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Section "B"

fourth semester

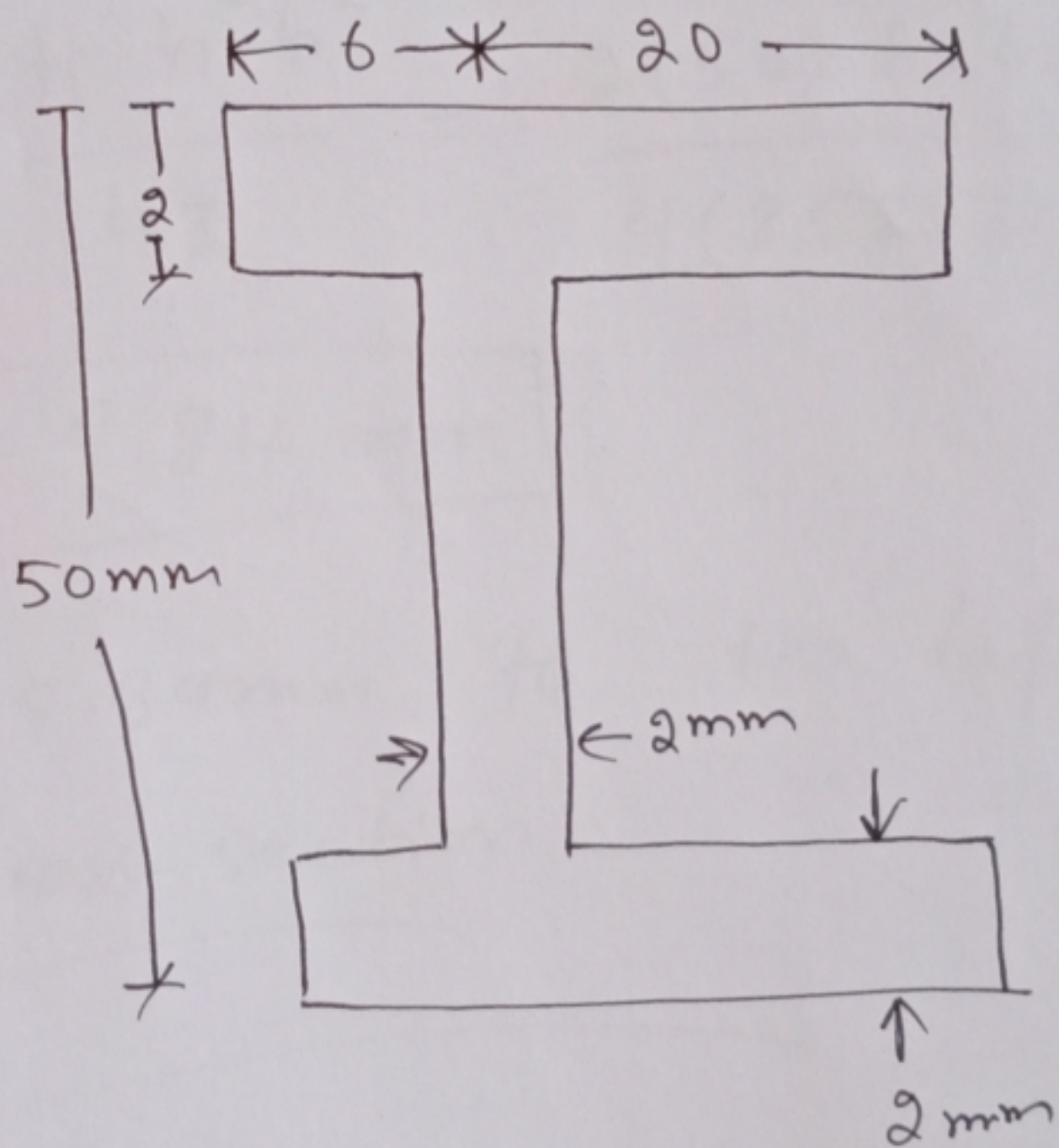
Sub : MOS II

Instructor : SIR MUHAMMAD
SAQIB

✓ 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 \Rightarrow

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

So Moment ⁽²⁾ of Inertia as.

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

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

$$I = 85867.66 \text{ mm}^4$$

We have formula for e as:

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

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

Hence $e = 9.84 \text{ mm}$ to the left
of the cross-section.

