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Section:

B

Deptt:

BE(C)

Subject

MOS-II

Submitted to:

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Question No 01 (a):

Determine the location of the Shear Center for the beams having the cross sectional dimensions shown in the figures 1. All members are to be consider thin walled and Calculation should be based on the Centerline dimension

Given Data:

Uper Section : 6mm and 20mm
Flange : 2mm
thickness : 2mm

Required:

Location of Shear Center: ?

Solution:

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

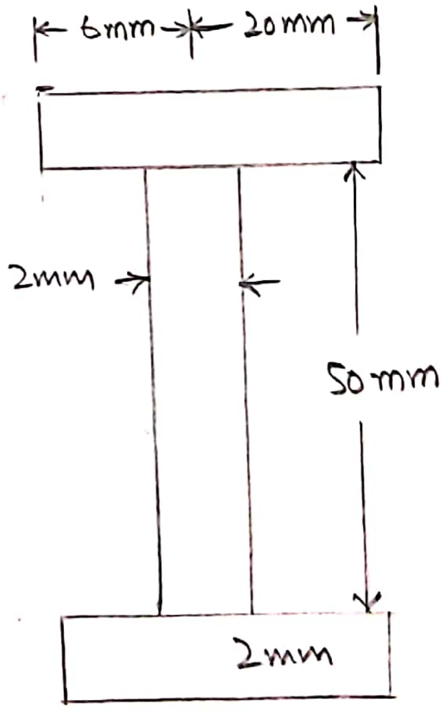
$$I = 2\left(\frac{26(2)^3}{12} + (26\times 2)(24)^2 \right) + \left(\frac{2(46)^3}{12} \right)$$

$$I = 29969.33 + 16222.66$$

$$I = 76161.33 \text{ mm}^4$$

$$e = \frac{2(50)^2(26)^2}{4\times 76161.33}$$

$$\boxed{e = 11.099 \text{ mm}}$$



Question No 01 (b):

Determine the Thickness of the Wall of a Water tank Constructed from Steel plates filled to a height of 26ft, the Circumferential Stress is limited to 6000psi the Specific weight of Water is 62.4 lb/ft³.

Given Data:

height of filled tank, $h = 26ft$

Water tank diameter, $d = 22ft$

Circumferential Stress, $\sigma_t = 6000psi$

Specific weight of Water, $\gamma_w = 62.4 lb/ft^3$

Required Data:

Thickness, $t = ?$

Solution:

Pressure developed by

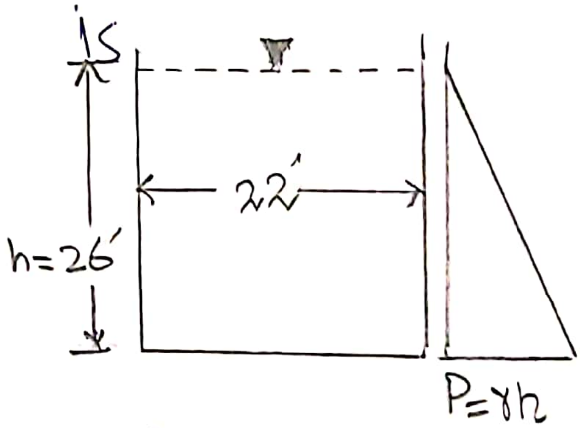
$$P = \gamma h$$

Circumferential stress,

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

$$\sigma_t = \frac{\gamma h D}{2t} \quad \therefore \{ P = \gamma h \}$$

So thickness is



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

$$t = \frac{\frac{62.4}{12^3} \times 26 \times 12 \times 22 \times 12}{2 \times 6000}$$

$$\boxed{t = 0.247 \text{ inch}}$$

Question no 02(a):

The 100 by 150mm wooden beam Shown in figure 2 is used to Support a Uniformly distributed load of 4KN on a Simply Span of 3m. the applied load acts in a plane making an angle of 30 degree with verticle Calculate the maximum bending Stress at mid Span and for the Same section locate the neutral axis. Neglect the weight of the beam.

