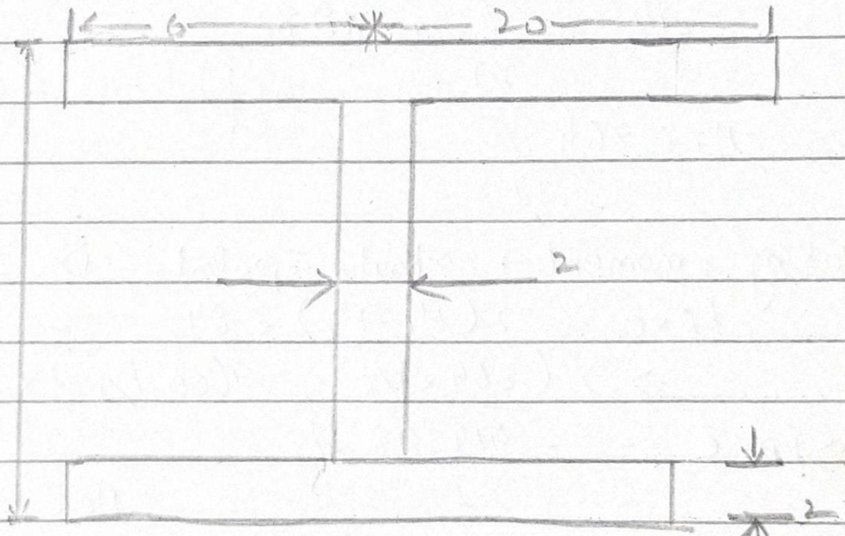
SUBJECT MACHENICS OF SOLID 2

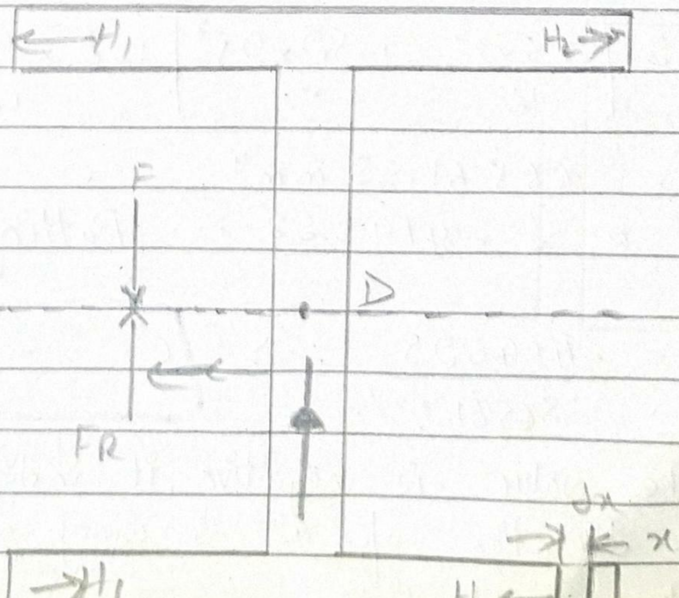
SIR ENG MUHAMMAD SAQIB

uestion # 1 (a)

Determine the location of the shear centre for the beam's having the cross sectional dimension's shown in the the figure 1. All member's are to be considered thin walled and calculation should be based on the center line dimension.

Given data :-





$$H_2 = \int q_1 \, dA = \int \frac{F A\bar{y}}{I.t} \, dA$$

$$\Rightarrow \frac{F}{I.t} \int A\bar{y} \, dA$$

$$\Rightarrow \frac{F}{I.t} \int_0^{20} 2(20-x) \times (24 \times 2) \, dx$$

$$\Rightarrow \frac{F}{I \times 2} \left[19200 \right]$$

$$\Rightarrow 9600 \frac{F}{I}$$

$$H_1 = \frac{F}{2I} \int_0^{6} 2(6-x) \times 24 \times 2 \, dx$$

$$H_1 = \frac{F}{2I} \times 1728$$

$$H_1 = 864 \frac{F}{I}$$

Taking moment about point D

$$F_R \times e = 2(H_1 - H_2) \times 24$$

$$\Rightarrow 2\left(864 \times F/I - 9600 . F/I\right) \times 24$$

$$\Rightarrow F_R e = -\frac{419328}{I} F$$

Here $F_R = F$

$$\Rightarrow e = -\frac{419328}{I} \quad \text{— (A)}$$

$$I = 2\left[\frac{26 \times 2^3}{12} + 52 \times 25^2\right] + \frac{2 \times 46^3}{12}$$

$$I = 86561.33 \text{ mm}^4$$

$$\Rightarrow e = -\frac{419328}{I}$$ Putting value

$$e = -\frac{419328}{86561.33} \Rightarrow \boxed{e = -4.84 \text{ mm}}$$

As the value is negative, it indicates that our assume direction of e is wrong and it is 4.84 mm to the right side.