①

QNO #01 part (b)

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

Solution: \rightarrow

Given data.

$$\sigma_t = 6000 \text{ Psi}$$

$$\Rightarrow \frac{6000 \text{ lb}}{\text{in}^2} \left[\frac{12 \text{ in}}{\text{ft}} \right]^2$$

$$\text{So } \sigma_t = 864000 \text{ lb/ft}^2$$

$$\text{Diameter is } \Rightarrow 22 \text{ ft}$$

$$h = 26 \text{ ft}$$

$$\text{Specific weight of water} = 62.4 \text{ lb/ft}^3$$

Required thickness \Rightarrow ? ⁽²⁾

We have have formula.

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

By cross multiplication.

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

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

Putting values.

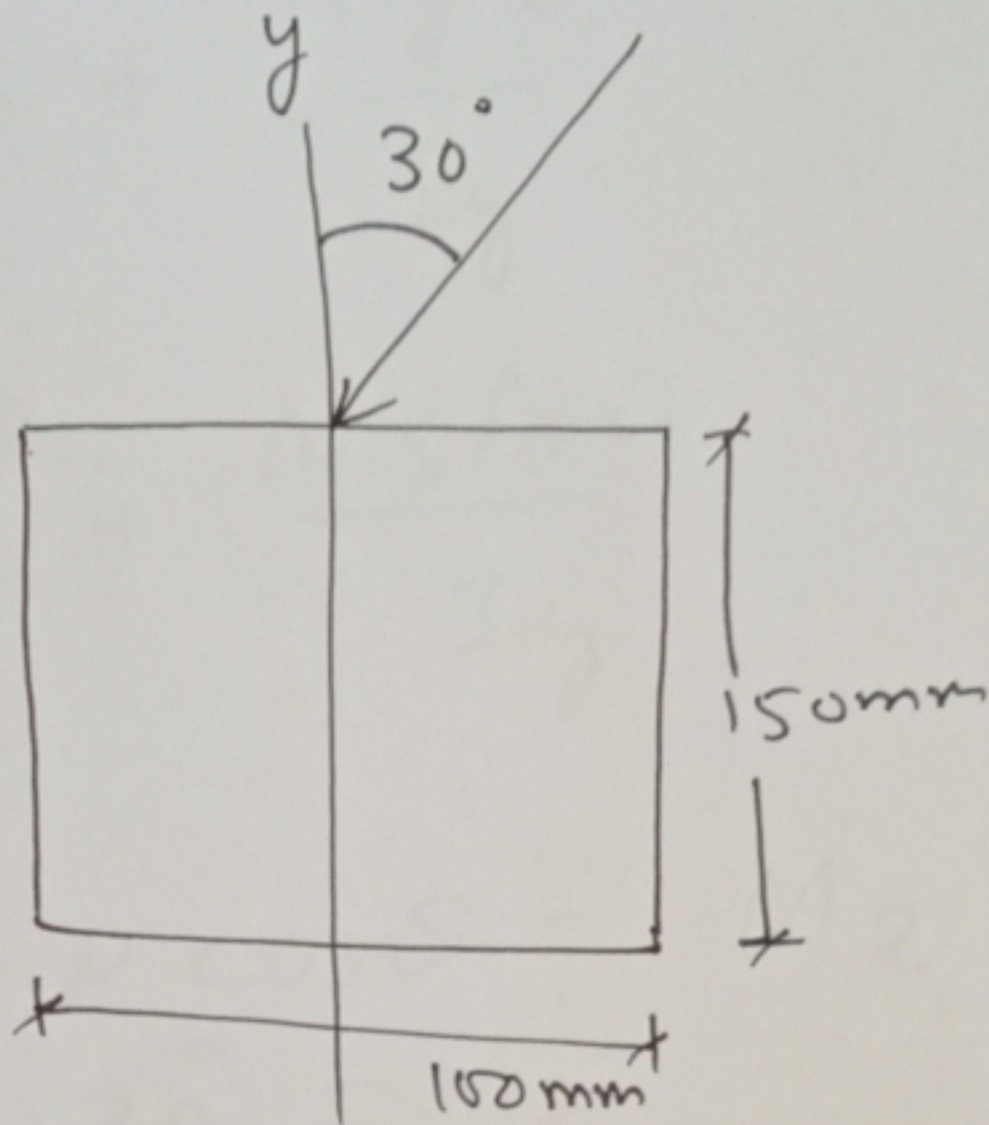
$$t = \frac{(62.4)(26)(22)}{2(864000)}$$

$$t = 0.20655 \text{ ft} \Rightarrow 0.20655 \times 12$$

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

① Q No # 2 part (a)

