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Stress Analysis ACHA5015

11/1/21

Q1

a) deflection at the free end.

$$l = 1.5 \text{ m}$$

$$EI = 2.2 \times 10^6 \text{ N/m}^2$$

$$\text{Point load} = 3.5$$

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

$$y_{\max} = y_{\text{due}} + y_P$$

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

$$y_{\max} = \frac{1500 \times 1.5^4}{8 \times 2.2 \times 10^6} + \frac{3500 \times 1.5^3}{3 \times 2.2 \times 10^6}$$

$$\therefore y_{\max} = 2.2204 \times 10^{-3} \text{ m}$$

$$y_{\max} = 4.314 \times 10^{-4} + 1.789 \times 10^{-3}$$

b)  $y_{\text{due}} = y_{\max} - y_P$

$$y_{\text{due}} = 5 \times 10^{-3} - 1.789 \times 10^{-3} = 3.211 \times 10^{-3} \text{ m}$$

$$3.211 \times 10^{-3} = \frac{wL^4}{8EI}$$

$$w = \frac{y_{\text{due}} \times 8EI}{L^4}$$

$$w = \frac{3.211 \times 10^{-3} \times 8 \times 2.2 \times 10^6}{1.5^4} = 11163.18 \text{ N/m}$$

$$\Delta w = 11163.18 - 1500 = \underline{\underline{9663.18}}$$

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Q3

a)  $\epsilon_x = -10 \times 10^{-6}$   
 $\epsilon_y = +13 \times 10^{-6}$   
 $\nu = 0.20$   
 $E = 165 \times 10^9$

$$\sigma_x = \frac{E}{1-\nu^2} (\epsilon_x + \nu \epsilon_y) = \frac{165 \times 10^9}{1-0.2^2} (-10 \times 10^{-6} + (0.2 \times 13 \times 10^{-6}))$$

$$\sigma_x = -1.27 \times 10^6 \text{ Pa or } 1.27 \text{ MPa}$$

$$\sigma_y = \frac{E}{1-\nu^2} (\epsilon_y + \nu \epsilon_x) = \frac{165 \times 10^9}{1-0.2^2} (13 \times 10^{-6} + (0.2 \times -10 \times 10^{-6}))$$

$$\sigma_y = 34.37 \times 10^9 \text{ Pa}$$

or

$$\underline{\underline{34.37 \text{ GPa}}}$$

0% tensile

b)  $\sigma_x = 20 \times 10^6 \text{ N/m}^2$   
 $\sigma_y = -15 \times 10^6 \text{ N/m}^2$

$$\epsilon_x = \frac{1}{E} (\sigma_x - \nu \sigma_y) = \frac{1}{165 \times 10^9} (20 \times 10^6 - (0.2 \times -15 \times 10^6))$$
$$\epsilon_x = 139 \times 10^{-6}$$

$$\epsilon_y = \frac{1}{E} (\sigma_y - \nu \sigma_x) = \frac{1}{165 \times 10^9} (-15 \times 10^6 - (0.2 \times 20 \times 10^6))$$
$$\epsilon_y = -115.15 \times 10^{-6}$$

P2

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Q4

$$D = 200\text{mm} (0.2\text{m})$$

$$L = 390\text{mm} (0.39\text{m})$$

$$t = 1.5 \times 10^{-3}\text{m}$$

$$\eta_c = 0.9$$

$$\eta_L = 0.6$$

$$\sigma_{\max} = 100 \times 10^6$$

$$\sigma_c = \frac{pD}{2t\eta_c}$$

$$\sigma_L = \frac{pD}{4t\eta_L}$$

$$P = \frac{2t\eta_c\sigma_c}{D}$$

$$P = \frac{4t\eta_L\sigma_L}{D}$$

$$P_{\max_c} = \frac{2 \times 1.5 \times 10^{-3} \times 0.9 \times 100 \times 10^6}{0.2}$$

$$P_{\max_L} = \frac{4 \times 1.5 \times 10^{-3} \times 0.6 \times 100 \times 10^6}{0.2}$$

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

$$P_{\max_c} = 1.35 \times 10^6 \text{ N/m}^2$$

$$P_{\max_L} = 1.8 \times 10^6 \text{ N/m}^2$$

$$P_{\max_c} = 1.3 \text{ bar}$$

$$P_{\max_L} = 18 \text{ bar}$$

$$\therefore P_{\max} = 19.3 \text{ bar}$$

## Q5) ISOTROPIC CUBE

$$\begin{aligned} a) \quad l &= 350 \times 10^{-3} \text{ m} \\ P &= 50 \times 10^6 \text{ N/m}^2 \\ E &= 165 \times 10^9 \text{ N/m}^2 \\ \nu &= 0.3 \end{aligned}$$

$$\frac{K-E}{3(1-2\nu)} = \frac{165 \times 10^9}{3(1-(0.3))} = 137.5 \times 10^9 \text{ N/m}^2$$

$$K = \frac{\sigma}{\epsilon_v} = \frac{-P}{\epsilon_v}$$

$$\epsilon_v = \frac{-P}{K} = \frac{-50 \times 10^6}{137.5 \times 10^9} = -3.636 \times 10^{-4}$$

$$\Delta V = \epsilon^3 \times E_v = (0.15)^3 \times -3.636 \times 10^{-4} = \underline{\underline{-1.227 \times 10^{-6} \text{ m}^3}}$$

b) Orthotropic materials have material properties at a particular point, which differ along three axis for example wood exhibits a orthotropic quality.