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Section = B

Paper = MOS II

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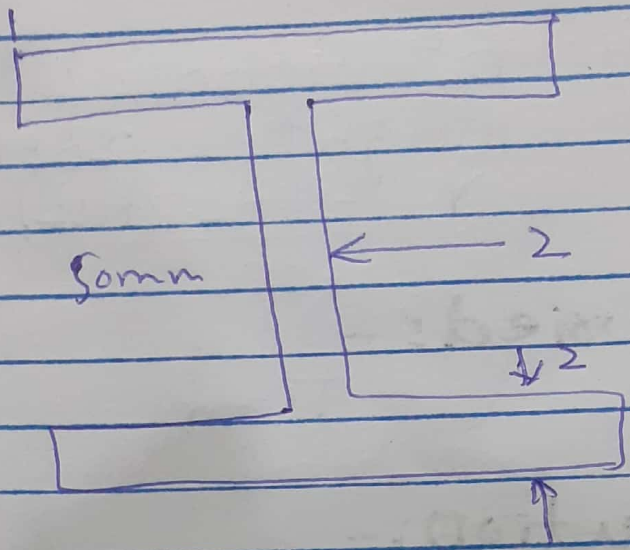
Question 1:-

Part A:-



Required location of Shear center.

Solution

As we know

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

and

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

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

$$I = 50034.66 + 20833$$

$$I = 70867.99\,mm^4$$

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

$$\boxed{= 11.02mm}$$

So shear center $e = 11.02mm$

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Question 1:-

Part = B:-

Given:-

$\sigma^t = 6000 psi$
height = 26ft
$\gamma = 62.41 lb/ft^3$

Required:-

$T = ?$

Solution:-

As we know that

$P = \gamma h$

$\sigma^t = \frac{PD}{2t}$

$t = \frac{PD}{2\sigma^t}$

$t = \frac{62.41 \times 26 \times 22}{2 \times 6000}$

$\boxed{t = 2.974}$ ft

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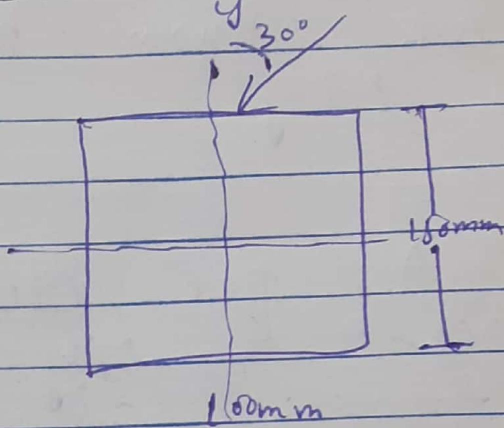
Question # 2 :-

Part = A :-

Given data :-

$w = 4 KN/m$

$L = 3m$

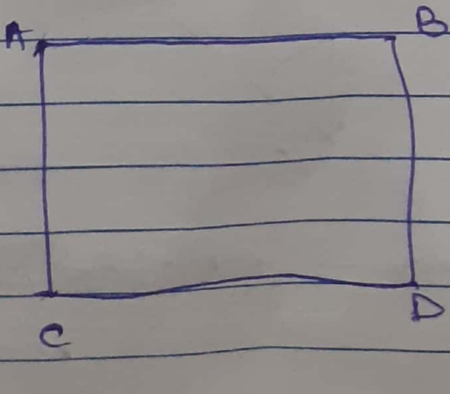


Required :-

Maximum Bending Stress = ?

Solution :-

As the bending moment is maximum at extremes. So we would find stresses at, A, B, C & D (as shown).



As we know

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

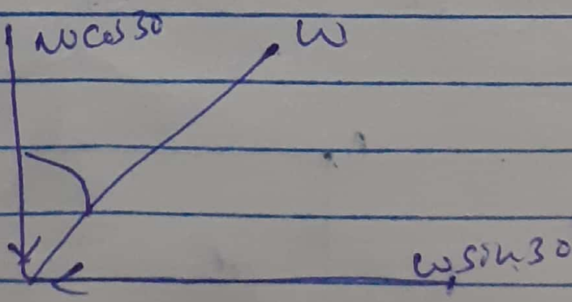
we know to find M_x & M_y

As per Question the Max & My should be found at the mid-

As for simply supported we have

$$M_{mid} = \frac{wl^2}{8} \quad -①$$

Now we have to find the components of w in x & y direction.



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

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

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

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 & B & tension at C & D.

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

Now ~~Ex~~

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.

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

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

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

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

Now (Taking tension +ve).

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

$$= -10390.7 + 9000$$

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

at B =

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

$$= -10390.7 - 9000$$

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

Now

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

$= 10390.7 + 9000$

$= 19390.7 \ \frac{KN}{m^2}$ (Tension).

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

$= 10390.7 - 9000$

$= 1390.7 \ \frac{KN}{m^2}$ (Tension)

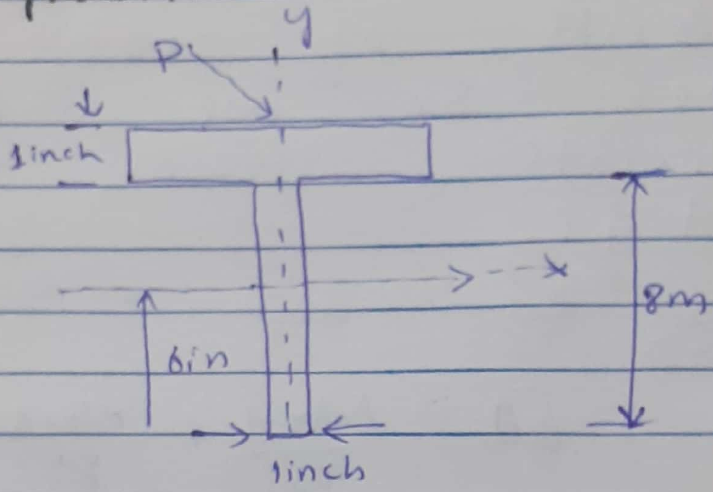
So the maximum stresses are on B & C.

