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Subject = MOS II

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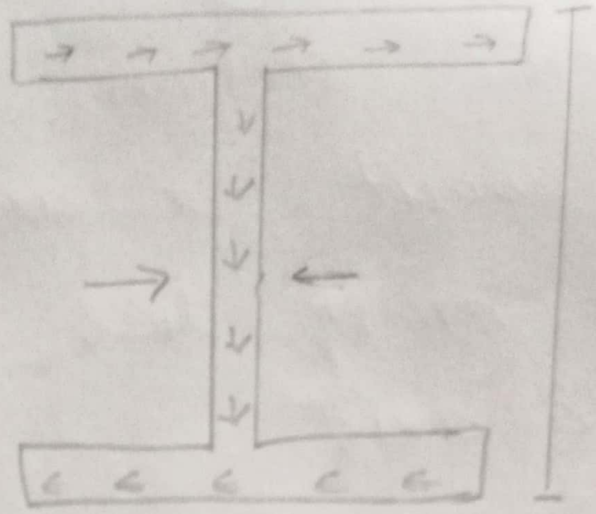
Q No 1



The section is symmetrical about x-axis & not y-axis.

So any external force on section will create twisting in the section

So in order to avoid twisting we will find out plane where external load will balance the internal shear flow in the section.

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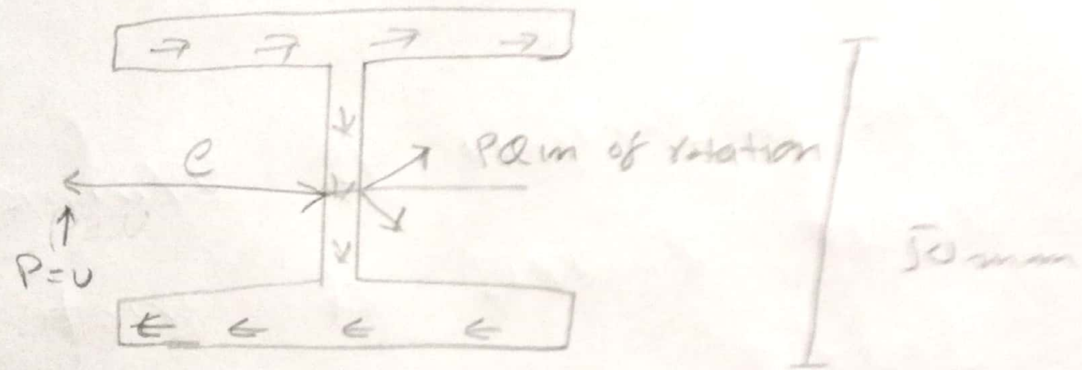
As the section is symmetrical only about x-axis the shear center must lies some where on x-axis



$$\Sigma M_c = 0$$

Clockwise moment = Anticlock wise moment

$$V \times e + ft \times 50 = ft \times 50$$

$$e = \frac{Ft \times 50 - ft \times 50}{V} \rightarrow (1)$$

Now we will find out I_x & Y

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$$I = \Sigma \left(I + Ad^2 \right)$$

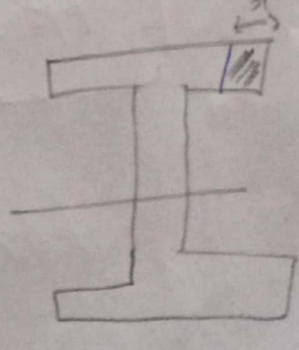
$$I = 2\left[\frac{26\times 2^3}{12} + 26\times 2 \times (25-1)^2\right] + \left[\frac{2\times 50^3}{12} + 0\right]$$

$$I_{xx} = 59938.66 + 20833.34$$

$$I = 80771.99\ mm^4$$

El $y = 25mm$

Now For Flange



$$f_f = \int_0^x q/s \; dx$$

$$= \int_0^x \frac{VQ}{I} \, dx$$

$$\frac{25V}{40386} \int_0^x x \cdot dx \qquad Q = A\bar{y}$$

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$$\int_0^y \frac{V}{80772} \times 50x \, dx$$

