

ANDREW WHITE (1803827)

$$\textcircled{1} \quad EI = 2.2 \times 10^6$$

$$L = 1.5$$

$$a) \quad \text{Deflection} = \frac{FL^3}{3EI} + \frac{WL^4}{8EI} \quad (y_{PL} + y_{UDL})$$

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

$$= 1.7898 \times 10^{-3} + 4.3146 \times 10^{-4}$$

$$= \underline{\underline{2.22 \times 10^{-3} \text{ m}}}$$

$$b) \quad y = y_{PL} + y_{UDL}$$

$$y_{PL} = y - y_{UDL}$$

$$= 5 \times 10^{-3} - 4.3146 \times 10^{-4}$$

$$= 4.56854 \times 10^{-3} \text{ m}$$

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

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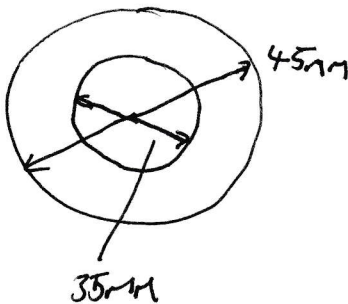
(1b cont.)

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

$$F = \frac{4.56854 \times 10^{-3} \times 3(2.2 \times 10^6)}{1.5^3}$$

$$F = 8934 \text{ N}$$

$$\therefore \Delta F = 8934 - 3500 = \underline{\underline{5434 \text{ N}}}$$



$$P = 115 \text{ Bar} = 115 \times 10^5 \text{ Pa}$$

a) Boundary conditions are that:

Absolute Pressure = Gauge pressure + atmospheric pressure

$\therefore$ When atmospheric pressure acts on one side of the wall it will equal 0.

$\therefore$ INNER

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

$$\sigma_r = -P = -115 \times 10^5$$

OUTER

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

$$\sigma_r = 0$$

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(26)

INNER

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

$$\sigma_r = -115 \times 10^5$$

OUTER

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

$$\sigma_r = 0$$

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

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$$-115 \times 10^5 = a - \frac{b}{0.0175^2}$$

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

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

$$b = 0.0225^2 a$$

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

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

$$a = \frac{(115 \times 10^5)(0.0175^2)}{0.0225^2 - 0.0175^2} = \underline{\underline{17.61 \times 10^6}}$$

$$\therefore b = 0.0225^2 a$$

$$b = 0.0225^2 \times 17.61 \times 10^6 = \underline{\underline{8.92 \times 10^3}}$$

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(2c)

$$\sigma_{ci} = a + \frac{b}{r^2}$$

$$= 17.61 \times 10^6 + \frac{8.92 \times 10^3}{0.0175^2}$$

$$= 46.74 \times 10^6 \text{ Pa}$$

$$= \underline{\underline{46.74 \text{ MPa}}}$$

$$\sigma_{co} = a + \frac{b}{r^2}$$

$$= 17.61 \times 10^6 + \frac{8.92 \times 10^3}{0.0225^2}$$

$$= 35.23 \times 10^6 \text{ Pa}$$

$$= \underline{\underline{35.2 \text{ MPa}}}$$

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$$\textcircled{3} \quad \epsilon_x = -10 \times 10^{-6} \quad \nu = 0.2$$

$$\epsilon_y = 13 \times 10^{-6} \quad E = 165 \text{ GPa} = 165 \times 10^9 \text{ Pa}$$

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

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

$$\begin{aligned} \sigma_x &= -1.27 \times 10^6 \\ &= \underline{\underline{-1.27 \text{ MPa}}} \quad (\text{compressive}) \end{aligned}$$

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

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

$$\begin{aligned} \sigma_y &= 1.89 \times 10^6 \\ &= \underline{\underline{1.89 \text{ MPa}}} \quad (\text{tensile}) \end{aligned}$$

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$$(3b) \sigma_x = 20 \text{ MPa} = 20 \times 10^6 \text{ Pa}$$

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

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

$$\nu = 0.2$$

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

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

$$\epsilon_x = 1.39 \times 10^{-4} = 139 \times 10^{-6} = \underline{\underline{139 \mu \epsilon}}$$

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

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

$$\epsilon_y = -1.15 \times 10^{-4} = -115 \times 10^{-6} = \underline{\underline{-115 \mu \epsilon}}$$

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(4)

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

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

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

$$t = 1.5 \text{ mm} = 0.0015 \text{ m} = 1.5 \times 10^{-3} \text{ m}$$

$$\frac{r_L}{R_m} = 0.9$$

$$\frac{r_c}{R_m} = 0.7$$

$$\sigma_c = \frac{pD}{2t r_L}$$

$$\sigma_L = \frac{pD}{4t r_c}$$

$$p = \frac{\sigma_c 2t r_L}{D}$$

$$p = \frac{\sigma_L 4t r_c}{D}$$

$$p = \frac{100 \times 10^6 \times 2 \times 0.0015 \times 0.9}{0.2}$$

$$p = \frac{100 \times 10^6 \times 4 \times 0.0015 \times 0.7}{0.2}$$

$$p = 1.35 \times 10^6$$

$$p = 2.1 \times 10^6$$

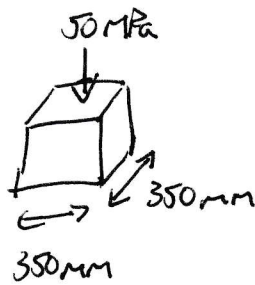
$$p = 13.5 \times 10^5 = \underline{\underline{13.5 \text{ bar}}}$$

$$p = 21 \times 10^5 = \underline{\underline{21 \text{ bar}}}$$

$\therefore$ Max. pressure = 21 bar / 2.1 MPa

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(5a)



$$L = 350 \text{ mm} = 0.35 \text{ m} \quad V = (0.35)^3$$

$$p = 50 \text{ MPa} = 50 \times 10^6 \text{ Pa}$$

$$\nu = 0.3$$

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

$$K = ? \quad \epsilon_v = ? \quad \Delta V = ?$$

$$K = \frac{\sigma}{\epsilon_v} = \frac{P}{\Delta V}$$

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

$$K = -\frac{P}{\Delta V}$$

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

$$K = 1.375 \times 10^{11} = \underline{\underline{137.5 \times 10^9 \text{ N/m}^2}}$$

$$K = \frac{\sigma}{\epsilon_v} = -\frac{P}{\Delta V}$$

$$K = -\frac{P}{\epsilon_v}$$

$$\epsilon_v = -\frac{P}{K} = -\frac{50 \times 10^6}{137.5 \times 10^9} = \underline{\underline{-363.6 \times 10^{-6}}}$$

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5a cont.

$$\Sigma_v = \frac{\Delta V}{V}$$

$$\Delta V = V \Sigma_v$$

$$\Delta V = (0.35)^3 \times -363.6 \times 10^{-6}$$

$$\Delta V = \text{or } \underline{\underline{-15.6 \times 10^{-6} \text{ m}^3}}$$

5b

Orthotropic materials have different ^{properties,} elastic ~~constants~~ ~~in different directions.~~ such as, elastic components, in different directions.

A material which exhibits these characteristics is wood.