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Section "B"

fourth semester

Sub : MOS II

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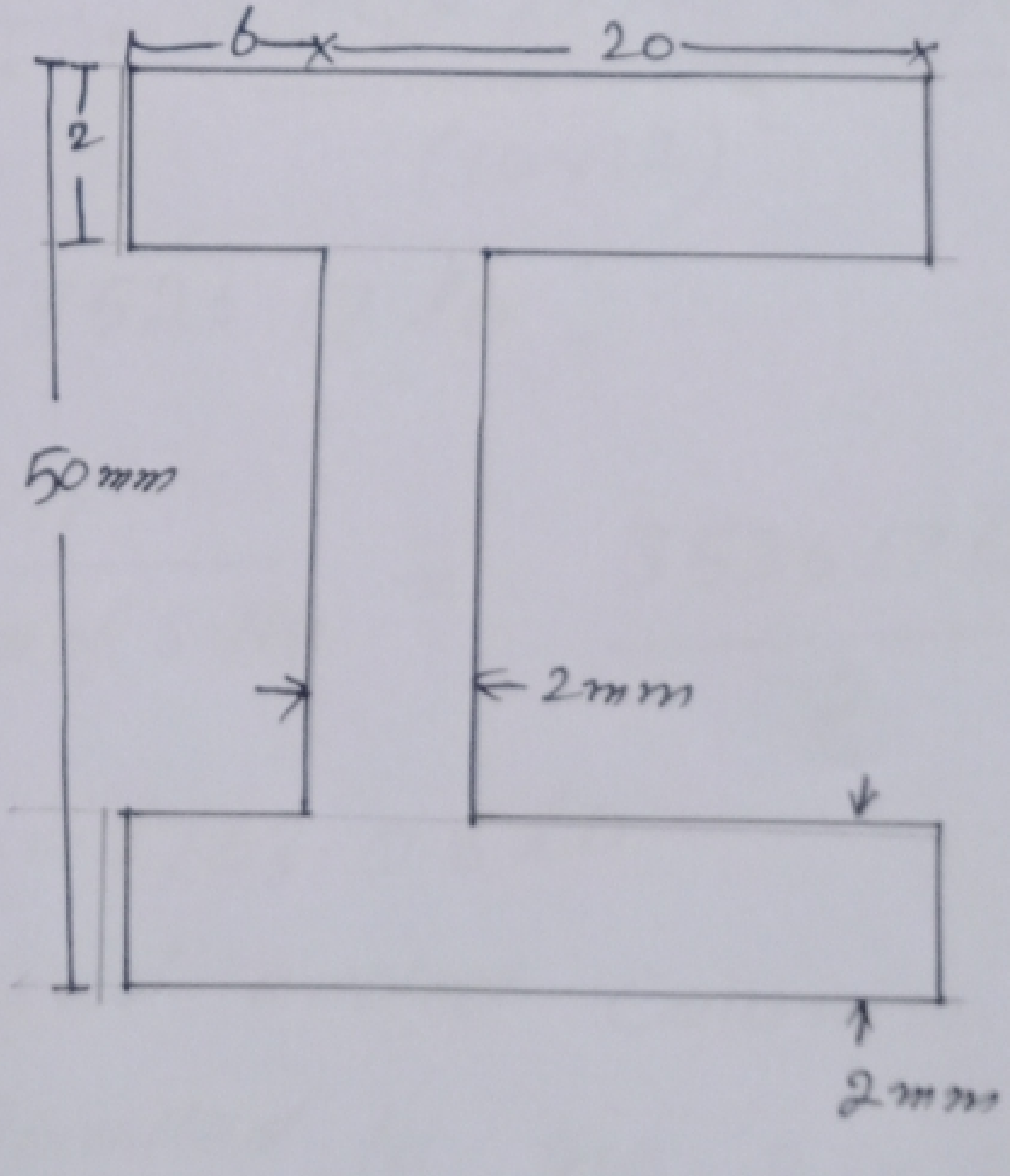
: Final term Paper :

Q No # 01 Part (a)

Determine the location of the shear center for the Beam having cross-sectional dimension shown in the figure. All members are to be considered thin walled and the calculation should be center line dimensions.