$$= \frac{25V}{40386} \int_0^y x \cdot dx \qquad Q = A\bar{y}$$

$$= (2 \times x) 25$$

$$= 50x$$

$$F_t = \frac{25V}{40386} \left| \frac{x^2}{2} \right|_0^x \rightarrow (2)$$

now for $x = 0$ (from right angle)

$$F_f = \frac{25V}{40386} \left(\frac{20^2}{2} - 0 \right)$$

$$F_f = 0.123V$$

from left sides

$x = 6$

eq (2) $F_f = \frac{25V}{40386} \left[\frac{x^2}{2} \right|_0^6$

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$$F_f = \frac{25V}{40386}\left(\frac{b^2}{2} - 0\right)$$

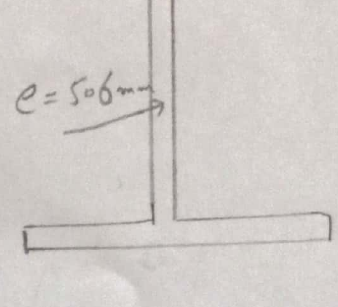
$$\boxed{F_F = 0.011\,V}$$

Now putting values in eq (1)

$$e = \frac{-0.011\,V \times 50 + 0.123 \times 50}{V}$$

$$e = 5.06\,V/V$$

$$e = 5.06\,mm$$



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Question No: 01

Part "B" (CLO 2)

Given Data:

Circumferential Stress = $\sigma_c \leq 6000 psi$

Radius = $62.4\ lb/ft^3$

Dia = 22 ft

Height = 26 ft

Required:

Determine the thickness of the wall of a water tank?

Sol:-

As we know that the pressure developed by water

$P = \gamma h$

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$$\sigma_c = \frac{PD}{2t}$$

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

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

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

$$t = 0.02 ft$$

$$\boxed{t = 0.24 \text{ inches}}$$

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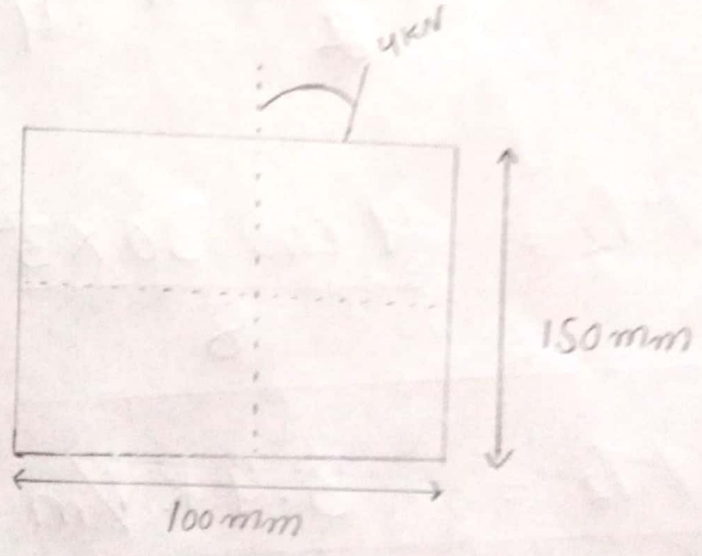
Q2 : Part (a) (CLO-3)

Given Data :-

$W = 4KN$

$L = 3m$

$\theta = 30^\circ$



Required :-

(a) Max bending stresses at Mid span = ?

(b) Locate neutral axis = ?

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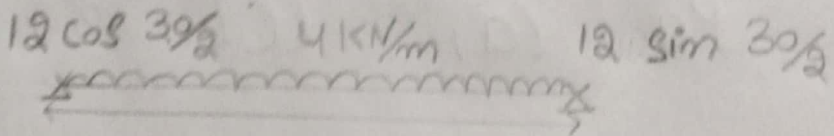
Sol:-



$$\frac{4 \times 3 \cos 30}{2} \qquad \frac{4 \times 3 \sin 30}{2}$$

For UDL Max moment max Mid section.