Solution: →



Moment of Inertia

$$I_x = \frac{bh^3}{12} = \frac{0.1(0.15)^3}{12} = 2.8125 \times 10^{-5}$$

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

Now we find Inertia along y-axis.

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

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

(2)

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

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

where

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

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

$$M_z = 10.8510$$

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

$$M_y = 12 \sin 30^\circ$$

$$M_y = -11.8563$$

$$\sigma = \frac{1.851}{2.812 \times 10^{-5}} + \left(\frac{-11.8563}{1.25 \times 10^{-5}} \right)$$

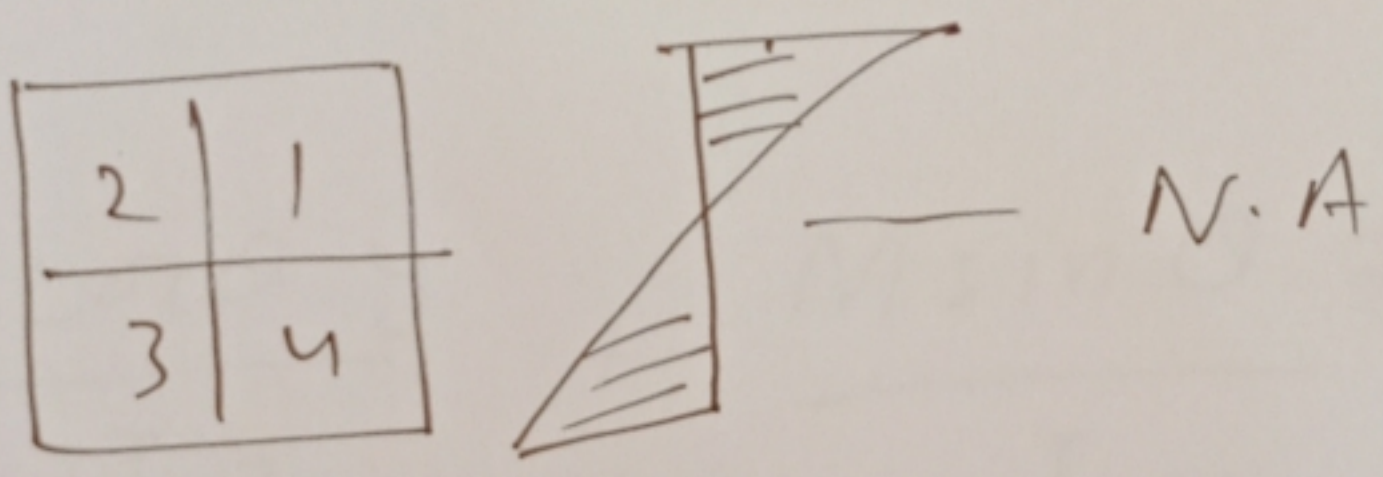
$$\sigma = 882628 \text{ N/m}^2$$

3

Singn Convension

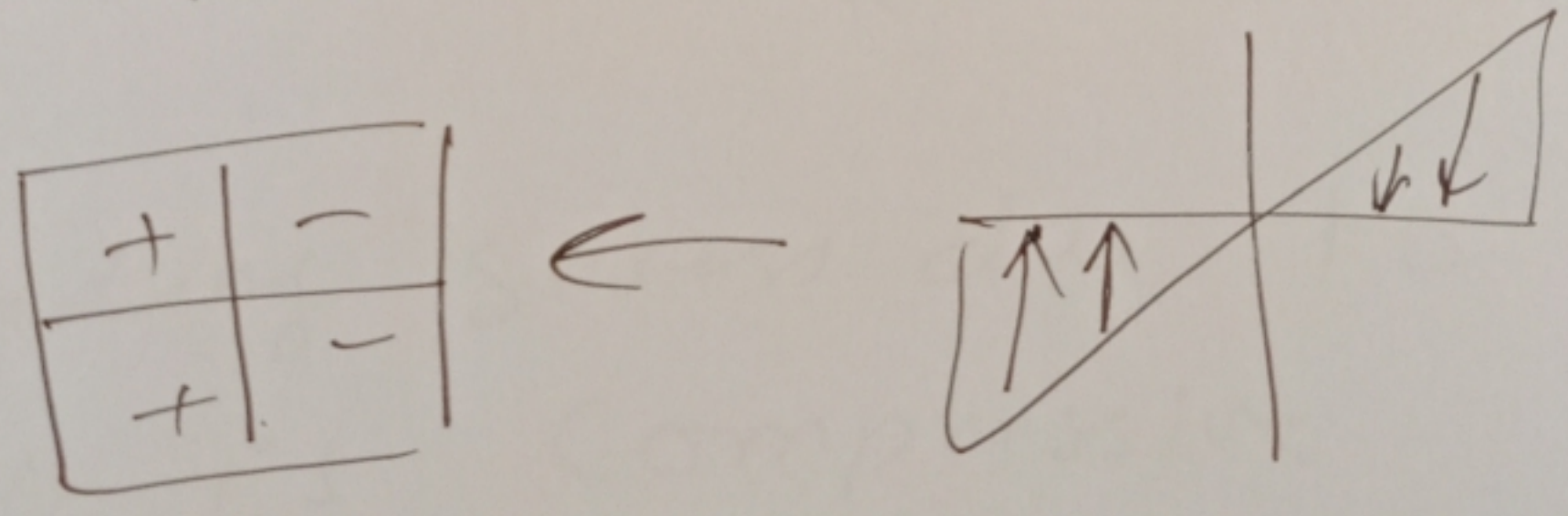
2	1
3	4