Solution :→

First of All we find the moment of inertia of the section.

Case I

Column act as a hinged column about an axis perpindiculer to the 2in dimension Then

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

$Le = L$ for Hinged Ended Beam.

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

$$P_{cr} = 3526.17\ lb$$

$$P_{safe} = \frac{P_{cr}}{\text{factor of safty}} = \frac{3526.17\ lb}{2}$$

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

Case II a fixed ended column about axis parralled to the 2 in dimension so it means that perpindiculer to 0.75 in dimension.

Q No # I Part (b)

Determine the Thickness of the wall of a water tank constructed from steel plate filled to a haight of 26ft the circumferential stress is limited to 6000 psi if the specific weight of water is $62.4\ lb/ft^3$.

Solution :-

Given Data.

$$\sigma_t = 6000\ psi$$

$$\Rightarrow \frac{6000\,lb}{in^2}\left(\frac{12\,in}{ft}\right)$$

So $\sigma_t = 864000\ lb/ft^2$

Daimeter is $\Rightarrow 22ft$

$$h = 26ft$$

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

Required thickness $\Rightarrow$?

We have formula.

$$\sigma_t = \frac{\gamma h D}{2t} \quad \text{——— (1)}$$

$$\sigma t = \frac{\gamma h D}{2t} \quad \text{——— (1)}$$

By cross Multiplication.

$$2t * \sigma t = \gamma h D$$

& $$t = \frac{\gamma h D}{2\sigma t}$$

Putting values.

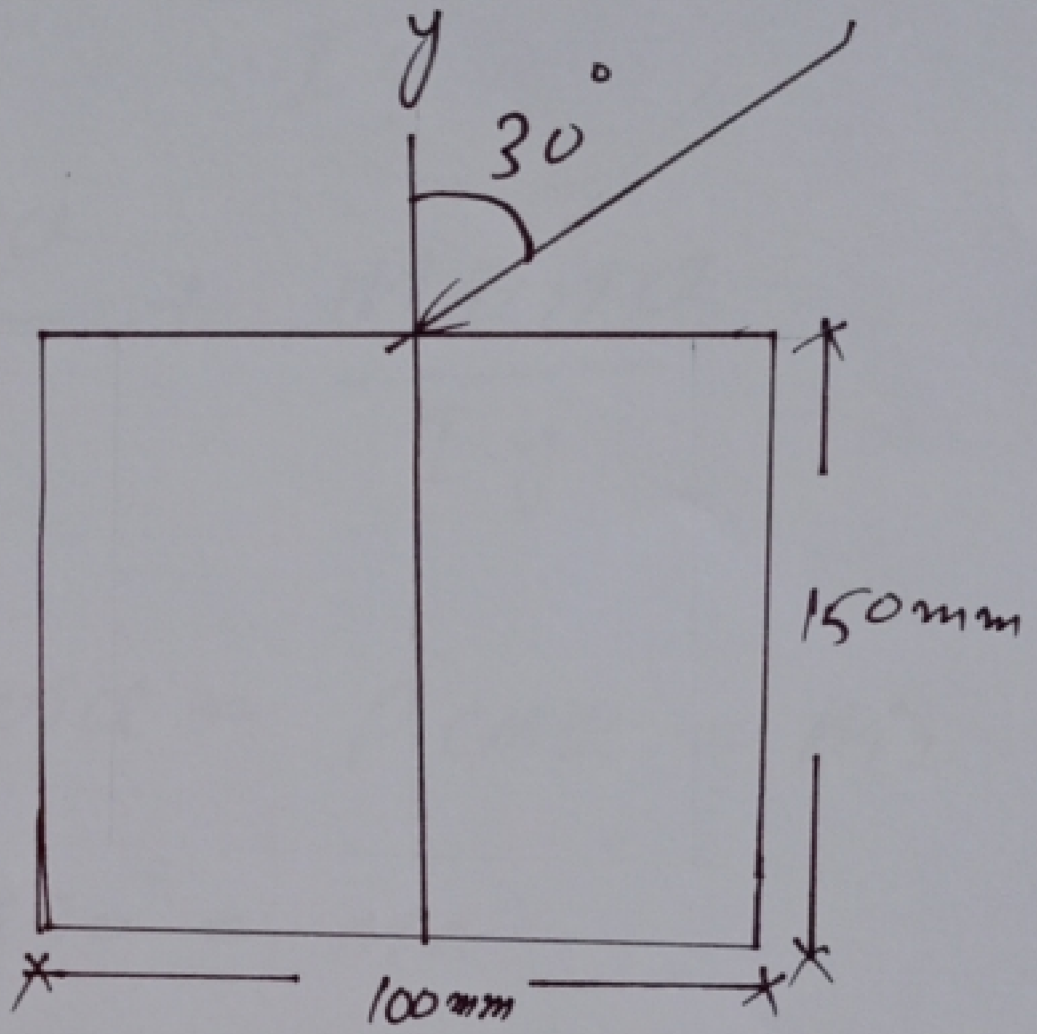
$$t = \frac{(62.4)(26)(22)}{2(864000)}$$

