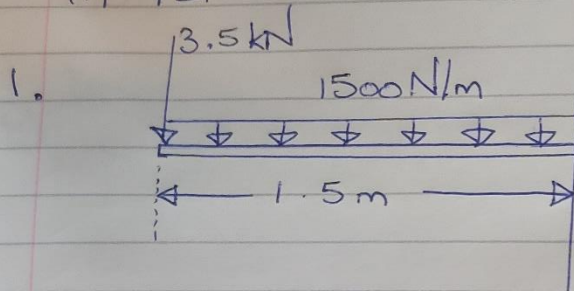


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STRESS ANALYSIS + GAE ACHA 5015

11/01/21



PL 3.5 kN

UDL 1500 N/m

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

a) DEFLECTION: $\frac{FL^3}{3EI} + \frac{WL^4}{8EI}$

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

$$= - \frac{11812.5}{6600000} - \frac{7593.75}{17600000}$$

$$= -1.79 \times 10^{-3} - 4.31 \times 10^{-4}$$

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

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 11/01/21

1. DEFLECTION = 5mm = 0.005m

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

$$y_{PL} = y - y_{UDL} = -0.005 - (4.31 \times 10^{-4})$$

$$y_{PL} = -4.57 \times 10^{-3}$$

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

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

$$\therefore F = \frac{-30162}{3.375} = -8.937 \times 10^3 \text{ N}$$

$$\therefore \Delta F = F + P_L = -8.937 \times 10^3 + 3.5 \times 10^3$$

$$= -5.44 \times 10^3 \text{ N}$$

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2.

$$OD \quad 45mm = 0.045m \quad r_o = 0.045 \div 2 = 0.0225m$$

$$ID \quad 35mm = 0.035m \quad r_i = 0.035 \div 2 = 0.0175m$$

$$P_i = 115 \text{ bar} \quad P_o = 0$$

$$\text{HOOP STRESS, } \sigma_h = A + \frac{B}{r^2}$$

a) BOUNDARY CONDITIONS:

$$\sigma_r = -P_o \quad @ \quad r = r_o$$

$$\sigma_r = -P_i \quad @ \quad r = r_i$$

$$P_i = 115 \text{ bar} = 1.15 \times 10^7 \text{ Pa}$$

$$\sigma_h = \frac{P_i r_i^2 - P_o r_o^2}{r_o^2 - r_i^2} + \frac{(P_i - P_o) r_o^2 r_i^2}{(r_o^2 - r_i^2) r^2}$$

$$b) A = \frac{P_i r_i^2 - P_o r_o^2}{r_o^2 - r_i^2} = \frac{(1.15 \times 10^7 \times 0.0175^2) - (0 \times 0)}{0.0225^2 - 0.0175^2}$$

$$= \frac{3.52 \times 10^3}{2 \times 10^{-4}} = 17.6 \times 10^6$$

$$B = \frac{(P_i - P_o) r_o^2 r_i^2}{r_o^2 - r_i^2} = \frac{(1.15 \times 10^7 - 0) 0.0225^2 \times 0.0175^2}{2 \times 10^{-4}}$$

$$= 8.91 \times 10^3$$

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11/01/21

$$C. \text{ ~~max~~ } @ r_i: \sigma_h = A + \frac{B}{r^2} \quad @ r_o: \sigma_h = A + \frac{B}{r^2}$$

$$= 17.6 \times 10^6 + \frac{8.91 \times 10^3}{0.0175^2} = 17.6 \times 10^6 + \frac{8.91 \times 10^3}{0.00030625}$$

$$\sigma_{h@r_i} = 46.7 \times 10^6 \text{ N/m}^2 \quad \sigma_{h@r_o} = 35.2 \times 10^6 \text{ N/m}^2$$

$$3. \epsilon_x = -10 \times 10^{-6}$$

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

$$\nu = 0.2$$

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

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

$$= 1.728 \times 10^{11} \times (-7.4 \times 10^{-6})$$

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

$$\sigma_x = -1.27 \times 10^6 \text{ N/m}^2 \text{ (compressive)}$$

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

$$= 1.72 \times 10^{11} \times (13 \times 10^{-6} + 0.2 \times -10 \times 10^{-6})$$

$$= 45.38 \times 10^6 \text{ N/m}^2 \text{ (TENSILE)}$$

$$= 45.38 \times 10^6 \text{ N/m}^2 \text{ (TENSILE)}$$

$$\sigma_y = 1.892 \times 10^6 \text{ (TENSILE)}$$

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3.

$$\begin{aligned} b) \quad \sigma_x &= 20 \times 10^6 \text{ Pa} \\ \sigma_y &= -15 \times 10^6 \text{ Pa} \end{aligned}$$

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

$$= 6.06 \times 10^{-12} (2.3 \times 10^6)$$

$$\epsilon_x = 1.39 \times 10^{-4}$$

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

$$= 6.06 \times 10^{-12} (-15 \times 10^6 - 0.2 \times 20 \times 10^6)$$

$$= 6.06 \times 10^{-12} (-19 \times 10^6)$$

$$\epsilon_y = -1.15 \times 10^{-4}$$

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4.

$$D = 200 \text{ mm} = 0.2 \text{ m}$$

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

$$t = 1.5 \text{ mm} = 0.0015 \text{ m}$$

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

$$\eta_L = 0.9$$

$$\eta_c = 0.6$$

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

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

$$P_{\text{max}_c} = \frac{2 \times 0.0015 \times 0.9 \times 100 \times 10^6}{0.2}$$

$$= 1.35 \times 10^6 \text{ N/m}^2$$

$$= 13.5 \text{ Bar}$$

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

$$P = \frac{4t\eta_c \sigma_L}{D} = \frac{4 \times 0.0015 \times 0.6 \times 100 \times 10^6}{0.2}$$

$$= 1.8 \times 10^6 \text{ N/m}^2$$

$$= 18 \text{ Bar}$$

$$P_{\text{max}_c} = 13.5 \text{ bar}$$

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5. $L = 350 \text{ mm} = 0.35 \text{ m}$
 $P_o = 50 \times 10^6 \text{ Pa}$
 $\nu = 0.3$
 $E = 165 \times 10^9 \text{ Pa}$

a) $K = \frac{E}{3(1-2\nu)} = \frac{165 \times 10^9}{3(1-2(0.3))} = 1.38 \times 10^{11} \text{ N/m}^2$

$$k = \frac{\sigma}{\epsilon_v} = \frac{-P}{\epsilon_v}$$

$$\epsilon_v = \frac{-P}{k} = \frac{-50 \times 10^6}{1.38 \times 10^{11}} = -3.62 \times 10^{-4}$$

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

$$\Delta V = \epsilon_v V = 3.62 \times 10^{-4} \times 0.35^3$$

$$\Delta V = 1.55 \times 10^{-5}$$

b) ORTHOTROPIC MATERIALS HAVE DIFFERENT PROPERTIES IN DIFFERENT DIRECTIONS
 AN EXAMPLE WOULD BE ~~ORISOM~~ WOOD.