If we take Compression as Negative and tension and the Beam is a simply supported.



Quardant 1, 2 -ve

Quadrant 3, 4 +ve



Q 1, 4, -ve

Q 2, 3 +ve

(4)
In case of unsymmetrical loading
The Neutral axis lies at an
angle of α , The principle
axis and the algebraic sum
of stresses at N.A is zero.

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

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 point A on
N.A lies in quadrant (2)
where

→ Bending stress due to
 $P \cos \alpha$ is Compressive

(5)

→ Bending stress due to $P \sin \theta$ is Tensile.

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

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

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

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

$$\Rightarrow \tan \alpha = \frac{I_z}{I_y} \cdot \tan \theta$$

(b)

Now put values of I_z, I_y and θ in the equation.

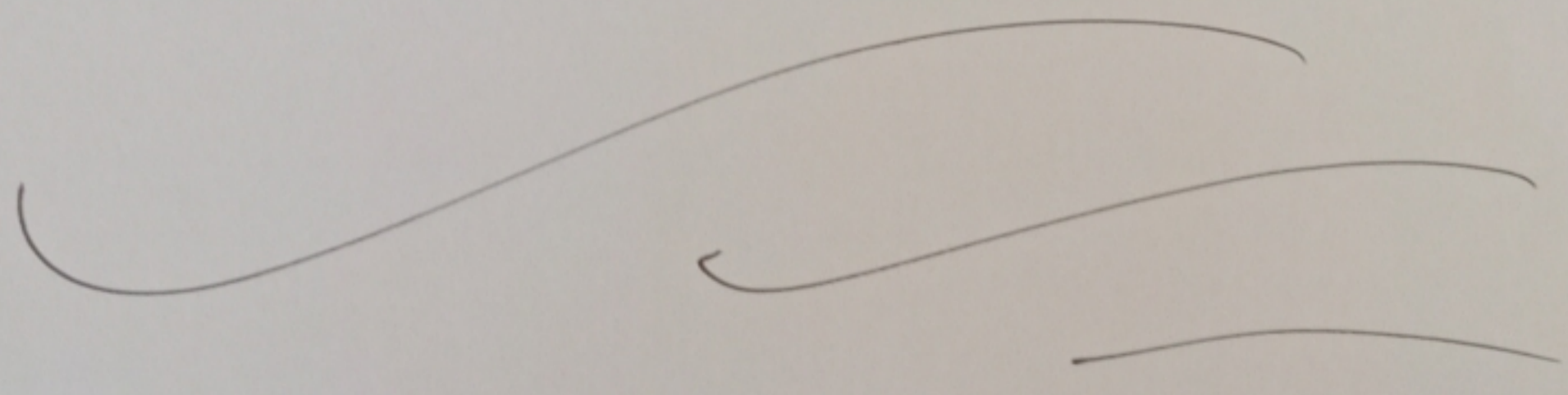
$$\tan \alpha = \frac{I_z}{I_y} \tan \theta$$