$$t = 0.20655 ft \Rightarrow 0.20655 \times 12$$

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

Q No#2 Part (a)

Solution :->



Moment of inertia

$$I_x = \frac{bh^3}{12} = \frac{0.1(0.15)^3}{12} = 2.8125\times10^{-5}$$

$$I_x = 2.8125\times10^{-5}$$

Now we find Inertia along y-axis.

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

$$\boxed{I_y = 1.25\times10^{-5}}$$

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

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

where

$$M = \cos\alpha = P\cos\alpha = M_z$$

$$= 12\cos 30^\circ = M_z$$

$$M_z = 10.8510$$

$$M\sin\alpha = P\sin\alpha = M_y$$

$$M_y = 12\sin 30$$

$$\boxed{M_y = -11.8563}$$

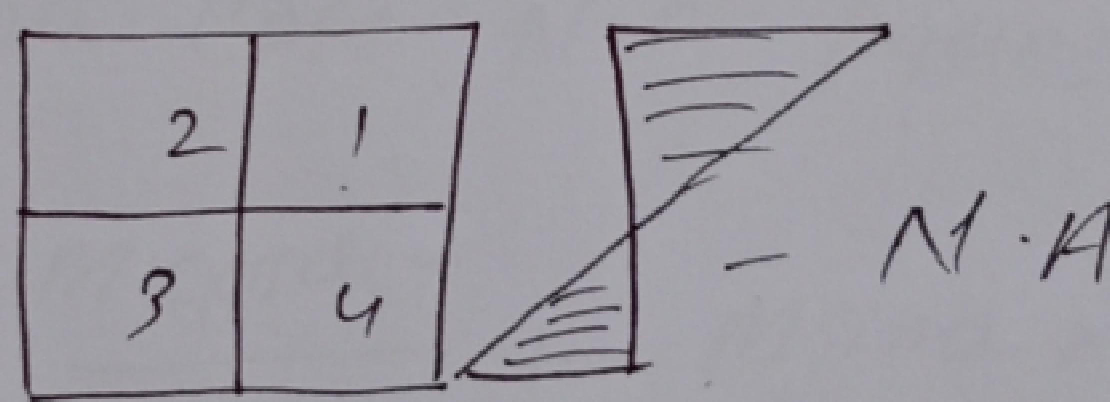
$$\sigma = \frac{1.851}{2.812\times10^{-5}} + \left(\frac{11.8563}{1.25\times10^{-5}}\right)$$

