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Question 1

i) $L = 1.5\text{m}$
 $EI = 2.2 \times 10^6 \text{ N/m}^2$
 $F = 3500 \text{ N}$
 $w = 1500 \text{ N}$

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

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

$$y_{\max} = 431.46 \times 10^{-6} + 1.78 \times 10^{-3}$$

$$y_{\max} = 2.21 \times 10^{-3} \text{ m}$$

ii) $y = y_{PL} = y_{wL}$

$$y_{PL} = y - y_{wL}$$

$$y_{PL} = -0.5 \times 10^{-3} - (-431.46 \times 10^{-6})$$

$$y_{PL} = -9.31 \times 10^{-4}$$

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

$$F = \frac{-9.31 \times 10^{-4} \times 3 \times 2.2 \times 10^6}{1.5^3}$$

$$F = -1820 \text{ N}$$

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Question 3

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

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

$$\nu = 0.20$$

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

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

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

$$\sigma_x = -1221875$$

tensile

$$\sigma_x = -1.22 \times 10^6 \text{ MPa}$$

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

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

$$= 1890625$$

Compressive

$$= 1.89 \times 10^6 \text{ MPa}$$

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(i) $\sigma_x = 20 \times 10^6$
 $\sigma_y = -15 \times 10^6$

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

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

$$\epsilon_x = 139,39 \times 10^{-6}$$

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

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

$$\epsilon_y = -115,15 \times 10^{-6}$$

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question 4

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

$$L = 0.34 \text{ m}$$

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

$$\eta_L = 0.9$$

$$\eta_c = 0.6$$

$$\sigma_{max} = 100 \times 10^6 \text{ N/m}^2$$

$$\sigma_L = \frac{p D}{4 t \eta_c}$$

$$\sigma_c = \frac{p D}{2 t \eta_L}$$

$$p = \frac{4 t \eta_c \sigma_L}{D}$$

$$p = \frac{2 t \eta_L \sigma_c}{D}$$

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

$$p_{maxL} = 1.8 \times 10^6 \text{ N/m}^2$$

$$= 18 \text{ bar}$$

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

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

$$= 13.5 \text{ bar}$$

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

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Question 5

q) $L = 350 \times 10^{-3}$
 $P = 50 \times 10^6 \text{ N/m}^2$
 $V = 0.3$
 $E = 165 \times 10^9 \text{ N/m}^2$

$$K = \frac{E}{3(1-2V)}$$

$$K = \frac{165 \times 10^9}{3(1-0.6)} \quad K = 137.5 \times 10^9 \text{ N/m}^2$$

$$K = \frac{\sigma}{\epsilon V} = \frac{-P}{\epsilon V}$$

$$\epsilon V = \frac{-P}{K} = \frac{-50 \times 10^6}{137.5 \times 10^9}$$

$$\epsilon V = -363.63 \times 10^{-6}$$

$$\Delta V = L^3 \times \epsilon V$$

$$\Delta V = (0.35)^3 \times -363 \times 10^{-6} = 15.6 \times 10^{-6} \text{ m}^3$$

orthotropic = different elastic constants
in different directions

This is because of grain
structure

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Question 2

$$\begin{aligned}d_o &= 0.45 & r_o &= 0.225 \\d_i &= 0.35 & r_i &= 0.125 \\P &= 115 \times 10^3\end{aligned}$$

$$r_o = 0.255 \quad \sigma_R = 0$$

$$\sigma_R = -u - \frac{b}{r^2}$$

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