

Q1.

Formulas

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

$$P = 3.5 \times 10^3$$

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

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

$$\frac{FL^3}{3EI} + \frac{WL^4}{8EI}$$

$$\frac{-3.5 \times 10^3 \times 1.5^3}{3 \times 2.2 \times 10^6} = \frac{-1.79 \times 10^{-3}}{1} \text{ m}$$

$$\frac{-1500 \times 1.5^4}{8 \times 2.2 \times 10^6} = -4.31 \times 10^{-4} \text{ m}$$

$$-1.79 \times 10^{-3} - 4.31 \times 10^{-4} = -2.22 \times 10^{-3} \text{ m}$$

$$y_{PL} = y - y_{dL} = -5 \times 10^{-3} - (-4.31 \times 10^{-4}) = -4.569 \times 10^{-3}$$

$$y_{PL} = \frac{FL^3}{3EI} \Rightarrow \frac{y_{PL} \times 3 \times EI}{L^3} = F$$

$$\frac{-4.569 \times 10^{-3} \times 3 \times 2.2 \times 10^6}{1.5^3} = -8934.93$$

$$F = -8934.93$$

$$\therefore \Delta F = 7436.89 \text{ N}$$

Q2.

$$D_o = 45 \text{ mm} = 45 \times 10^{-3}$$

$$D_i = 35 \times 10^{-3} \text{ m}$$

$$p = 115 \times 10^5 \text{ N/m}^2$$

$$r_o = 22.5 \times 10^{-3} \text{ m}$$

$$r_i = 17.5 \times 10^{-3} \text{ m}$$

$$\sigma_r = a - \frac{b}{r^2} \quad \text{--- ~~201250~~ ---}$$

$$0 = a - \frac{b}{22.5 \times 10^{-3}{}^2}$$

(1)

$$0 = b - (22.5 \times 10^{-3})^2 a$$

$$\text{@ } r_i = 17.5 \times 10^{-3}$$

$$\sigma_r = -115 \times 10^5$$

$$\sigma_r = a - \frac{b}{r^2} \Rightarrow -115 \times 10^5 = a - \frac{b}{17.5 \times 10^{-3}{}^2}$$

$$201250 = b - (17.5 \times 10^{-3})^2 \times a \quad (2)$$

$$(2) - (1) \quad 201250 = (-17.5 \times 10^{-3})^2 a + 22.5 \times 10^{-3} \times a$$

$$a = \frac{201250}{(22.5 \times 10^{-3})^2 - (17.5 \times 10^{-3})^2} = \frac{201250}{1.00625 \times 10^{-4}} \text{ N/m}^2$$

$$0 = b - (22.5 \times 10^{-3})^2 \times a$$

$$b = (22.5 \times 10^{-3})^2 \times a$$

$$b = (22.5 \times 10^{-3})^2 (1.01 \times 10^9) (1.00625 \times 10^4)$$

$$b = 509.41 \times 10^3 \text{ N/m}^2$$

$$\text{@ } r_i \quad \sigma_r = a + \frac{b}{r^2} = 1.00625 \times 10^9 + \frac{509.41 \times 10^3}{17.5 \times 10^{-3}{}^2} = 1.035 \times 10^9 \text{ Pa}$$

$$\text{@ } r_o \quad \sigma_r = a + \frac{b}{r_o^2} = 1.00625 \times 10^9 + \frac{509.41 \times 10^3}{22.5 \times 10^{-3}{}^2} = 1.029 \times 10^9 \text{ Pa}$$

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Q3.

formulas.

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

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

$$\nu = 0.2$$

$$E = 165 \times 10^9$$

$$\sigma_1 = \frac{E}{1-\nu^2} (\epsilon_x - \nu \epsilon_y)$$

$$\sigma_2 = \frac{E}{1-\nu^2} (\epsilon_y - \nu \epsilon_x)$$

$$\epsilon_1 = \frac{1}{E} (\sigma_1 - \nu \sigma_2)$$

$$\epsilon_2 = \frac{1}{E} (\sigma_2 - \nu \sigma_1)$$

$$\sigma_1 = \frac{165 \times 10^9}{1 - (0.2)^2} (-10 \times 10^{-6} + (0.2 \times 13 \times 10^{-6})) = -1.27 \times 10^6 \text{ Pa}$$

compressive

$$\sigma_2 = \frac{165 \times 10^9}{1 - (0.2)^2} (13 \times 10^{-6} + (0.2 \times -10 \times 10^{-6})) = 1.89 \times 10^6 \text{ Pa}$$

tensile

$$\sigma_x = 20 \times 10^6$$

$$\sigma_y = -15 \times 10^6$$

$$\epsilon_1 = \frac{1}{165 \times 10^9} (20 \times 10^6 - (0.2 \times -15 \times 10^6)) = \cancel{134.39 \times 10^{-6}} = 134.39 \times 10^{-6}$$

DE

$$\epsilon_2 = \frac{1}{165 \times 10^9} (-15 \times 10^6 - (0.2 \times 20 \times 10^6)) = -115.15 \times 10^{-6} \text{ DE}$$

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Q4.

formulas

$$D = 0.2 \text{ m}$$

$$L = 0.39$$

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

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

$$n_L = 0.9$$

$$n_c = 0.6$$

$$p = ?$$

$$\sigma_c = \frac{pD}{2tn_L}$$

$$\sigma_c = \frac{pD}{4tn_c}$$

$$p = \frac{2tn_L \sigma_c}{D}$$

$$p = \frac{2 \times 1.5 \times 10^{-3} \times 0.9 \times 100 \times 10^6}{0.2} = 1.35 \times 10^6 \text{ N/m}^2$$
$$\underline{\underline{= 13.5 \text{ bar}}}$$

$$p = \frac{4tn_c \sigma_c}{D}$$

$$p = \frac{4 \times 1.5 \times 10^{-3} \times 0.6 \times 100 \times 10^6}{0.2} = 1.8 \times 10^6 = 18 \text{ bar}$$

$$\therefore \underline{\underline{p_{max} = 13.5 \text{ bar}}}$$

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Q5.

$$C = 350 \text{ mm} = 0.35 = 0.35^3 = 0.042875$$

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

$$\nu = 0.3$$

$$E = 165 \times 10^9$$

formulas.

$$K = \frac{E}{3(1-2\nu)} \quad / \quad \epsilon_v = \frac{-P}{K}$$

i.

$$K = \frac{165 \times 10^9}{3(1-2 \times 0.3)} = \underline{\underline{137.5 \times 10^9 \text{ N/m}^2}} \quad \epsilon_v = \frac{\Delta V}{V}$$

$$\epsilon_v = \frac{-50 \times 10^6}{137.5 \times 10^9} = \underline{\underline{-363.64 \times 10^{-6}}}$$

$$\epsilon_v V = \Delta V \Rightarrow -363.64 \times 10^{-6} \times 0.042875 = \underline{\underline{-15.59 \times 10^{-6} \text{ m}^3}}$$

Q6 - anisotropic materials tend to have ~~diff~~ varied elastic constants in different directions. This can be attributed to individual grain crystalline structures of the materials.