$$M_z = \frac{wL}{2} \times \frac{L}{4} = \frac{wL^2}{8}$$

$$M_z = \frac{4 \cos 30 \times 3^2}{8}$$

$$\boxed{M_z = 3.9 \text{ KN/m}}$$

Now For M_y

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

$$M_y = 2.25 \text{ KN.m}$$

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

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$$I_y = \frac{0.150 \times 0.1^3}{12}$$

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

$$I = \frac{0.100 \times 0.150^3}{12}$$

$$\boxed{I = 2.81 \times 10^{-5}\ m^4}$$

As we know that total bending stress at mid span

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

$y = 0.075\ m$

$z = 0.05\ m$

$I_z = 2.81 \times 10^{-5}\ m^4$

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

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$$\sigma_z = \frac{M_z\, y}{I_z}$$

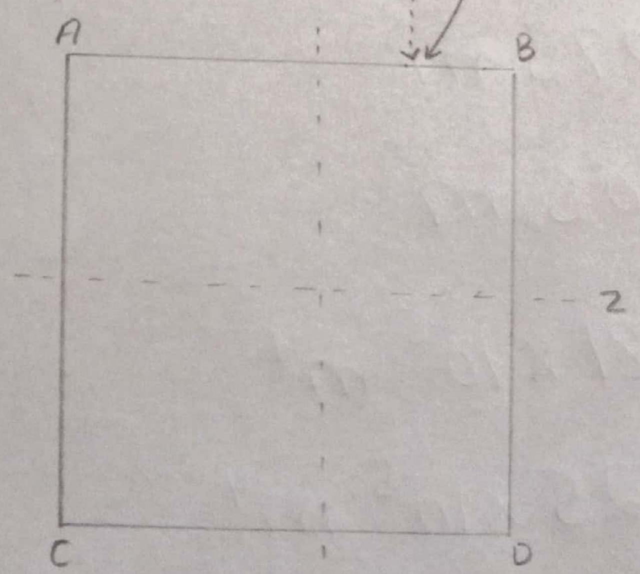
$$\sigma_z = \frac{3.9 \times 0.075}{2.81 \times 10^{-5}}$$

$$\boxed{\sigma_z = 10409.25 \ KN/m^2}$$

$$\sigma_y = \frac{M_y \cdot z}{I_y}$$

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

$$\sigma = 9000 \ KN/m$$



Maximum bending Stress at the extreme fiber

$\sigma_A = -\sigma_2 + +\sigma_y$

$\sigma_B = -\sigma_2 + -\sigma_y$

$\sigma_C = +\sigma_2 + +\sigma_y$

$\sigma_y = -\sigma_2 + -\sigma_y$

Note → $\sigma_2 = 10409.25$ KN/m²

$\sigma_y = 9000$ KN/m²

Now

$\sigma_A = -10409.25 + 9000 = (-1409.25$ KN/m²$)$

$\sigma_B = -10409.25 + (-9000) = (-1940.25$ KN/m²$)$

$\sigma_C = 10409.25 + 9000 = (1940.25$ KN/m²$)$

$\sigma_D = 10409.25 + (-9000) = (1409.25$ KN/m²$)$

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Question No. 02 :- Part (b) CLO. 3

Given Data:

$\bar{y} = 3.07$ in

$x = 3$ in

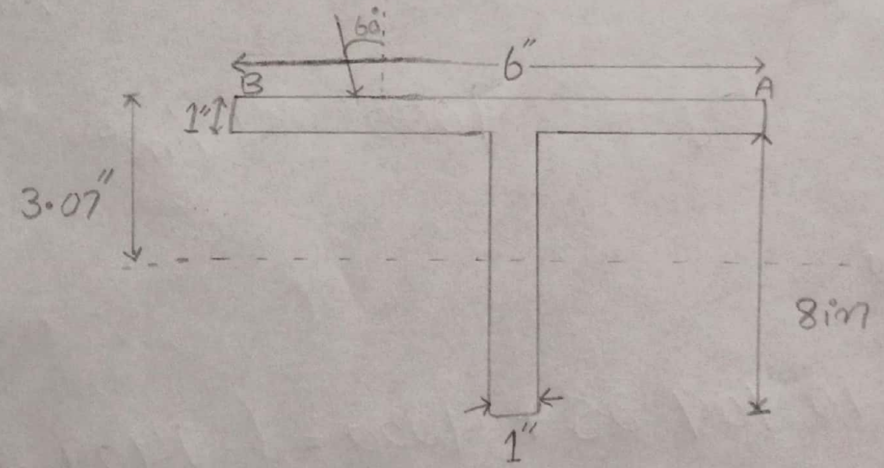
$I_x = 112.6$ in^4

$I_y = 18.7$ in^4

Compressive Stress $\leq$ 12000 Psi

Tensile Stress $\leq$ 5000 Psi

Figure:-



Required:- Max load that will not overstress the beam?