est 1(b)

Determine the thickness of the wall of a water tank counstructed from steel plates filled to a height of 26ft, the circumferential stress is limited to 6000 psi the specific weight of water is 62.4 lb/ft3

Given data:-

$h = 26ft$

$\sigma_t \Rightarrow 6000$ psi

$\gamma_w \Rightarrow 62.4\ lb/ft^3 \Rightarrow 0.36\ lb/in^3$

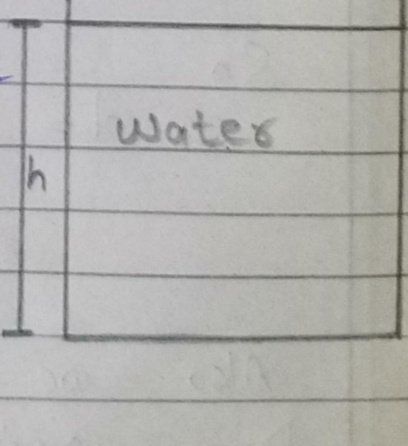
$*\ \Rightarrow 26ft$ converting in to inch

$h = 312$ inch

Req:-

~~thinckk~~ thickness = t = ?

As we know that



$P = \gamma h$ (for water)

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

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

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

Putting value's

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

$$\boxed{\Rightarrow t = 9.38 \times 10^{-4} \; D} \quad \text{—— (i)}$$

Since D is not given in the Question, So t depends on D

for different value's of D we would have different values of t

eg let take's

$D = 30$ ft

$\Rightarrow 30 \times 12$
$\Rightarrow 360$ inch

So

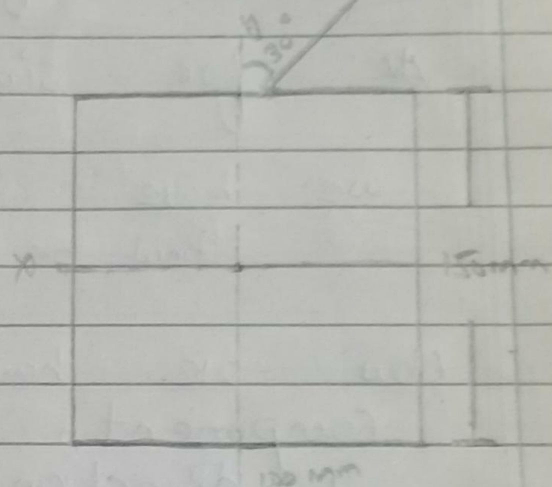
$t = 9.38 \times 10^{-4} \times 360$

$= 0.337$ in

Also we can take any value of D and consequently calculate t.

Question # 2 (a)

The 100 by 150 mm wooden beam shown in figure 2 is used to support a uniformly distributed load of 4KN on a simply span of 3m _ _ _ _ _ _ the beam



Given data:-

$$w = 4\ KN/m$$
$$L = 3\ m$$

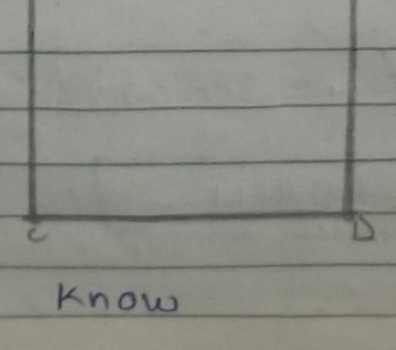
Required:-

Maximum bending stress = ?