Given Data:

Beam Section : 100 x 150 mm
Uniform load : 4KN
Span : 3m
angle with verticle : 30°

Required Data:

Maximum bending stress at mid span and for same section locate neutral axis

Solution:

Moment of inertia

$$I_z = \frac{bh^3}{12} = \frac{0.1\,m\,(0.15m)^3}{12} = 2.8125 \times 10^{-5} m^4$$

$$I_y = \frac{bh^3}{12} = \frac{(0.15m)(0.1m)^3}{12} = 1.25 \times 10^{-5} m^4$$

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

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

$$M_z = M\cos 30 = 12 \times \cos 30^{\circ}$$

$$M_z = 10.39 \times 10^3 \; N.m = 10392.30 \; N.m$$

$$M_y = M \sin 30^{\circ} = 12 \times \sin 30 = 6000 N.m$$

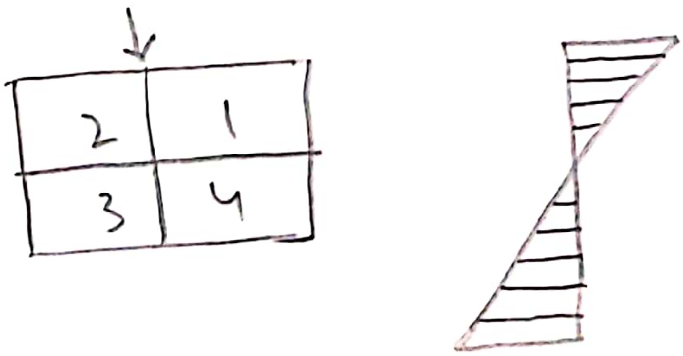
$$\sigma = \frac{10392.3 \times 0.075}{2.8125 \times 10^{-5}} + \frac{6000 \times 0.05}{1.25 \times 10^{-5}}$$

$$\boxed{\sigma = 51712800 \ N/m^2}$$

Sign Convention:

2	1
3	4

if we take Compression as negative tension as +ve and the



Quadrant 1, 2, -ve

Quadrant 3, 4, +ve

+	−
+	−

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

In Case of Symmetrical loading the neutral axis lie of an angle of "α" the principal axis and the algebric Sum of stress at N.A is zero in this Case neutral axis pass through 2, 4

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

Let Consider a point "A" on N.A lies in Quadrant "2"

Where

Bending Stress due to $P\cos\alpha$ is Compressive
Bending Stress due to $P\sin\alpha$ is tensile

$$0 = \frac{M\cos\alpha y}{I_z} + \frac{M\sin\alpha Z}{I_y}$$

(9)

$$0 = -\frac{M\cos\theta\, y}{I_z} + \frac{M\sin\theta\, z}{I_y}$$

$$\Rightarrow \frac{M\cos\theta\, y}{I_z} = \frac{M\sin\theta\, z}{I_y}$$

$$y/z = \frac{I_z \cancel{M}\sin\theta}{\cancel{M}\cos\theta\, I_y} = \frac{I_z}{I_y}\tan\theta$$

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

$$\Rightarrow \tan\alpha = \frac{I_z}{I_y}\tan 30$$

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

$$\tan\alpha = 1.294$$

$$\alpha = \tan^{-1}(1.294)$$

$$\boxed{\alpha = 52.2^\circ}$$

Question No 09 (b):

The T Section Shown in figure 3 is the Cross Section of a Simply Supported beam 16ft long that Carries a Central load inclined 60 degree left to the y axis the Centroid is 3.07 in below the top of the Section $I_x = 112.6\ in^4$ and $I_y = 18.7\ in^4$ if Compressive Stress is limited to 12000psi and tensile Stress to 5000psi What is the maximum load that will not over stress the beam?

Given Data:

Length = 16ft

angle of load = 60 degree

$I_x = 112.6\ in^4$

$I_y = 18.7\ in^4$

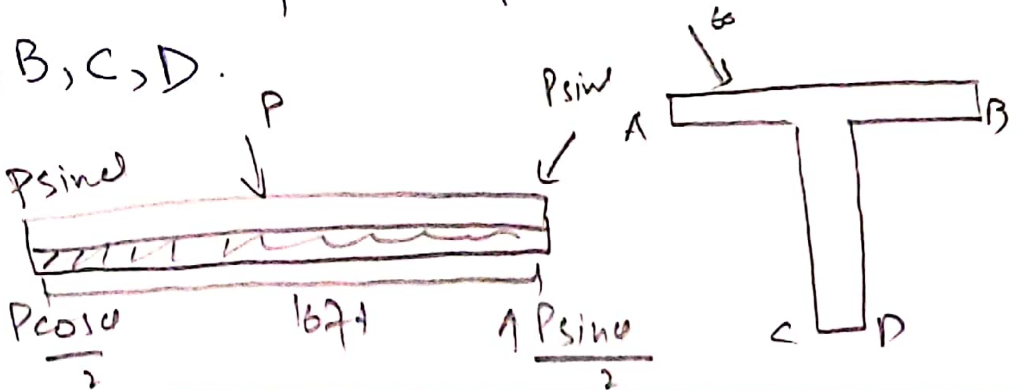
Compressive stress = 12000psi
tensile stress = 5000psi

