

ACHASOLS

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Question One

a) $L = 1.5m$

$EI = 2.2 \times 10^6 Nm^2$

Max slope =

$$\frac{dy}{dx} = \frac{FL^2}{2EI} + \frac{WL^3}{6EI}$$

Max deflection

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

$$= \frac{3.5 \times 10^3 \times 1.5^3}{3(2.2 \times 10^6)} + \frac{1500 \times 1.5^4}{8(2.2 \times 10^6)}$$

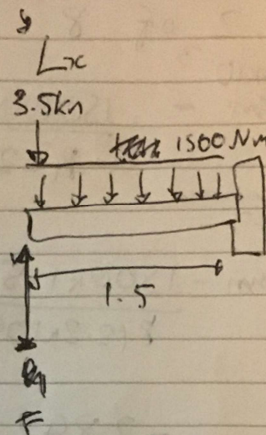
or $2.22 \times 10^{-3} m$

b) if $y = 5mm$

~~$5mm = \frac{F(1.5)^3}{3(2.2 \times 10^6)} + \frac{1500 \times 1.5^4}{8(2.2 \times 10^6)}$~~

$$5mm = \frac{F(1.5)^3}{3(2.2 \times 10^6)} + \frac{1500 \times 1.5^4}{8(2.2 \times 10^6)}$$

$$\frac{5mm}{F(1.5)^3} = \frac{1500 \times 1.5^4}{8(2.2 \times 10^6)}$$



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$$\frac{5 \times 10^{-3}}{8(2.2 \times 10^6)} - \frac{1500 \times 1.5^4}{8(2.2 \times 10^6)} = \frac{F(1.5)^3}{3(2.2 \times 10^6)}$$

$$\frac{5 \times 10^{-3}}{8(2.2 \times 10^6)} - \frac{1500 \times 1.5^4}{8(2.2 \times 10^6)} \times (3 \times 2.2 \times 10^6) = F(1.5)^3$$

$$-2847.65125 = F(1.5)^3$$

$$\frac{-2847.65125}{1.5} = F^3$$

$$-1898.434167 = F^3$$

$$F = \sqrt[3]{-1898.434167}$$

$$F = 12.38 \text{ N}$$

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

$$y - \frac{WL^4}{8EI} = \frac{FL^3}{3EI}$$

$$y - \frac{WL^4}{8EI} \times 3EI = FL^3$$

$$\frac{y - \frac{WL^4}{8EI} \times 3EI}{L} = F^3$$

$$\sqrt[3]{\frac{y - \frac{WL^4}{8EI} \times 3EI}{L}} = F$$

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Question 2

a)

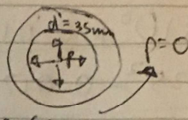
$$D = 45 \text{ mm} \rightarrow 0.045 \text{ m}$$

$$d = 35 \text{ mm} \rightarrow 0.035 \text{ m}$$

$$t = 10 \text{ mm} \rightarrow 0.01$$

$$p = 115 \text{ bar} \rightarrow 11.5 \times 10^6 \text{ N/m}^2$$

$$\sigma_c = ?$$



a) boundary conditions

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

$$\text{outside surface } \sigma_r = -p = -11.5 \times 10^6 \text{ N/m}^2$$

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

$$\sigma_r = 0$$

b) inner surface

$$\sigma_r = \frac{a-b}{r^2}$$

$$-11.5 \times 10^6 = \frac{a-b}{0.0175^2}$$

$$-11.5 \times 10^6 (0.0175)^2 = 0.0175^2 (a-b)$$

$$11.5 \times 10^6 \times 0.0175^2 = 0.0175^2 (a-b)$$

$$0.0175^2 (a-b) = 0.0225^2 a - 0.0175^2 a$$

outer surface

$$\sigma_r = \frac{a-b}{r^2}$$

$$0 = \frac{a-b}{0.0225^2}$$

$$0 = 0.0225^2 (a-b)$$

$$b = 0.0225^2 a$$

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$$11.5 \times 10^6 \times 0.075 = a(0.075^2 + 0.0225^2)$$