$$\sigma = 882628\ N/m^2$$

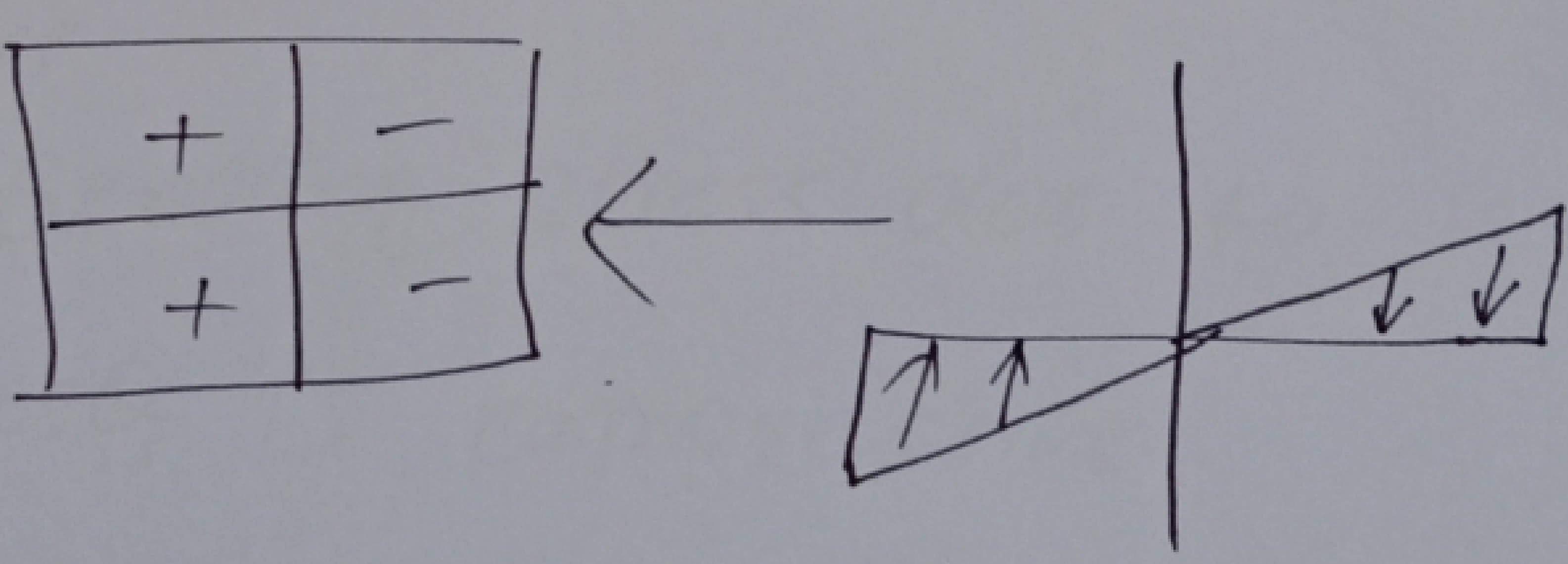
Singn Conversion

2	1
3	4

if we take compression as Negative and tension and the Beam is a simply supported.



Quardant 1, 2, -ve
Quadrant 3, 4, +ve



in case of unsymmetrical loading The Neutral axis lies of an angle of α, The principle axis and the algebric sum of stresses at N.A. is zero.

$$\sigma = \frac{M\cos\alpha \, y}{I_z} + \frac{M\sin\alpha \, z}{I_y} \quad \text{--- (1)}$$

In This Case N.A passes through 2, 4

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

Let consider in point (A) on N.A lies in Quadrant (2) where

$\Rightarrow$ Bending stress due to $P\cos\theta$ is compressive.