Solution:-

As the bending moment is maximum at extremes. So we would find stress at

A, B, C, and D (as shown)



As we know

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

we have to find M_x & M_y

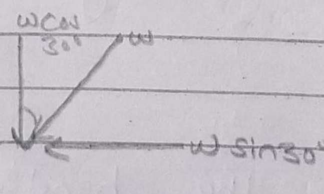
As per Question the M_x and M_y should be found at the mid

As for simply supported

we have

$$M_{mid} = \frac{wl^2}{8} \quad \text{——— (1)}$$

Now we have to find the component's of w in x and y direction's



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

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

$\boxed{M_x = 3.9 \text{ KN-m}}$

Now

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

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

M_x is causing compression at A and B tension at C and D

Now I_x and I_y

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

Putting value

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

$$\boxed{I_x = 2.815 \times 10^{-5} m^4}$$

$$I_y = \frac{hb^3}{12}$$

Putting values

$$\Rightarrow \frac{0.15 \times 0.13}{12} \Rightarrow 1.25 \times 10^{-5} m^4$$

$$\boxed{I_y = 1.25 \times 10^{-5} m^4}$$

Now stress at extremme fibers

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

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

$$\sigma_y = \frac{2.25 \times 0.05}{1.25 \times 10^{-5}}$$

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

Now (taking tension +↑)

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

$$= -10390.7 + 9000$$

$$= -1390.7 \text{ kN/m}^2 \text{ (Comp)}$$

$$\text{at } B \Rightarrow \frac{M_x y}{I_x} + \frac{M_y x}{I_y}$$

$$\Rightarrow -10.3907 - 9000$$

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

Now

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

$$\Rightarrow 10390.7 + 9000$$

$$\Rightarrow 19390.7 \text{ kN/m (Tension)}$$

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

$$\Rightarrow 10390.7 - 9000$$

$$1390.7 \text{ kN/m}^2 \text{ (tension)}$$

~~So at D~~ $\cancel{M_x y}$ $\cancel{+ M_y x}$

So the maximum stresses are on B and C.

B is under compression of $19390.7\ KN/m^2$ and C is under tension of the same value.

Question 2(b):-

The T Section in figure 3 is the cross section of a simply supported a Uniformly ---------- the beam?

Given data:-

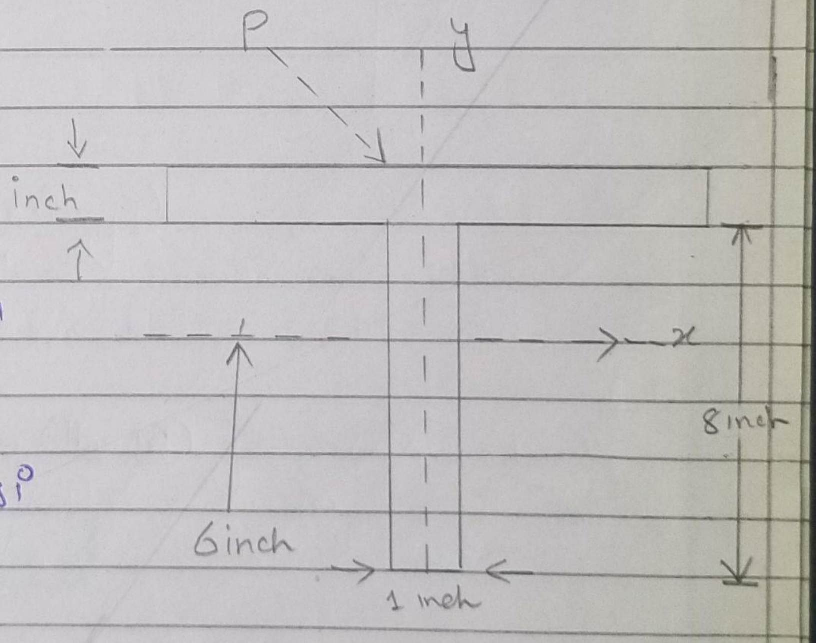
$L = 16\ ft$

$I_x = 112.6\ in^4$

$I_y = 18.7\ in^4$

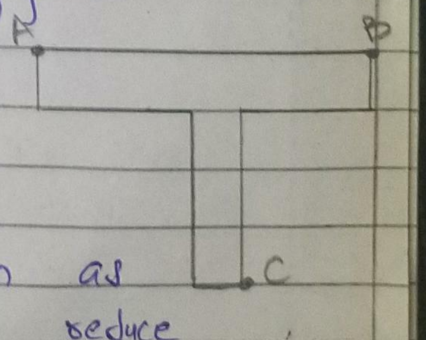
$\sigma_c = 12000\ psi$

$\sigma_t = 5000\ psi$



Sol:-

By looking to the figure we can judge that maximum compression would occur on A and maximum tension at C at B there will be tension as well as compression, which will reduce the effect of each other So we will