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

Question = 2:-

Part = B:-

Given:-



$L = 16ft.$

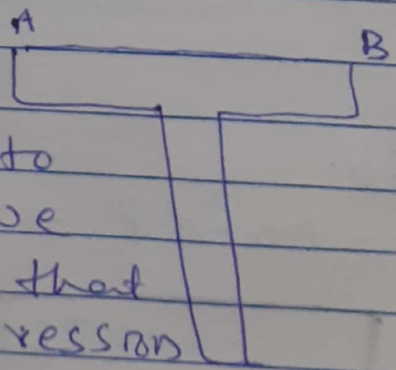
$I_x = 112.6 in^4$

$I_y = 18.7 in^4$

$\sigma_c = 12000\ psi$

$\sigma_t = 5000\ psi$

Solution:-



By looking to the figure we can judge that maximom compressson would occur on A

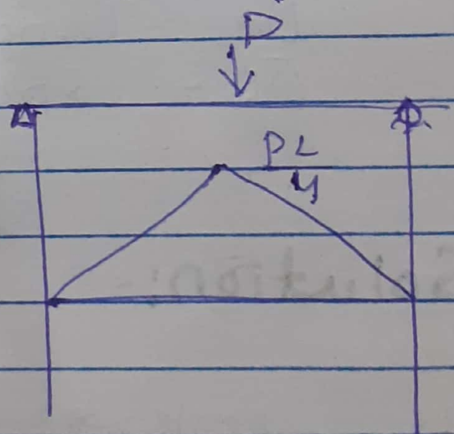
& maximum tension ~~at~~
at C at B there will
be tension as well
as compression, which
will reduce that
effects of each ~~occur~~
other So we will
calculate stresses at
A & C

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

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

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

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

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

Now

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

$$\Rightarrow 1200 = \frac{48 P \cos 60^\circ \times 3.07}{112.6} + \frac{48 P \sin 60^\circ \times 3}{18.7}$$

Solving the equation

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

Now

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

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

Solving the equation

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

So the maximum load P applied should be 1638.6 lb..

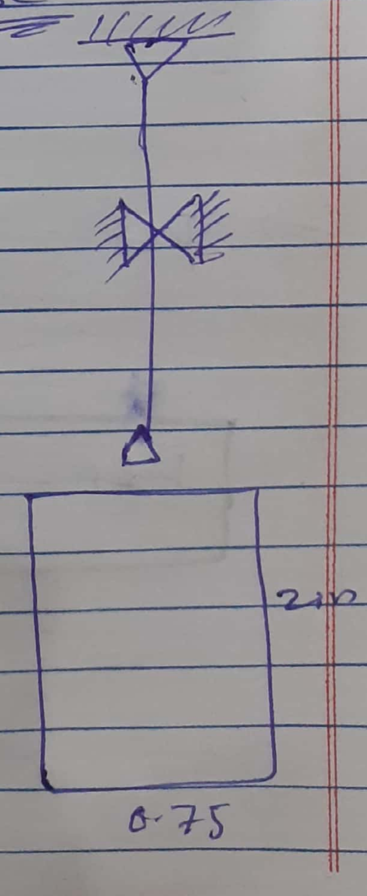
Question = 3 :-

L = 10 ft

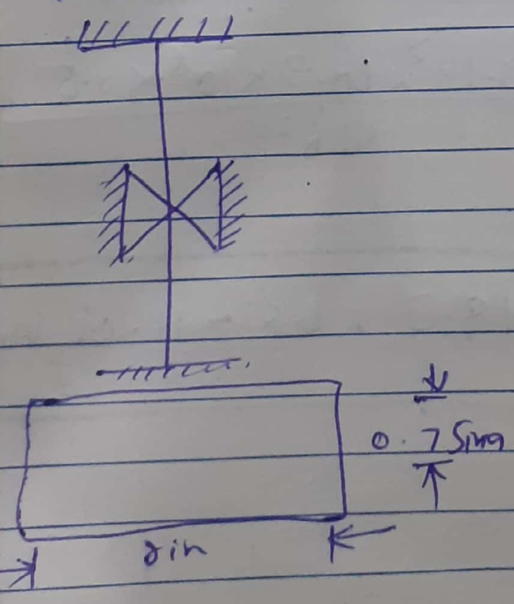
Sol :-

According to the given data as conditions of the supports it is not clear that it which direction, the column will buckle so we will Analyse both cases.

Case = 2



Case = 1



for

Case -1 :-

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

Here for case -I

$n = 2$, $E = 10.3\times10^6$ psi

$$I = \frac{0.75\times2^3}{12} = 0.5 \text{ in}^4$$

$Le = 0.5L = 0.5\times16\times12$

$= 96$ft.

$$\Rightarrow P_{cr} = \frac{2\times3.14^2\times10.3\times10^6\times0.5}{96^2}$$

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

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for

Case = 2 :-

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

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

i-e $= L = 16 \times 12 = 192$.

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

$\Rightarrow \boxed{P_{cr} = 387.8 \ Lbs = 0.387 \ kips}$

So

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