$\Rightarrow$ Bending stress due to psinα is Tensile.

$$eq(1) \Rightarrow 0 = -\frac{M\cos\alpha\, y}{I_z} + \frac{M\sin\alpha}{I_y} z_A$$

$$0 = -\frac{M\cos\alpha\, y_A}{I_z} + \frac{M\sin\alpha}{I_y} z_y$$

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

$$\frac{y_A}{z_A} = \frac{I_z}{I_y} \frac{\sin\alpha}{\cos\alpha} \Rightarrow$$

$$\Rightarrow \tan\phi = \frac{I_z}{I_y} \tan\alpha$$

Now put values of I_z, I_y an α in the equation

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

$$\tan \delta = \frac{2.8125 \times 10^{-5}}{1.25 \times 10^{-5}} \tan 30^\circ$$

$$\tan \delta = -14.1429$$

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

$$\boxed{\delta = 1^\circ 30' 5''}$$

Q No# 2 Part (b)

T-section show in the figure is the cross-section. of simply supported Beam 16ft long that carries a central concentrated load inclined 60° degree left to the y-axis the centroid is 3.07 in below from top of the section $I_x = 112.6\ in^4$ and $I_y = 18.7\ in^4$ If compressive stress is limited to 12000 psi and tensile is 5000 psi. What is the maximum load that will not overstress the Beam?