$$a = \frac{11.5 \times 10^6 \times 0.0175^2}{0.0225^2 - 0.0175^2} = 17.61 \times 10^6$$

$$b = 0.0225^2 a$$

$$= 0.0225^2 \times 17.61 \times 10^6 = 8.92 \times 10^3$$

$$c) \sigma_c = \frac{a+b}{a+r^2}$$

$$= 17.61 \times 10^6 + \frac{8.92 \times 10^3}{0.0175}$$

$$= 18.12 \times 10^6 \text{ Pa}$$

$$\text{inner} = 18.12 \text{ MPa}$$

~~but~~

$$\sigma_{ce} = 17.61 \times 10^6 + \frac{8.92 \times 10^3}{0.0225}$$

$$= 18.01 \times 10^6 \text{ Pa}$$

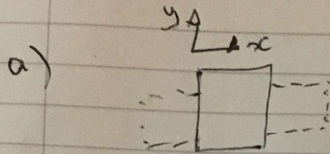
$$\text{outer} = 18.01 \text{ MPa}$$

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Question 3



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

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

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

$-v = 0.2$

$E = 165 \times 10^9$

$$\sigma_x = \frac{E}{1-v^2} (\epsilon_x + v\epsilon_y)$$

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

$$\sigma_x = -2.17 \times 10^6 \text{ Pa}$$

$$= -2.17 \text{ MPa}$$

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

$$\sigma_y = 2.23 \times 10^6$$

$$= 2.23 \text{ MPa}$$

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$$b) \quad \nu = 0.2$$

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

$$\sigma_x = 20 \times 10^3 \text{ Pa}$$

$$\sigma_y = -15 \times 10^3 \text{ Pa}$$

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

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

$$\epsilon_x = \frac{1}{165 \times 10^9} (20 \times 10^3 - (0.2 \times -15 \times 10^3))$$

$$\epsilon_x = 1.39 \times 10^{-7}$$

$$\epsilon_y = \frac{1}{165 \times 10^9} (-15 \times 10^3 - 0.2 \times 20 \times 10^3)$$

$$\epsilon_y = -1.15 \times 10^{-7}$$

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Question 4

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

$$L = ~~0.29~~ 0.39 \text{ m}$$

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

$$\sigma_c = 100 \times 10^3 \text{ Pa}$$

$$\sigma_L = 100 \times 10^3 \text{ Pa}$$

$$R_L = 0.9$$

$$R_c = 0.6$$

$$P = ~~100 \times 10^3 \text{ N/m}^2~~ \quad P = ?$$

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

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

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

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

$$P_c = \frac{100 \times 10^3 (2 \times 1.5 \times 10^{-3}) \times 0.9}{0.2}$$

$$P = 1350 \text{ N/m}^2$$

$$P_L = \frac{100 \times 10^3 (4 \times 1.5 \times 10^{-3}) \times 0.6}{0.2}$$

$$P = 1800 \text{ N/m}^2$$

$$P_{\max} = ~~1800 \text{ N/m}^2~~ \\ 1350 \text{ N/m}^2$$

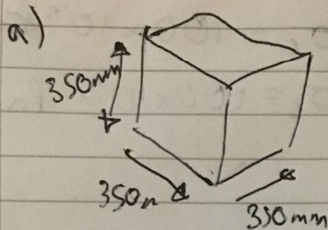
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Question 5



$$\text{volume} = 0.043 \text{ m}^3$$

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

$$\nu = 0.3$$

$$\text{Pressure} = 50 \times 10^3 \text{ Pa}$$

$$k = ?$$

$$\Delta v = ?$$

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

$$k = 6.875 \times 10^{10}$$

$$\epsilon_v = \frac{50 + 50 + 50}{165 \times 10^9} (1 - 2(0.3)) = 3.64 \times 10^{-10}$$

b) ~~Orthotropic has elastic properties~~

orthotropic has different elastic properties in different directions (x, y, z)