

1900011

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$$1 - F = 3500 \text{ N}$$

$$w = 1500 \text{ N/m}$$

$$EI = 2.2 \times 10^6 \text{ Nm}^2$$

a - deflection

$$y = \frac{FL^3}{3EI} + \frac{wL^4}{8EI}$$

$$y = \frac{-3500 \text{ N} \times 1.5^3}{3 \times 2.2 \times 10^6 \text{ Nm}^2} + \frac{-1500 \times 1.5^4}{8 \times 2.2 \times 10^6}$$

$$y = -2.22 \times 10^{-3} \text{ m}$$

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$$-2.22 \text{ mm}$$

b - ~~displacement~~

$$-0.005 = \frac{F \times 1.5^3}{3 \times 2.2 \times 10^6} + \frac{-1500 \times 1.5^4}{8 \times 2.2 \times 10^6}$$

$$F = -8934.03 \text{ N}$$

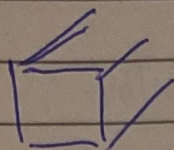
$$DF = -8934.03 - (-3500) = -5434.03 \text{ N}$$

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Q5-



350 mm

0.35 m

$$P = 50 \times 10^6 \text{ Pa}$$

$$\nu = 0.3$$

$$E = 165.0 \times 10^9 \text{ Pa}$$

a-

k?

 $\epsilon_v = ?$ $\Delta V = ?$

$$k = \frac{E}{3(1-2\nu)}$$

$$k = \frac{165 \times 10^9 \text{ N/m}^2}{3(1-2(0.3))}$$

$$k = 1.375 \times 10^{11} \text{ N/m}^2$$

$$k = -\frac{P}{\epsilon_v} \Rightarrow 1.375 \times 10^{11} \text{ N/m}^2 = -\frac{50 \times 10^6 \text{ N/m}^2}{\epsilon_v}$$

$$\epsilon_v = -363.64 \times 10^{-6}$$

$$\epsilon_v = \frac{\Delta V}{V} = -363.64 \times 10^{-6} = \frac{\Delta V}{(0.35)^3}$$

$$\Delta V = -15.59 \times 10^{-6} \text{ m}^3$$

b- Orthotropic materials have different elastic constants in different directions.

This may be due to grain structure of tubes, laminates or composites etc.

Q 3=

$$\epsilon_x = -10 \times 10^{-6}$$

$$\nu = 0.20$$

$$\epsilon_y = 13 \times 10^{-6}$$

$$E = 165 \times 10^9 \text{ Pa}$$

$$a- \sigma_x = \frac{E}{(1-\nu^2)} \cdot (\epsilon_x + \nu \epsilon_y)$$

$$\sigma_x = \frac{165 \times 10^9}{1 - (0.20)^2} \cdot (-10 \times 10^{-6} + 0.20 \times 13 \times 10^{-6})$$

$$\sigma_x = -1.27 \times 10^6 \text{ N/m}^2 \text{ compressive}$$

$$\sigma_y = \frac{E}{(1-\nu^2)} \cdot (\epsilon_y + \nu \epsilon_x)$$

$$\sigma_y = \frac{165 \times 10^9}{1 - 0.20^2} \cdot (13 \times 10^{-6} + 0.20 \times (-10 \times 10^{-6}))$$

$$\sigma_y = 1.89 \times 10^6 \frac{\text{N}}{\text{m}^2} \text{ tensile.}$$

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b-

$$\sigma_x = 20 \times 10^6 \text{ Pa}$$

$$\epsilon_x = ?$$

$$\sigma_y = -15 \times 10^6 \text{ Pa}$$

$$\epsilon_y = ?$$

~~$$\sigma_x = 15 \times 10^6 \text{ Pa}$$~~

~~$$\sigma_{yz} = \dots$$~~

~~$$20 \times 10^6 = 165 \times 10^9 \times \dots$$~~

$$\epsilon_x = \frac{1}{E} (\sigma_x - \nu \sigma_y)$$

$$\epsilon_y = \frac{1}{E} (\sigma_y - \nu \sigma_x)$$

$$\epsilon_y = \frac{1}{165 \times 10^9} (-15 \times 10^6 - 0.2 \times 20 \times 10^6)$$

$$\epsilon_y = -115.15 \times 10^{-6}$$

$$\epsilon_x = \frac{1}{165 \times 10^9} (20 \times 10^6 - 0.20 (-15 \times 10^6))$$

$$\epsilon_x = 239.39 \times 10^{-6}$$

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$$q_4 = d = 200 \text{ mm} \quad 0.2 \text{ m}$$

$$T = 1.5 \text{ mm} \quad 0.0015 \text{ m}$$

$$l = 390 \text{ mm} \quad 0.39 \text{ m}$$

$$\eta_L = 0.9$$

$$\eta_C = 0.6$$

$$P = ?$$

$$\sigma = 100 \times 10^6 \text{ Pa}$$

$$\sigma_C = \frac{P \times D}{2T \times \eta_L}$$

$$100 \times 10^6 = \frac{P \times 0.2}{2 \times 0.0015 \times 0.9}$$

$$P = 1350000 \frac{\text{N}}{\text{m}^2}$$

$$1.35 \times 10^6 \frac{\text{N}}{\text{m}^2}$$

$$\sigma_L = \frac{PD}{4T\eta_C}$$

$$100 \times 10^6 = \frac{P \times 0.2}{4 \times 0.0015 \times 0.6}$$

$$P = 1800000 \frac{\text{N}}{\text{m}^2}$$

$$P = 1.8 \times 10^6 \frac{\text{N}}{\text{m}^2}$$

THE maximum value for pressure is $1.35 \times 10^6 \frac{\text{N}}{\text{m}^2}$

Q2-

a- the boundary conditions are

INNER SURFACE $r = 17.5 \text{ mm}$ $\sigma_r = -115 \text{ bar}$ compressive

OUTER SURFACE $r = 22.5 \text{ mm}$ $\sigma_r = 0 \text{ bar}$ compressive

$$1 \text{ bar} = 100000 \text{ Pa}$$

$$b- \sigma_r = -11.5 \times 10^6 = a - b/r^2 = \frac{a-b}{0.0175^2}$$

$$\sigma_r = 0 = a - b/r^2 = \frac{a-b}{0.0225^2}$$

$$-11.5 \times 10^6 \times (17.5 \times 10^{-3})^2 = (17.5 \times 10^{-3})^2 a - B$$

$$11.5 \times 10^5 \times (17.5 \times 10^{-3}) = B - (17.5 \times 10^{-3})^2 a$$

$$11.5 \times 10^5 \times (17.5 \times 10^{-3})^2 = (22.5 \times 10^{-3})^2 a - (17.5 \times 10^{-3})^2 a$$

$$a = \frac{11.5 \times 10^5 \times 0.0175^2}{0.0225^2 - 0.0175^2} = 17.6 \times 10^6 //$$

$$\Rightarrow B = 0.0225^2 \times a$$

$$B = 0.0225^2 \times 17.6 \times 10^6$$

$$B = 8910$$

$$c - \sigma_c = a + \frac{b}{r^2}$$

using $A = 17 \times 10^6 \text{ Pa}$
 $b = 8920 \text{ N}$

~~$$\sigma_c = a + \frac{b}{r^2}$$~~

$$r = 17.5 \times 10^{-3} \text{ m} \quad \sigma_c = 46.09 \times 10^6 \text{ Pa}$$

$$r = 22.5 \times 10^{-3} \text{ m} \quad \sigma_c = 35.2 \times 10^6 \text{ Pa}$$