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

$$\tan \alpha = -14.4129$$

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

$$\alpha = 1^\circ 30' 5''$$



①

Q No # 2 part (b)

T-section shown in the figure is the cross-section of simply supported Beam 16 ft 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 $I_x = 112.6 \text{ in}^4$ and $I_y = 18.7 \text{ in}^4$ 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: \rightarrow

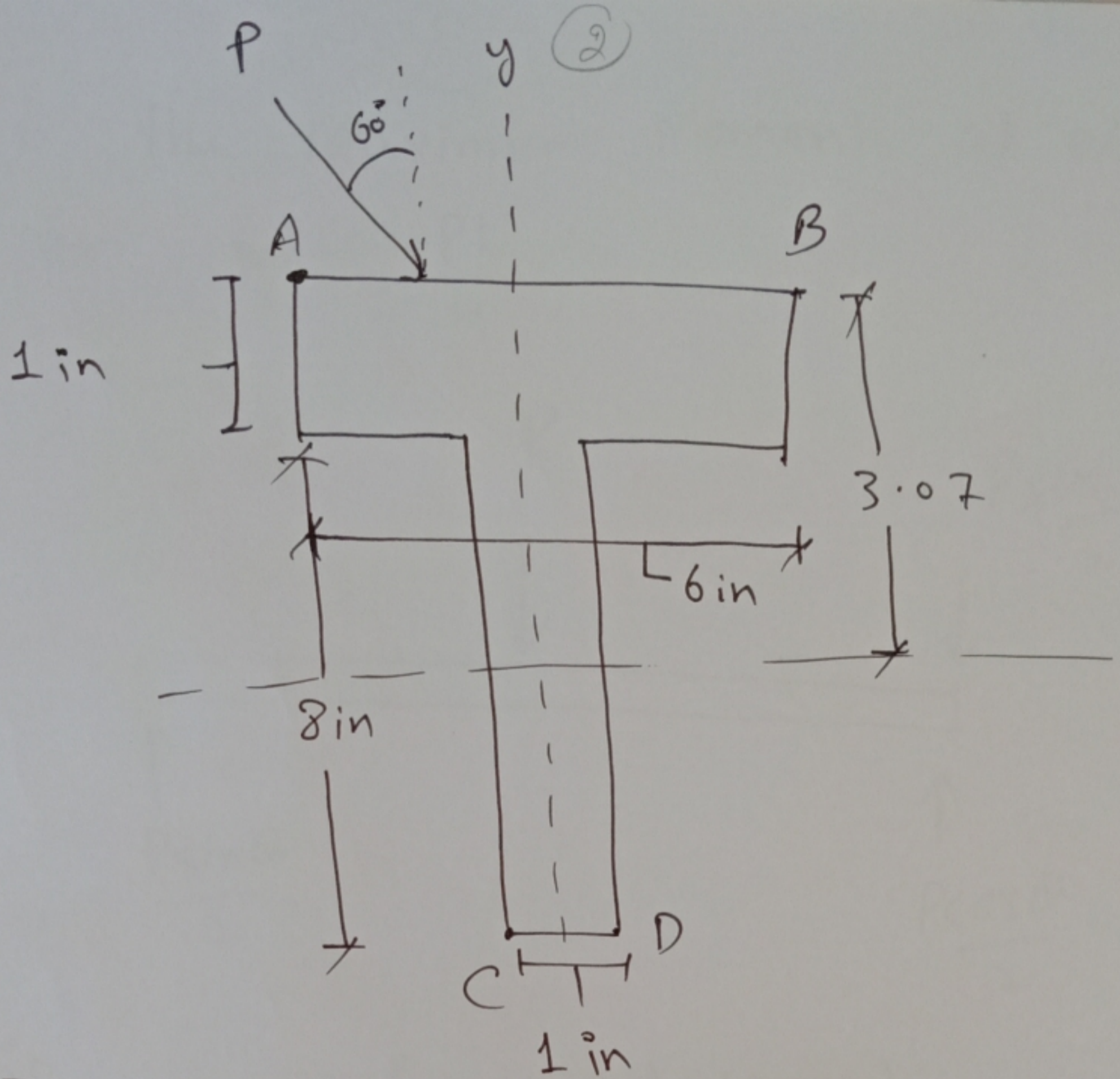
$$\text{Length} = L = 16 \text{ ft}$$

$$I_x = 112.6 \text{ in}^4$$

$$I_y = 18.7 \text{ in}^4$$

$$\sigma_c = 12000 \text{ psi}$$

$$\sigma_t = 5000 \text{ psi}$$

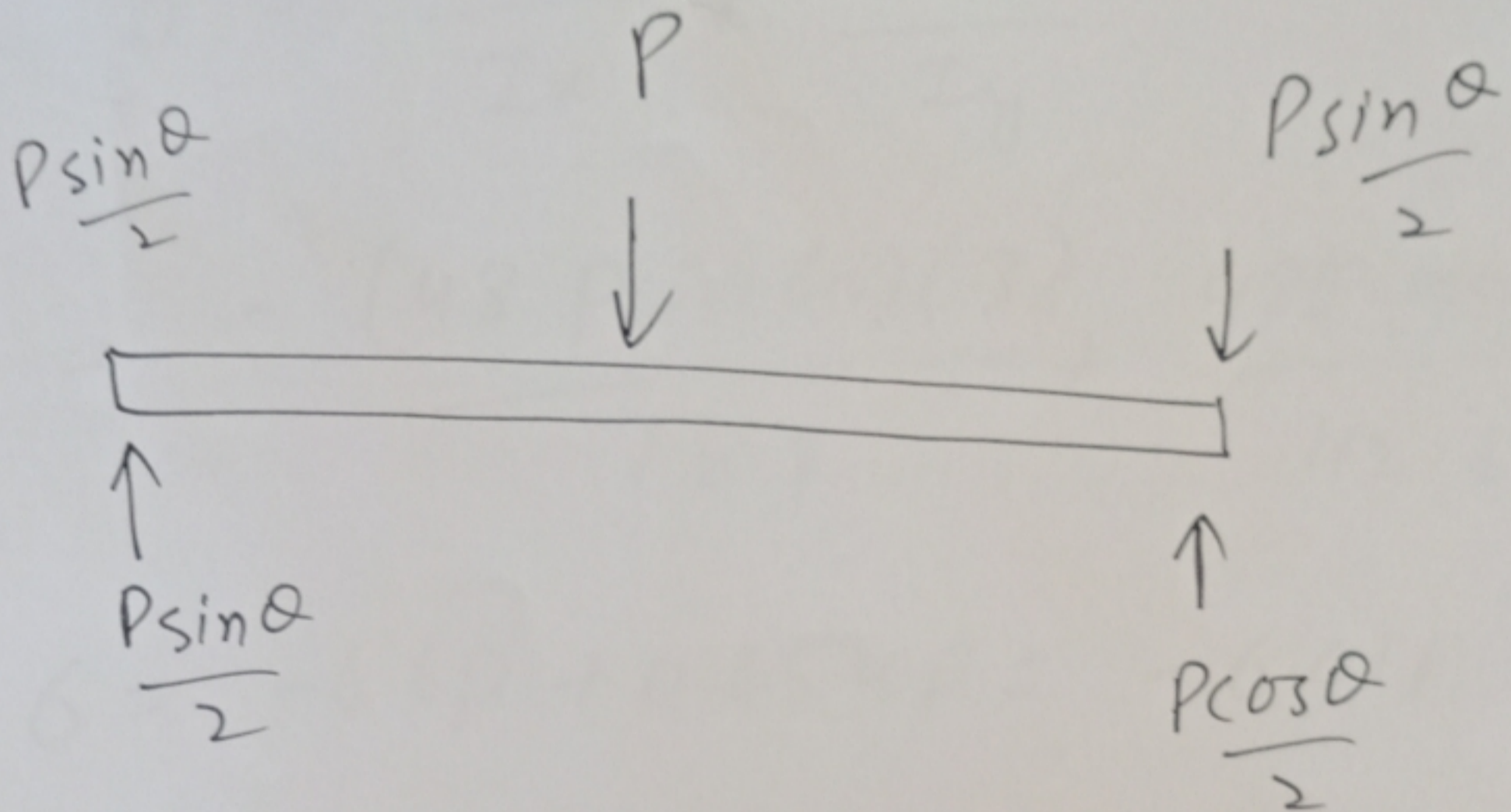


The Maximum bending stress occurs at the mid section due to the maximum bending moment. So the critical section is the mid section where the compressive and tensile stresses can exceed the limiting values.

(3)

For the Maximum Moment - at mid

Section $M = \frac{PL}{4}$



So

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

$$M_x = 48 \sin 60$$

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

$$M_y = 48 \cos 60$$

