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7894

Sec A.

Mechanics of SOLID - 2.

Civil Engineering Department

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Q no (1) (a). ①

Given Data:

Section Height = 50 mm.

Thickness = b = 26 mm.

T_f = 2mm.

Required:

Shear Center = ?

Solution:

In Case of Unsymmetrical member, Shear Centre is some distance away from geometrical centre, That some is known as eccentricity, which is given by.

$$e = \frac{T_f h^2 b^2}{4I} \quad \therefore I = \text{Moment of inertia}$$

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

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

$$I = 50034.67 + 20833.33$$

$$I = 70868.0033.$$

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(2)

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

$$e = \frac{2 \times 50^2 \times 25^2}{4(70868.0033)} = \frac{3125000}{283472.01}$$

$$e = 11.024 \text{ mm}$$

Hence Shear Center is 11.024 mm away from geometrical centre.

Q No (1) (b)

Given Data:.

Height = 26 ft

Diameter = 22 ft.

Circumferential stress = ~~62.4 lb/ft³~~ 6000 PSI

Specific weight = 62.4 lb/ft³.

Required:.

Thickness of walls = ?

Solution:.

As we know.

$$P = \gamma h.$$

$$\delta_t = \frac{PD}{2t}.$$

$$\delta_t = \frac{\gamma h D}{2t}.$$

$$t = \frac{\gamma h D}{2\delta_t} = \frac{62.4/(12)^3 \times (26 \times 12) \times (22 \times 12)}{2 \times 6000}.$$

$$t = 0.247 \text{ in}.$$

Q(2)(a) (4)

~~Given Data~~ :.

Solution.

Moment of Inertia

$$I_z = \frac{bh^3}{12} \Rightarrow \frac{0.1(0.15)^3}{12}$$

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

Now

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

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

$$\delta = \frac{M_z Y}{I_z} + \frac{M_y Z}{I_y}$$

$$\delta = \frac{M \cos\theta}{I_z} + \frac{M \sin\theta}{I_y}$$

Where

$$M_z = \cos\theta \Rightarrow P \cos\theta = M_z$$

$$M_z = 12 \cos 30$$

$$\boxed{M_z = 1.8510}$$

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

$$M_y = 12 \sin 30^\circ = 11.8563$$

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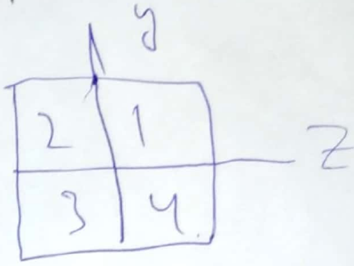
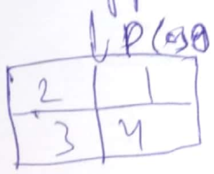
$$\sigma = \left(\frac{M_z}{I_z}\right) + \left(\frac{M_y}{I_y}\right)$$

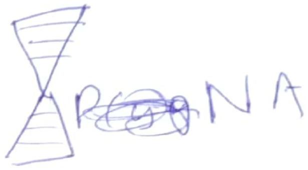
$$= \frac{1.851}{2.812\times10^{-5}} + \left(\frac{-11.8563}{1.25\times10^{-5}}\right).$$

$$\sigma = 882678\ N/m^2.$$



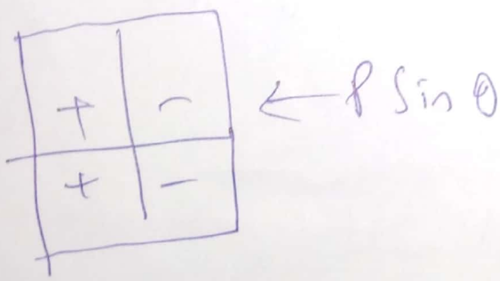
Now if we take Compression as negative and tension as positive and beam is Simply Supported





Quadrant 1, 2 → −ve

Quadrant 3, 4 → +ve.



Quadrant 1.4 → −ve

Quadrant 2, 3 → +ve.

Unsymmetrical loading the Neutral axis lies of an angle of "X". The Principle axis and Algebric Sum of Stress at NA is Zero

$$\delta = \frac{M\cos\theta + y}{I_z} + \frac{M\sin\theta}{I_y} - Z \quad \text{--- (9)}$$

N.A Passes through 2,4.

$$\delta = \frac{M\cos\theta \cdot y}{I_z} + \frac{M\sin\theta \cdot Z}{I_y}$$

let us Consider a Point A on NA Lies on Quadrant 2 where

Bending stress due to $P\cos\theta$ is Compressive

Bending stress due to $P\sin\theta$ is tensile.

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Q2) Part (b):

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Given Data:

~~Centre Concentrated load~~

length of beam = 16 ft.

Angle of inclination = 60°

$I_x = 112.6 \, in^4$

$I_y = 18.7 \, in^4$

$\delta_T = 5000$ PSI.

$\delta_c = 12000$ PSI.

Required:

Maximum load = ?

Solution:

There will be tension as well as Compression which will reduce the effect of eachother, So we will Calculate Stress at A and C So.

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

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

Now M_x and M_y

$$M_x = P\cos 60 \, (16\times 12)$$

$$M_x = 48\,p\cos 60.$$

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

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

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

$$\sigma_A = \frac{48P\cos 60^\circ \times 3.07 + 48P\sin 60 \times 3.07}{1126 \quad + \quad 18.7}.$$

$$P = 1638.6 \text{ lb}.$$

Now

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

$$5000 = 48\,p\cos 60 + 593 + \frac{48\,P\sin 60 \times 0.5}{18.7}.$$

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

Maximum stress load $= 1638.6$ lb.

Q(3) (9)

Given Data:

length = 10 ft.

$E = 10.3 \times 10^6$

$b = 0.75$

$h = 2$.

Factor of Safety = 2.

Required:

a) Safe load at hinged = ?

b) Safe load at Fixed = ?

Solution

a) For hinged Column

$l_e = L$.

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

$$P_{cr} = \frac{n^2 E I \pi^2}{l_e^2} = \frac{(1)^2 (10.3 \times 10^6)(0.5)\pi^2}{(10 \times 12)^2}.$$

$$P_{cr} = \frac{50776940}{14400} = 3526.176 \text{ lb}.$$

$$P \text{ Safe load} = \frac{P_{cr}}{\text{Factor of Safety}} = \frac{3526176}{2} = 1763.088 \text{ lb}$$

(10)

(b) Strut act Colum.

$\cancel{Le}$ $Le = L/2$ (for fixed ended)

$Le = \frac{10}{2} = 5\,ft.$

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

$P_{cr} = \frac{n^2 E I \pi^2}{Le^2} = \frac{(1)^2 (10.3 \times 10^6)(0.07)(3.14)^2}{(5 \times 12)^2}$

$P_{cr} = \frac{7108771.6}{(60)^2}$ $= \cancel{1154779.5267}$.

$P_{cr} = 1974.658\,lb.$

$P_{safe\ load.} = \frac{1974.658}{2}$

$= 987.3293\,lb.$