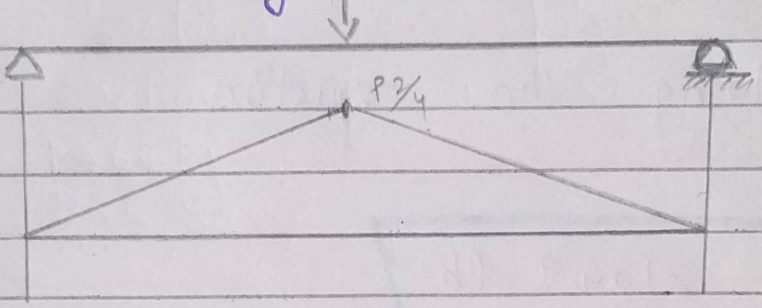
Calculate stress at A and C

So

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

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

Now M_x and M_y



So

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

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

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

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

Now

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

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

Solving the equation

Questio

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

Now

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

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

Solving the equation.

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

So the maximum load P applied should be 1638.6 lb.

Question 3 :-

A 10ft long strut based in the middle has a rectangular section of 0.75 in by 2 in. A bolt through — — — — $E = 10.3 \times 10^6$

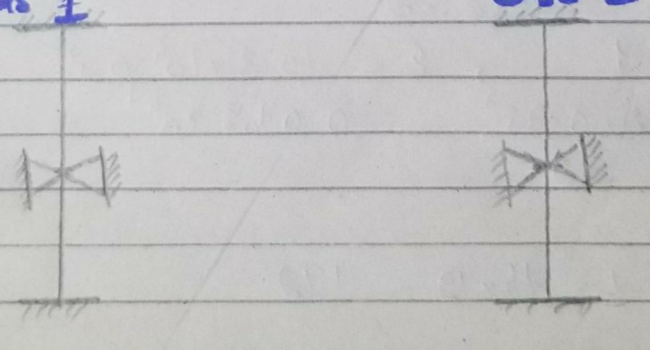
* **Given data:-**

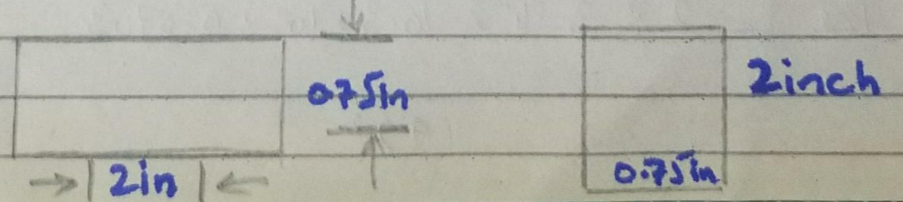
$L = 10$ ft
$E = 10.3 \times 10^6$

Sol:-

According to the given data and condition of the supports it is not clear that in which direction the column will buckle. So we will analyse both cases.

Cas 1 **Case 2**





For Cas I

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

Here for Cas. I

$n = 2$, $E = 10.3 \times 10^6$ psi

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

$I = 0.5 \text{ in}^4$

$Le = 0.5L \Rightarrow 0.5 \times 16 \times 12$

$\Rightarrow 96$ ft

$$\Rightarrow P_{cr} = \frac{2 \times 3.14^2 \times 10.3 \times 10^6 \times 0.5}{96^2}$$

$$\boxed{P_{cr} = 11019.3 \text{ lbs} = 11.01 \text{ kip}}$$

Now for case-2

$n = 1$, $E = 10.3 \times 10^6$ psi

$I = \frac{2 \times 0.75^3}{12} = 0.0703 \text{ in}^4$

$Le = L = 16 \times 12 = 192$

$$\Rightarrow P_{cr} = \frac{2 \times 3.14^2 \times 10.3 \times 10^6 \times 0.0703}{192^2}$$

$$\boxed{P_{cr} = 387.8 \text{ lbs} = 0.387 \text{ kips}}$$

So

$$\boxed{\text{Safe load} = \frac{0.387}{2} = 0.2 \text{ kip}}$$