④

Stress at A, B, C, D

① A

$$\sigma = \frac{Mx}{I_x} + \frac{My}{I_y}$$

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

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

& compression ≤ 12000 Psi

So $12000 = 6.01P$

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

$P = 1996.6 \text{ lb}$

at (B)

(5)

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

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

So Tension ≤ 5000 psi

$$5000 = 6.01 P$$

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

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

$$\text{So } P = 1996.6 > 831$$

P value check for point C & D

also take the Maximum.

Q NO # 03

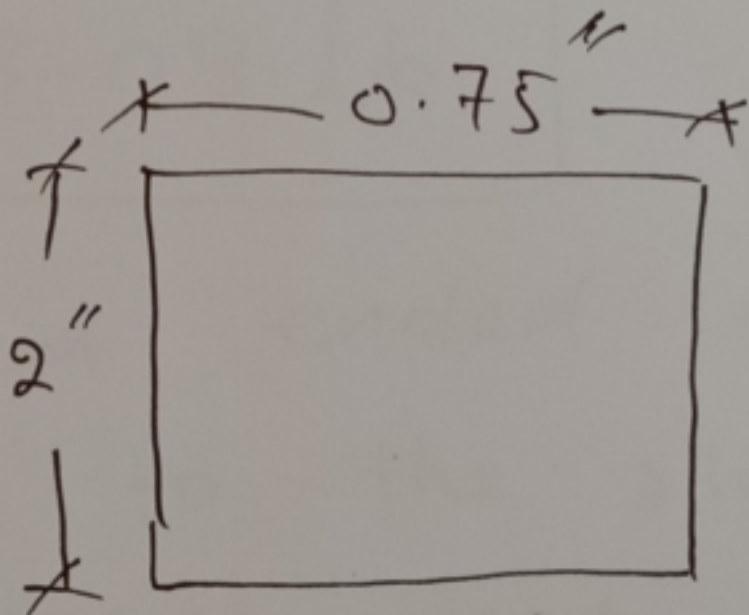
A 10 ft long strut braced in the middle has a Rectangular section 0.75×2 in. A bolt through each end secures the strut so that it acts as a hinged column about the axis perpendicular to the 2 in dimension, and a fixed ended column about axis parallel to the 2 in dimension. Determine the safe load P about using factor of safety is 2 and $E = 10.3 \times 10^6$.

Solution: \rightarrow

Given:

length = 10 ft

Dimension = 0.75×2 in



Factor of safety = 2

(2)

Case I

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

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

$L_e = L$ for hinged ended beam.

$$P_{cr} = \frac{n^2 EI \pi^2}{L_e^2} = \frac{(1)^2 (10.3 \times 10^6) (0.5) (\pi)^2}{(10 \times 12)^2}$$

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

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

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

Case II a fixed ended column about axis parallel to the 2 in dimension. So it means that perpendicular to 0.75 in dimension.

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

$$L_e = \frac{L}{2} \quad (\text{for fixed ended column})$$

$$P_{cr} = \frac{n^2 EI \pi^2}{L_e^2} = \frac{(1)^2 (10.3 \times 10^6) (0.07) (\pi)^2}{\left(\frac{10 \times 12}{2}\right)^2}$$

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

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

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

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

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