Required Data:

What is maximum load that will not overstress load

Solution:

The maximum Bending stress occur at the mid Section due to minimum bending moment So 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 accurate at the extreme fibre for example Point A, B, C, D.



For point load max moment at mid section

$$M = PL/4$$

So,

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

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

Stress at A, B, C, D

At A:

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

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

$$= -0.654P + 6.6P$$

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

tension $\leq$ 5000psi

$5000 = 6.01P$

$P = \frac{5000}{6.01} = 831.94\,lb$

At B:

$$6 = -\frac{(48)P\cos(60)(3.07)}{112.6} - \frac{(48)(P\sin(60)(3)}{18.7}$$

$= -0.654P - 6.6$

$= -7.2P$ Compression

$12000 = -7.25P$

$P = \frac{12000}{7.25} = 1655\,lb$

$1655\,lb > 831$

Controlling value is 831.9lb

At C_L

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

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

$$= 1.26P + 1.11P$$

$$\sigma = 2.37P$$

tension $\leq$ 5000 psi

$$5000 = 2.37P$$

$$P = \frac{5000}{2.37} = 2109.7 \text{ lb}$$

At D_L

$$\sigma = \frac{(48)P\cos(60)(5.93)}{112.6} - \frac{48P\sin(60)(0.5)}{18.7}$$

$$\sigma = 1.26P - 1.11P$$

$$\sigma = 0.15P \text{ Tensile}$$

$$P = \frac{5000}{0.15} = 33333.33 \text{ lb}$$

$$\boxed{\text{So Controlling value is } 2109.70 \text{ lb}}$$

Question No 03:

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

Given Data:

Length of strut = 10ft
rectangular section = 0.75in x 2in
factor of safety = 2
$E = 10.3 \times 10^6$ psi

Required Data:

Determine Safe load , $P = ?$

Solution:

Strut is a Compressive member and act as a Column

Case-1:

Strut act as an hinged Column about an axis perp to the 2in dimension

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

$L_e = L$ (for hinged ended column)

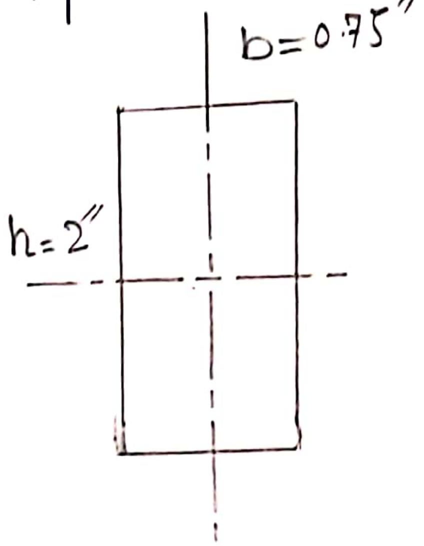
$$P_{cr} = \frac{n^2 E I \pi}{L_e^2}$$

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

$$P_{cr} = 3529.75\ lb$$

$$P_{safe} = \frac{P_{cr}}{\text{factor of Safety}}$$

$$P_{safe} = \frac{3529.75}{2}$$



$$P_{safe} = 1764.87 \text{ lb}$$

Case-2

Strut or Column act as a fixed Ended Column about an axis Parallel to 2in dimension

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

$L_e = L/2$ (for fixed ended Column)

then

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

$$= \frac{(1)^2 (10.3\times10^6)(0.07)(\pi^2)}{(10\times12/2)^2}$$

$P_{cr} = 1976.66\,lb$

$$P_{safe} = \frac{1976.66}{2}$$

$P_{safe} = 988.33\,lb$

In both cases take smaller value of P_{safe}

$$\boxed{P_{safe} = (988.33 < 1764.87)\,lb}$$