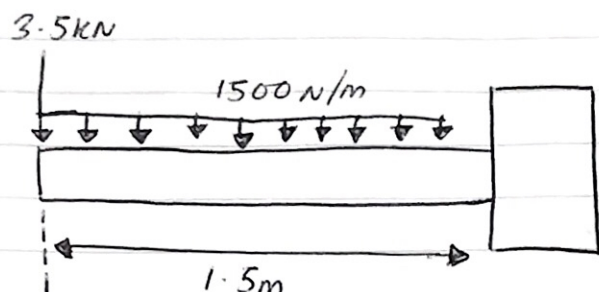


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Q1).



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

$$EI = 2.2 \times 10^6 \text{ Nm}^2$$

Q1a).

$$\begin{aligned} \text{deflection} &= \frac{fL^3}{3EI} + \frac{WL^4}{8EI} \\ &= \frac{-3500 \times 1.5^3}{3 \times 2.2 \times 10^6} + \frac{-1500 \times 1.5^4}{8 \times 2.2 \times 10^6} \end{aligned}$$

$$\begin{aligned} &= -1.79 \times 10^{-3} + \cancel{-4.31 \times 10^{-3}} - 0.431 \times 10^{-3} \\ &= -2.22 \times 10^{-3} \text{ mm} \end{aligned}$$

Q1b).

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

$$\begin{aligned} y_{PL} = y - y_{UDL} &= \cancel{-2.22 \times 10^{-3}} - \cancel{-4.31 \times 10^{-3}} - 0.43 \times 10^{-3} \\ &= -4.57 \times 10^{-3} \end{aligned}$$

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

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

$$\therefore f = \frac{-4.57 \times 10^{-3} \times 3 \times 2.2 \times 10^6}{1.5^3}$$

$$f = -8936.9 \text{ N}$$

$$= 5436.9 \text{ N}$$

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Q2). $d_o = 0.45\text{m}$ $r_o = 0.225\text{m}$
 $d_i = 0.35\text{m}$ $r_i = 0.175\text{m}$
 $P = 115 \times 10^5 \text{ N/m}^2$

Q2a). Boundary Conditions:

@ radius outer = $\sigma_R = 0$

@ radius inner = $\sigma_R = -P = -115 \times 10^5 \text{ N/m}^2$

Q2b). @ $r_o = 0.225\text{m}$ $\sigma_R = 0$

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

$$\therefore 0 = a - \frac{b}{0.225^2}$$

$$\therefore 0 = b - (0.225)^2 a \quad \text{eqn 1}$$

@ $r_i = 0.175\text{m}$ $\sigma_R = -115 \times 10^5 \text{ N/m}^2$

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

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

$$\therefore -115 \times 10^5 = a - \frac{b}{(0.175)^2}$$

$$\therefore -115 \times 10^5 = b - (0.175)^2 a \quad \text{EQN 2}$$

$$-352.19 \times 10^3$$

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equation 2 - equation 1

$$\begin{aligned} & -352.19 \times 10^3 \\ & = \cancel{115 \times 10^5} = -(0.175)^2 a + (0.225)^2 a \\ & = a = \frac{-352.19 \times 10^3}{0.225^2 - 0.175^2} = -17.61 \times 10^6 \text{ N/m}^2 \end{aligned}$$

$$b = -(0.225)^2 \times -17.61 \times 10^6 = 0.89 \times 10^6 \text{ N/m}^2$$

Q2c). @ $r_i = 0.175 \text{ m}$ $\sigma_c = a + \frac{b}{r^2}$

$$\therefore \sigma_c = -17.61 \times 10^6 + \frac{0.89 \times 10^6}{0.175^2}$$

$$\sigma_c = 11451224.49$$

$$\sigma_r = 11.45 \text{ MPa}$$

@ $r_o = 0.225 \text{ m}$ $\sigma_c = a + \frac{b}{r^2}$

$$\sigma_c = -17.61 \times 10^6 + \frac{0.89 \times 10^6}{0.225^2}$$

$$\sigma_c = -29753.1$$

$$\sigma_r = -29.8 \text{ MPa}$$

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Q3). $\epsilon_x = -10 \times 10^{-6}$
 $\epsilon_y = 13 \times 10^{-6}$
 $\nu = 0.20$
 $E = 165 \times 10^9 \text{ N/m}^2$

Q3a). $\sigma_x = \frac{E}{1-\nu^2} \times (\epsilon_x + \nu \epsilon_y) =$
 $\therefore \sigma_x = \frac{165 \times 10^9}{1-(0.20)^2} \times (-10 \times 10^{-6} + (0.20 \times 13 \times 10^{-6}))$
 $\sigma_x = -1.27 \times 10^6 \text{ kPa (compressive)}$

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

$\sigma_y = 1.89 \times 10^6 \text{ kPa (tensile)}$

Q3b). $\sigma_x = 20 \times 10^6$
 $\sigma_y = -15 \times 10^6$

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

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

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

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

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

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

Q4). $d = 0.2\text{m}$ Circumferential
 $l = 0.39\text{m}$ $\epsilon_c = \frac{PD}{2t\eta_c}$
 $t = 0.0015\text{m}$

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

$$\eta_c = 0.90$$

$$\eta_l = 0.60$$

Longitudinal =

$$\epsilon_l = \frac{PD}{4t\eta_l}$$

rearrange Circumferential for P

$$\epsilon_c \times 2t\eta_c = P \times D$$

$$\therefore P = \frac{\epsilon_c \times 2t\eta_c}{D}$$

$$\therefore P = \frac{100 \times 10^6 \times (2 \times 0.0015) \times 0.90}{0.2} = 1.35 \times 10^6$$

$$13.5 \text{ Bar}$$

Rearrange Longitudinal for P

$$\epsilon_l \times 4t\eta_l = P \times D$$

$$\therefore P = \frac{\epsilon_l \times 4t\eta_l}{D}$$

$$\therefore = \frac{100 \times 10^6 \times (4 \times 0.0015) \times 0.60}{0.2\text{m}}$$

$$= 1.8 \times 10^6 \text{ max pressure allowed } 18 \text{ Bar}$$

$$13.5$$

$$\text{Bar}$$

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Q5).

$$l = 0.35 \text{ m}$$

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

$$\nu = 0.3$$

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

$$\text{Q5a). } k = \frac{E}{3(1-2\nu)} = \frac{165 \times 10^9}{3 \times (1 - (2 \times 0.3))}$$

$$k = 137.5 \times 10^9 \text{ Pa}$$

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

$$\therefore \epsilon\nu = \frac{-P}{k} = \frac{-50 \times 10^6}{137.5 \times 10^9} = -363.6 \times 10^{-6}$$

$$\therefore \epsilon\nu = \frac{\Delta V}{V} = \Delta V = \epsilon\nu V$$

$$\therefore \Delta V = -363.6 \times 10^{-6} \times \frac{0.35^3}{0.35^3} = -15.59 \times 10^{-6} \text{ m}^3$$

$$\therefore \Delta V = -1559 \text{ mm}^3$$

Q5b). Orthotropic materials have different properties going in different directions. Woods are an example of ~~orthotropic~~ orthotropic materials as their mechanical properties at a point can be shown in the longitudinal, radial and also tangential directions.