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Lewis Aubrey 1802539 ACHA5015

1.)

1500N/m w

1.5M

3.5kN

a.) $L = 1.5M$
 $EI = 2.2 \times 10^6$

$y_{max} = y_{ude} + y_{PL}$

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

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

$y_{ude} = 431.46 \times 10^{-6}$

$y_{max} = 431.46 \times 10^{-6} + 1.79 \times 10^{-3}$

$y_{PL} = 1.79 \times 10^{-3}$

$y_{max} = 2.22 \times 10^{-3}$

b.) $y_{ude} = y - y_{PL}$
 $y_{PL} = 5 \times 10^{-3} - 431.46 \times 10^{-6} = 4.57 \times 10^{-3}$

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

$F = \frac{4.57 \times 10^{-3} \times (3 \times 2.2 \times 10^6)}{1.5^3} = 8.94 \times 10^3 N$

$\Delta F = 8.94 \times 10^3 - 3500 = 5440 N$

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3.) strain values

$$\epsilon_x = -10 \times 10^{-6}$$
$$\epsilon_y = +13 \times 10^{-6}$$
$$\nu = 0.20$$
$$\text{Modulus of elasticity} = 165 \text{ GPa}$$
$$\sigma_x = \frac{165 \times 10^9}{1 - 0.20^2} (-10 \times 10^{-6} + 0.2(13 \times 10^{-6})) = -1.27 \times 10^6$$
$$\sigma_y = \frac{165 \times 10^9}{1 - 0.20^2} (13 \times 10^{-6} + 0.2(-10 \times 10^{-6})) = 1.89 \times 10^6$$
$$\begin{aligned} \text{Compressive} &= \sigma_x = -1.27 \times 10^6 \text{ Pa} \\ \text{Tensile} &= \sigma_y = 1.89 \times 10^6 \text{ Pa} \end{aligned}$$

b)

$$\epsilon_x = \frac{1}{E} (\sigma_x - (\nu \times \sigma_y))$$
$$\epsilon_x = \frac{1}{165 \times 10^9} (20 \times 10^6 - (0.20 \times -15 \times 10^6))$$
$$\epsilon_x = 139.40 \times 10^{-6} \text{ N/F}$$
$$\epsilon_y = \frac{1}{165 \times 10^9} (-15 \times 10^6 - (0.20 \times 20 \times 10^6))$$
$$\epsilon_y = -115.15 \times 10^{-6} \text{ N/F}$$

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$$d = 0.2 \text{ m}$$
$$L = 0.39 \text{ m}$$
$$n_c = 0.6$$
$$\eta_l = 0.9$$
$$\sigma_{max} = 100 \times 10^6$$
$$t = 1.5 \times 10^{-3} \text{ m}$$
$$\sigma_c = \frac{PD}{2t n_c}$$
$$P = \frac{2t n_c \sigma_c}{D}$$
$$P_{max} = \frac{(2 \times 1.5 \times 10^{-3}) \times 0.9 \times 100 \times 10^6}{0.2} = 1.35 \times 10^6$$
$$P_{max} = 13.5 \text{ bar}$$
$$\sigma_c = \frac{PD}{4t n_c}$$
$$P = \frac{4t n_c \sigma_c}{D}$$
$$P_{max} = \frac{(4 \times 1.5 \times 10^{-3}) \times 0.6 \times 100 \times 10^6}{0.2}$$
$$P_{max} = 18 \text{ bar}$$
$$\therefore = P_{max} 13.5 \text{ BAR}$$

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5.) $L = 0.35 \text{ m}$

$$P = 50 \times 10^6$$

$$\nu = 0.3$$

$$E = 165.0 \text{ GPa} \quad 165 \times 10^9$$

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

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

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

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

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

$$\Delta V = (-363.64 \times 10^{-6}) \times (0.35)^3 \times 165 \times 10^9 \text{ m}^3$$

6.) An orthotropic material has different elastic properties in different directions, one example is wood.