Solution:→

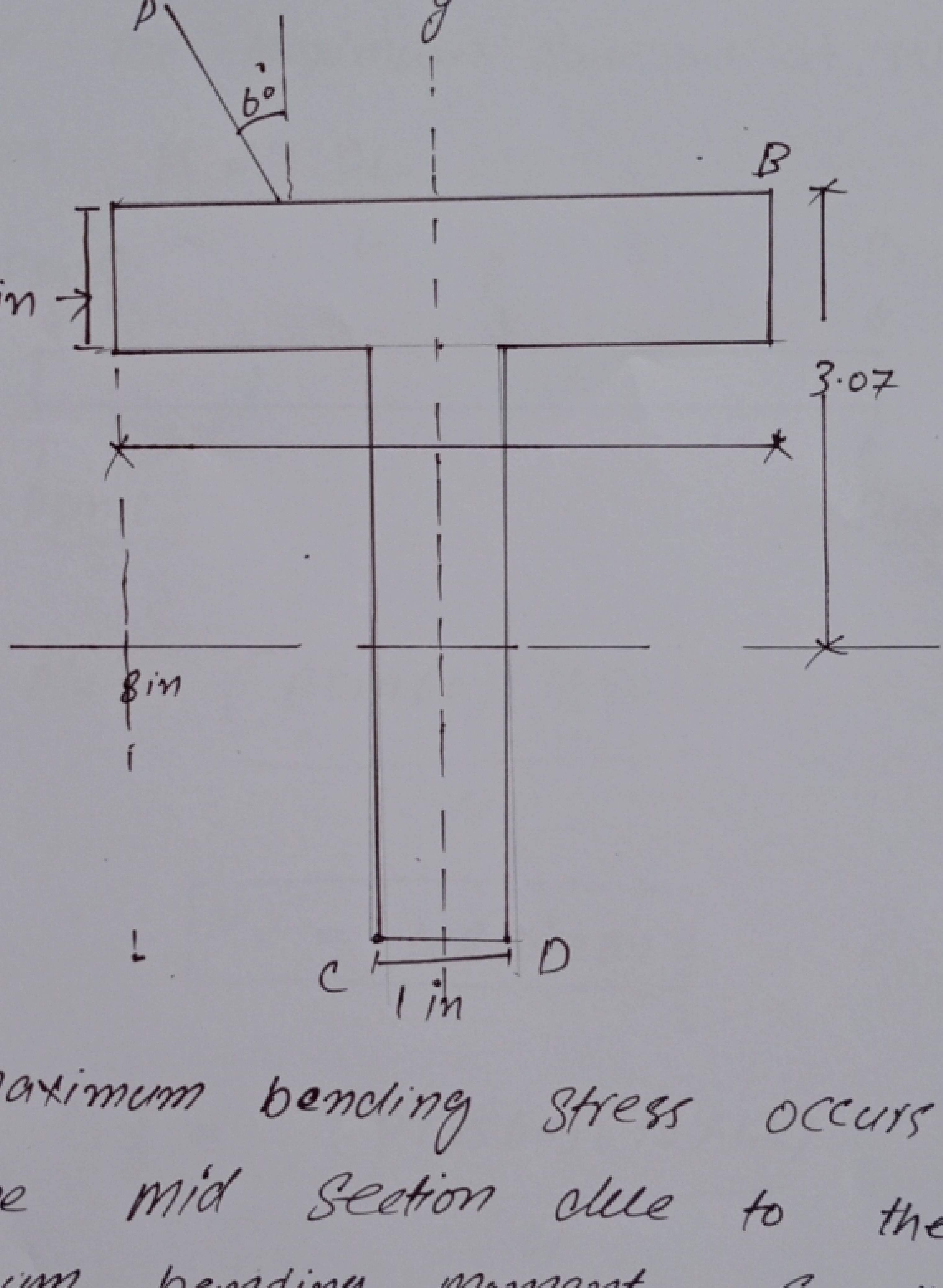
$$\text{Length} = L = 16\,ft$$

$$I_x = 112.6\ in^4$$

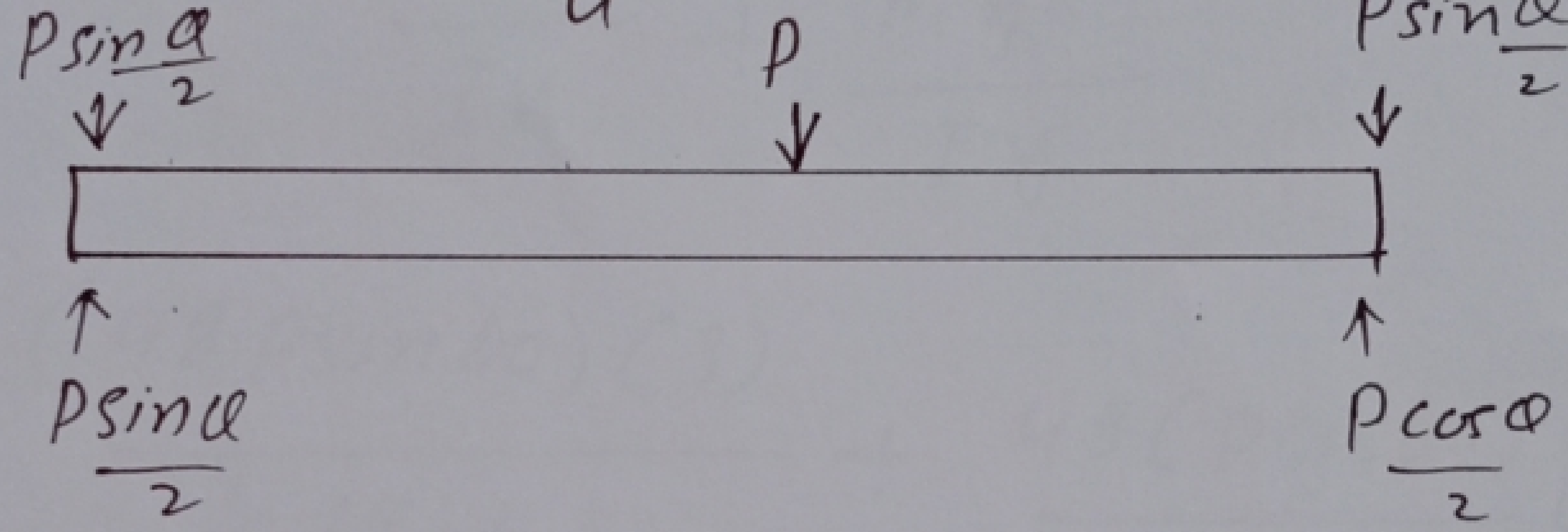
$$I_y = 18.7\ in^4$$

$$\sigma_c = 12000\ psi$$

$$\sigma_t = 5000\ psi$$



The maximum bending stress occurs at the mid section due to the maximum bending moment, So the Critical Section is the mid section where the Compressive and tensile stresses can enceed the limiting values, For the Maximum Moment at Mid Section $M = \frac{PL}{4}$



