

Q₁

- a) materials where the elastic constants are the same in all directions, cutting the material doesn't change this property. Materials such as ~~wood~~^{glass} or ~~rolled~~ metals and plastic.
- b) Orthotropic materials are things like wood, rolled metal and certain stone.

$$L = 400 \text{ mm} = 400 \times 10^{-3} \text{ m}$$

$$P = 40 \text{ MPa N/m}^2$$

$$\nu = 0.3$$

$$E = 165 \text{ GPa N/m}^2$$

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

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

$$= - \frac{40 \times 10^6}{137.5 \times 10^9} = \epsilon_v = \underline{290.9 \times 10^{-6}}$$

$$iii) \Delta L = C^3 \times \epsilon_v = (0.4)^3 \times 290.9 \times 10^{-6} = \underline{\Delta L = 7.5 \times 10^{-6}}$$

~~Ans~~

Q2

$$d = 0.28 \text{ m} \quad 280 \text{ mm}$$

$$L = 0.7 \text{ m} \quad 700 \text{ mm}$$

$$n_L = 0.909$$

$$n_C = 0.64$$

$$\sigma_{\max} = 110 \times 10^6 \text{ N/m}^2$$

$$P = 22 \times 10^5$$

$$\sigma_C = \frac{Pd}{2En_L}$$

$$\sigma_L = \frac{Pd}{4En_C}$$

$$\epsilon = \frac{Pd}{2\sigma_C n_L}$$

$$\epsilon = \frac{Pd}{4\sigma_L n_C}$$

$$\epsilon = \frac{22 \times 10^5 \times 0.28}{2 \times 110 \times 10^6 \times 0.9}$$

$$= \underline{3.1 \text{ mm}}$$

$$\epsilon = \frac{22 \times 10^5 \times 0.28}{4 \times 110 \times 10^6 \times 0.64}$$

$$= \underline{2.2 \text{ mm}}$$

$$\epsilon_{\min} = \underline{3.1 \text{ mm}}$$

Q3

a)

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

$$\epsilon_y = +16 \times 10^{-6}$$

$$\nu = 0.20$$

$$E = 160 \times 10^9 \text{ N/m}^2$$

$$\sigma_x = \frac{E}{1-\nu^2} (\epsilon_x + \nu \epsilon_y) = \frac{160 \times 10^9}{1-0.2^2} \left(-13 \times 10^{-6} + (0.2 \times 16 \times 10^{-6}) \right)$$

$$\sigma_x = \underline{-1.63 \times 10^6} \quad \text{Compressive}$$

$$\sigma_y = \frac{E}{1-\nu^2} (\epsilon_y + \nu \epsilon_x) = \frac{160 \times 10^9}{1-0.2^2} \left(16 \times 10^{-6} + (0.2 \times -13 \times 10^{-6}) \right)$$

$$\sigma_y = \underline{2.23 \times 10^6} \quad \text{Tensile}$$

b)

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

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

$$\epsilon_x = \frac{1}{E} (\sigma_x - \nu \sigma_y) = \frac{1}{160 \times 10^9} \left(10 \times 10^6 - (0.2 \times -15 \times 10^6) \right)$$

$$= \underline{81.25 \times 10^{-6}}$$

$$\epsilon_y = \frac{1}{E} (\sigma_y - \nu \sigma_x) = \frac{1}{160 \times 10^9} \left(-15 \times 10^6 - (0.2 \times 10 \times 10^6) \right)$$

$$= \underline{106.25 \times 10^{-6}}$$

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$$d_o = \cancel{0.55\text{ m}} \ 55\text{ mm} \quad / \ 0.055\text{ m} \quad r_o = 27.5 \text{ Outer}$$

$$d_i = 45\text{ mm} \quad / \ 0.045\text{ m} \quad r_i = 22.5$$

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