

Harry Grundy

ACHASOIS

Andrew Hamson

1703078

Stress Analysis

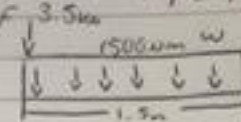
3500 N/m

11/01/2021

Q1) a)

$$L = 1.5 \text{ m}$$

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



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

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

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

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

$$y_{\text{PL}} = 1.79 \times 10^{-3} \quad y_{\max} = \underline{2.22 \times 10^{-3}}$$

$$\text{b) } y_{\text{due}} = y - y_{\text{PL}}$$

$$\therefore y_{\text{PL}} = y - y_{\text{due}}$$

$$y_{\text{PL}} = 5 \times 10^{-3} - 431.46 \times 10^{-6} = \underline{4.57 \times 10^{-3}}$$

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

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

$$\Delta F = 8.94 \times 10^3 - 3500 = \underline{5440 \text{ N}}$$

Harry Gundy

1703078

Q2)

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

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

$$r_o = 0.0225 \text{ m}$$

$$r_i = 0.0175 \text{ m}$$

$$\textcircled{a} \quad r_o = 0.0225 \text{ m} \quad \sigma_r = 0 \quad / \quad \textcircled{a} \quad r_i = 0.0175 \text{ m} \quad \sigma_r = -P = -115 \times 10^5$$

$$\sigma_r = a - \frac{b}{r^2} \quad / \quad -115 \times 10^5 = \frac{a - b}{(0.0175)^2}$$

$$0 = a - \frac{b}{(0.0225)^2} \quad \textcircled{b} \quad -115 \times 10^5 = b - (0.0175)^2 a$$

$$\textcircled{1} \quad b = -(0.0225)^2 a$$

$$-115 \times 10^5 = -10.0625 a + 0.0030625 a$$

$$-115 \times 10^5 = -9.75625 a$$

$$-115 \times 10^5 (0.0175)^2 = (0.0225)^2 a - (0.0175)^2 a$$

$$-115 \times 10^5 (0.0175)^2 = a (0.0225^2 - 0.0175^2)$$

$$\therefore a = \frac{115 \times 10^5 (0.0175)^2}{(0.0225^2 - 0.0175^2)} = 11.05 \times 10^6$$

$$\therefore b = -(0.0225)^2 \times 11.05 \times 10^6 = -5.59 \times 10^3$$

$$a = 11.05 \times 10^6$$

$$b = -5.59 \times 10^3$$

Herry Gundy

1703076

Q2)c)

$$\begin{aligned} \textcircled{a} \quad r_i = \sigma_c &= a + \frac{b}{r^2} = 11.05 \times 10^6 + \frac{-5.59 \times 10^3}{0.0175^2} \\ &= 7.2 \times 10^6 \\ &= \underline{7.2 \text{ Mpa}} \end{aligned}$$

$$\begin{aligned} \textcircled{a} \quad r_o = \sigma_c &= a + \frac{b}{r^2} = 11.05 \times 10^6 + \frac{-5.59 \times 10^3}{0.0225^2} \\ &= 8.02 \times 10^6 \\ &= \underline{8.02 \text{ Mpa}} \end{aligned}$$

Herry Grundy
Herry Grundy

1703078

1703078

Q3)a)

$$\sigma_x = \frac{E}{1-\nu^2} (E_x + \nu E_y)$$

$$\sigma_x = \frac{165 \times 10^9}{1-0.20^2} (-10 \times 10^{-6} + (0.20 \times 13 \times 10^{-6}))$$

$$\sigma_x = -1.27 \times 10^6 \text{ Pa}$$

$$\sigma_y = \frac{165 \times 10^9}{1-0.20^2} (13 \times 10^{-6} + (0.20 \times -10 \times 10^{-6}))$$

$$\sigma_y = 1.89 \times 10^6 \text{ Pa}$$

$$\text{Compressive} = \sigma_x = -1.27 \times 10^6 \text{ Pa}$$

$$\text{tensile} = \sigma_y = 1.89 \times 10^6 \text{ Pa}$$

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

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

$$E_x = \underline{\underline{139.40 \times 10^{-6} \text{ N/m}^2}}$$

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

$$E_y = \underline{\underline{-115.15 \times 10^{-6} \text{ N/m}^2}}$$

Harry Grundy

1703078

Q4)

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

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

$$\lambda_L = 0.9$$

$$\lambda_c = 0.6$$

$$\sigma_{\max} = 100 \times 10^6$$

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

$$\sigma_c = \frac{PD}{2t\lambda_L}$$

$$\sigma_L = \frac{PD}{4t\lambda_c}$$

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

$$P = \frac{4t\lambda_c\sigma_L}{D}$$

$$P_{\max c} = \frac{(2 \times 1.5 \times 10^{-3}) \times 0.9 \times 100 \times 10^6}{0.2} = 1.35 \times 10^6$$

$$P_{\max L} = \frac{(4 \times 1.5 \times 10^{-3}) \times 0.6 \times 100 \times 10^6}{0.2} = 1.8 \times 10^6$$

$$P_{\max} = \underline{13.5 \text{ Bar}}$$

$$P_{\max L} = \underline{18 \text{ Bar}}$$

$$\therefore P_{\max} = \underline{13.5 \text{ Bar}}$$

Herry Grundy

1703078

Q5)

(a)

$$L = \cancel{3.5 \times 10^{-2}} 0.35$$

$$P = 5 \times 10^6$$

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

$$V = 0.3$$

$$k = \frac{E}{3(1-2\nu)}$$

$$k = \frac{165 \times 10^9}{3(1-2 \times 0.3)} = 137.5 \times 10^9 \text{ N/m}^2$$

$$k = \frac{\sigma}{E\nu} \rightarrow k = \frac{-P}{E\nu} \rightarrow E\nu = \frac{-P}{k}$$

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

$$\Delta V = L^3 \times E\nu$$

$$\Delta V = (\cancel{0.35})^3 \times -363.64 \times 10^{-6} = -15.54 \times 10^{-6} \text{ m}^3$$

b)

orthotropic materials are materials that have different elastic constants in different directions an example of one is wood.