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

$$\boxed{M_x = 48 \sin 60}$$

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

$$\boxed{M_y = 48 \cos 60}$$

Stress at A, B, C, D

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

$$= -\frac{(48 P\sin 60)(3)}{18.7} + \frac{48(P\cos 60)}{112.6}(3.07)$$

$$\sigma = -6.6P + 0.654P = -6.01P$$

$\because$ Compression ≤ 12000 psi

So $12000 = 6.01P$

$$P = \frac{12000}{6.01}$$

$$\boxed{P = 1996.66}$$

at (B)

$$\sigma = \frac{-48P\cos(3.07)}{112.6} + \frac{(48P\sin 60)3}{18.7}$$

$$\sigma = 6.01P \text{ Tension}$$

So Tension $\leq$ 5000 psi

$$5000 = 6.01P$$

$$P = \frac{5000}{6.01}$$

$$P = 831.9 \text{ lb}$$

So $P = 1996.6 > 831$

P value check for Point C & D

Also take the Maximum.

Q NO #03:

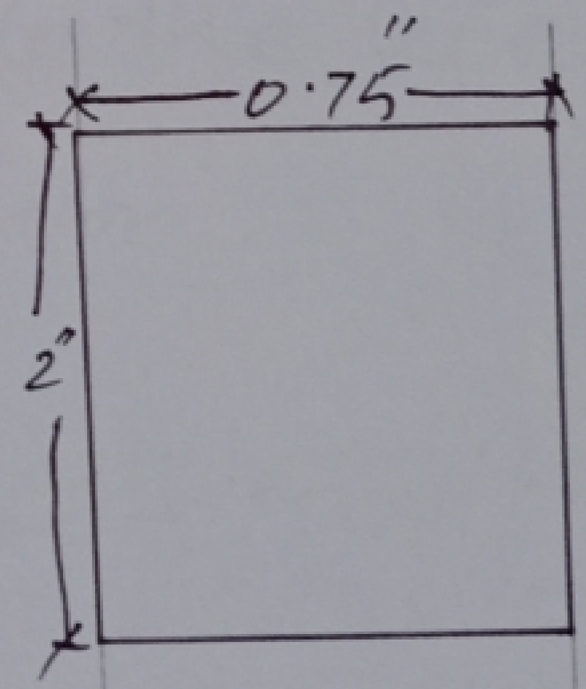
A 10ft long strut braced in the midde has a Rectanguler section 0.75x2in. A bolt through each end secures the strut so that it acts as a hinged Column about the axis Perpindiculer to the 2in dimension. And a fixed ended Column about axis parrallel to the 2in dimension. Determine the Safe load P about using factor of Safty is 2 and $E = 10.3 \times 10^6$.

Solution :- Given:

length = 10ft

Dimension = $0.75 \times 2''$

factor of Safty = 2



So moment of inertia as:

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

$$I = 2(32517.33) + (20833)$$

$$I = 85867.9\,mm^4$$

We have formula for e as:

$$e = \frac{t_f h^2 b^2}{4I} = \frac{2(50)^2(26)^2}{4(85867.33)}$$

$$\boxed{e = 9.84mm}$$

Hence $e = 9.84$ mm to the lefe of the cross-section.

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

$$l_e = \frac{L}{2}\ \text{(for fixed Ended column)}$$

$$P_{cr} = \frac{n^2 E \pi^2}{l_e^2} = \frac{(1)^2(10.3\times10^6)(0.07)(\pi)^2}{\left(\frac{10\times12}{2}\right)^2}$$

$$P_{cr} = 1974.6\,lb$$

$$P_{safe} = \frac{P_{cr}}{\text{factor of safty}} = \frac{1974.6}{2}$$

$$P_{safe} = 987.32\ lb$$

in both cases take the smaller value of P_{safe}.

$$\boxed{P_{safe} = 987.32 < 1763.08}$$