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Module name: Stress Analysis and CAE (ACHASOIS)

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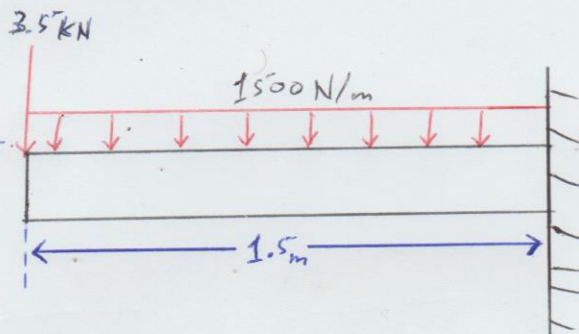
Question 1

$$L = 1.5 \text{ m} \quad v = 1.5^3 = 3.375$$

$$F = 3.5 \text{ kN} (3500 \text{ N})$$

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

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



$$a) \text{ Deflection} = \frac{fL^3}{3EI} + \frac{wL^4}{8EI}$$

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

$$y = -1.789 \times 10^{-3} + -0.288 \times 10^{-3}$$

$$y = \underline{\underline{-2.077 \times 10^{-3}}}$$

$$b) \quad y = y_{PL} + y_{u.d.L}$$

$$y_{PL} = y - y_{u.d.L} = 5 \times 10^{-3} - 3.375$$

$$y_{PL} = \underline{\underline{-16.88 \times 10^{-3} \text{ m}}}$$

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

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

$$F = \frac{-16.88 \times 10^{-3} \times 3 \times 2.2 \times 10^6}{1.5^3} = 33009.7 \text{ N}$$

$$\Delta F = 33009.7 - 3500 = \underline{\underline{29509.7 \text{ N}}}$$

$$Q3) \epsilon_x = -10 \times 10^{-6}$$

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

$$\nu = 0.20$$

$$E = 165 \text{ GPa} (165 \times 10^9 \text{ Pa})$$

$$\sigma_x = ?$$

$$\sigma_y = ?$$

$$a) \sigma_x = \frac{165 \times 10^9 \text{ Pa}}{1 - (0.20)} (-10 \times 10^{-6} + (0.20 \times 13 \times 10^{-6}))$$

$$\sigma_x = \underline{-1.53 \times 10^6 \text{ Pa}} \text{ (compressive)}$$

$$\sigma_y = \frac{165 \times 10^9 \text{ Pa}}{1 - (0.20)} (13 \times 10^{-6} + (0.20 \times -10 \times 10^{-6}))$$

$$\sigma_y = \underline{2.27 \times 10^6 \text{ Pa}} \text{ (tensile)}$$

$$b) \sigma_x = 20 \text{ MPa} (20 \times 10^6 \text{ Pa})$$

$$\sigma_y = -15 \text{ MPa} (-15 \times 10^6 \text{ Pa})$$

$$\epsilon_x = ?$$

$$\epsilon_y = ?$$

$$\epsilon_x = \frac{1}{165 \times 10^9 \text{ Pa}} (\cancel{20 \times 10^6} - (0.20 \times -15 \times 10^6))$$

$$\epsilon_x = \underline{139.39 \times 10^{-6}}$$

$$\epsilon_y = \frac{1}{165 \times 10^9 \text{ Pa}} (-15 \times 10^6 - (0.20 \times 20 \times 10^6))$$

$$\epsilon_y = \underline{-115.15 \times 10^{-6}}$$

Q4) diameter = 200 mm (2×10^{-3})

Length = 390 mm (3.9×10^{-3})

$t = 1.5$ mm (1.5×10^{-3})

$\sigma_{max} = 100$ MPa (100×10^6 Pa)

$n_t = 0.9$

$n_c = 0.6$

$P_{max} = ?$

$$\sigma_c = \frac{PD}{2tn_c}$$

$$\sigma_L = \frac{PD}{4tn_c}$$

$$P = \frac{2tn_c\sigma_c}{D}$$

$$P = \frac{4tn_c\sigma_L}{D}$$

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

$$P_{max_L} = \frac{4 \times 1.5 \times 10^{-3} \times 0.6 \times 100 \times 10^6}{2 \times 10^{-3}}$$

$$P_{max_c} = 135 \times 10^6 \text{ N/m}^2$$

$$P_{max_L} = 180 \times 10^6 \text{ N/m}^2$$

$$\underline{\underline{P_{max_L} = 180 \times 10^6 \text{ N/m}^2}}$$

Q5)

$$L = 350 \text{ mm} \quad \text{Volume} = (35 \times 10^{-3})^3 = 4.29 \times 10^{-5} \text{ m}^3$$

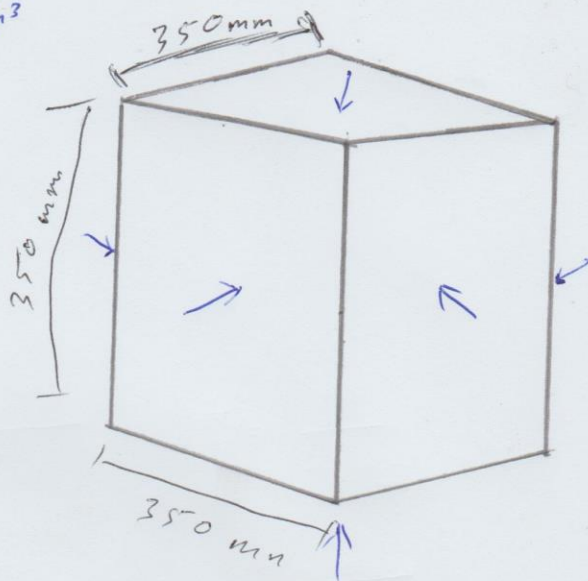
$$P = 50 \text{ MPa} (50 \times 10^6 \text{ Pa})$$

$$E = 165 \times 10^9 \text{ Pa}$$

$$\nu = 0.3$$

$$K = ?$$

$$\Delta V = ?$$



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

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

$$\text{using: } K = \frac{-P}{\epsilon_v} \rightarrow \epsilon_v = \frac{-P}{K} = \frac{-50 \times 10^6 \text{ Pa}}{137.5 \times 10^9} = \underline{\underline{-3.636 \times 10^{-4}}}$$

$$\text{using: } \epsilon_v = \frac{\Delta V}{V} \rightarrow \Delta V = \epsilon_v V = -3.636 \times 10^{-4} \times 4.29 \times 10^{-5}$$
$$\Delta V = \underline{\underline{-1.559 \times 10^{-8} \text{ m}^3}}$$

b) orthotropic materials have different elasticity of constants in ~~the~~ its x, y and z axis. This may be ~~due~~ ^{due} of the grain structure of fibre direction in composites.

An example of a type of orthotropic material would be: Wood