

Location : Swansea
Level : 5
Examination period : Jan 2021
Module code : ACHA5015
Time : 2 hours

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STRESS Analysis

Q1)

$$L = 1.5$$

$$F = 35 \text{ kN} = 3500$$

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

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

$$\begin{aligned} a) \quad & \frac{35 \times 1.5^3}{3 \times (2.2 \times 10^6)} + \frac{1500 \times 1.5^4}{8 \times (2.2 \times 10^6)} + \frac{3500 \times 1.5^3}{3 \times (2.2 \times 10^6)} \\ & 1.789 \times 10^{-3} + 1.006 \times 10^{-3} + 4.314 \times 10^{-4} \\ & = 2.22 \times 10^{-3} \end{aligned}$$

b)

$$g = g_{PL} + g_{DL}$$

$$g_{PL} = g - g_{DL} = -0.5 \times 10^{-3} - (4.314 \times 10^{-4})$$

$$g_{PL} = -9.314 \times 10^{-4}$$

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

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

$$= -1821.4$$

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Q2)

$$d_o = 45 \text{ mm} = 0.045 \text{ m}$$

$$d_i = 35 \text{ mm} = 0.035 \text{ m}$$

$$P = 115 \text{ bar} \quad 115 \times 10^5 \text{ N/m}^2$$

$$r_o = 22.5 \text{ mm}$$

$$r_i = 17.5 \text{ mm}$$

$$\sigma_o = 0$$

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

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Stress analysis

Q3)

$$\begin{aligned}\epsilon_x &= -10 \times 10^{-6} \\ \epsilon_y &= 13 \times 10^{-6} \\ \nu &= 0.20 \\ E &= 165 \times 10^9 \text{ N/m}^2\end{aligned}$$

a)

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

$$\sigma_x = -1271875 = -1.27 \times 10^6$$

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

$$\sigma_y = 1890625 = 1.89 \times 10^6$$

b)

$$\sigma_x = 20 \times 10^6 \text{ N/m}^2$$

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

$$\epsilon_x = \frac{1}{E} (\sigma_x - \nu \sigma_y) = \frac{1}{165 \times 10^9} (20 \times 10^6 - (0.2 \times -15 \times 10^6))$$
$$= 139.39 \times 10^{-6}$$

$$\epsilon_y = \frac{1}{E} (\sigma_y - \nu \sigma_x) = \frac{1}{165 \times 10^9} (-15 \times 10^6 - (0.2 \times 20 \times 10^6))$$
$$= -115 \times 10^{-6}$$

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Stress analysis

Q4

$$d = 700 \text{ mm} = 0.7 \text{ m}$$

$$L = 390 \text{ mm} = 0.39 \text{ m}$$

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

$$n_c = 0.9$$

$$n_t = 0.6$$

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

$$\sigma_c = \frac{P D}{2 t n_c}$$

$$\sigma_t = \frac{P D}{4 t n_t}$$

$$P = \frac{2 t n_c \sigma_c}{D}$$

$$P = \frac{4 t n_t \sigma_t}{D}$$

$$P_{\max c} = \frac{2 \times 1.5 \times 10^{-3} \times 0.9 \times 100 \times 10^6}{0.7}$$

$$P_{\max c} = 1.35 \times 10^6$$

$$P_{\max t} = \frac{4 \times 1.5 \times 10^{-3} \times 0.6 \times 100 \times 10^6}{0.7}$$

$$P_{\max t} = 1.8 \times 10^6$$

$$P_{\max c} = 135 \text{ bar} \quad P_{\max t} = 18 \text{ bar}$$

$$= 13.5 \text{ bar}$$

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Stress Analysis

Q5)

$$L = 350 \text{ mm} \times 10^{-3} = 0.35 \text{ m}$$

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

$$\nu = 0.3$$

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

a)

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

$$k = \frac{\sigma}{\epsilon \nu} = \frac{-P}{\epsilon \nu}$$

$$\epsilon \nu = \frac{-P}{k} = \frac{-50 \times 10^6}{137.5 \times 10^9} = -363.63 \times 10^{-6}$$

$$\Delta V = L^3 \times \epsilon \nu = (0.35)^3 \times ~~363.63~~ -363.63 \times 10^{-6}$$

$$= ~~0.158 \times 10^{-6}~~ = 15.59 \times 10^{-6}$$

b) orthotropic material ~~isotropic~~ has different elastic properties through different directions.