Sol:-

The maximum bending Stresses occur at the mid section due to the maximum bending moment, so that the critical section is the mid section where the compressive and tensile stresses can exceed the limiting values.

"we also know that at any given section the maximum stress occur at the extreme fiber.

For example A, B, C, & D

we know that for point load at mid section is:

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

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

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

$$M_y = 41.57P$$

Stresses at Point A, B, C & D

Point A:

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

$$= \frac{24 \times 3.07}{112.6} + \frac{41.57 \times 3}{18.7}$$

$$\sigma_z = -0.654 + 6.667$$

$$\sigma_z = 6.014 \text{ (Tension)}$$

∴ Tension ≤ 5000 Psi

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$$P = \frac{5000}{6.014}$$

$$P = 831.94 \, lb$$

For Point B:-

$$\sigma_B = \frac{M_x \, y}{I_x} + \frac{M_y \cdot x}{I_y}$$

$$\sigma_B = -0.554 + (6.667)$$

$$\sigma_B = -7.231 \quad (\text{compression})$$

& compression ≤ 12000 psi

$$P = \frac{12000}{7.231}$$

$$P = 1659.52$$

So, controlling values b/w A & B is $\boxed{831.94 \, lb}$

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For Point C:

$\sigma_C = 0.654 + 6667$

$\sigma_C = 7.321$ (Tension)

Tension ≤ 5000 psi

$P = \frac{5000}{7.321}$

$P = 682.97$ lb

For Point D

$\sigma_D = +0.654 + (6.667)$

$\sigma_D = -6.013$ (compression)

{ compression ≤ 12000

$P = \frac{12000}{6.013}$

$P = 1995.67$ lb

So, controlling value b/w C, D is **682.97 lb**

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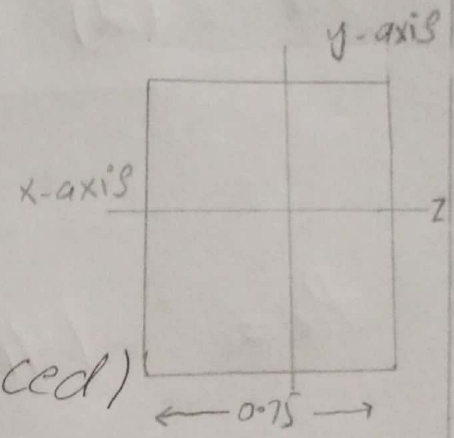
Q NO 4:-

Given Data

$L = 10ft$

$n = 2$ (~~Strut~~ center braced)



Case I :-

Struct act averge column about an axis perpendicular to the 2 in dimension

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

As we know that

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

For winged ended column

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$L_e = L$

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

$P_{cr} = 14104.70$ lb

Now $P_{safe} = \frac{P_{cr}}{FOS}$

$P_{safe} = 7052.35$

Case II

Strcut & column acts as a fixed end column about an parallel to 2in side

So

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

$L_e = L/2$ (For Fixed ended column)

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then

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

$$= \frac{(2)^2 \times 10.3 \times 10^6 \times (0.0703) \times (3.14)^2}{(10/2 \times 12)^2}$$

$$P_{cr} = 7932.48$$

$$P_{safe} = \frac{P_{cr}}{FOS}$$

$$P_{safe} = \frac{7932.48}{2}$$

$$P_{safe} = 3966.24 \text{ lb}$$

In both cases

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we will take smaller

values of P_{safe}

$P_{safe} = 3966.24 < 7052.35$

So will consider

$P_{safe} = 3966.24$ lb

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