

Thomas Crocker

1801936

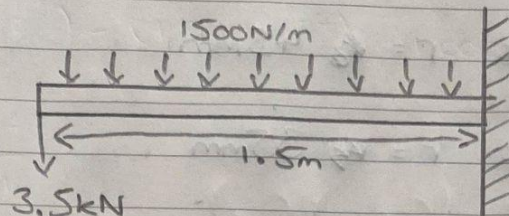
Stress Analysis and
CAE

ACHA5015

11/1/21

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1
2)
A



$$L = 1.5\text{m} \quad \text{Deflection} = \frac{FL^3}{3EI} + \frac{wL^4}{8EI}$$

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

$$F = -3500\text{N}$$

$$w = -1500\text{N/m} \quad = \frac{-3500 \times 1.5^3}{3 \times (2.2 \times 10^6)} + \frac{-1500 \times 1.5^4}{8 \times (2.2 \times 10^6)}$$

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

2)
B

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

$$y_{PL} = y - y_{UDE} = -(5 \times 10^{-3}) - (-431.46 \times 10^{-6})$$

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

$$y_{PL} = \frac{FL^3}{3EI} \quad F = \frac{y_{PL} \times 3EI}{L^3} = \frac{(-4.57 \times 10^{-3}) \times 3 \times (2.2 \times 10^6)}{1.5^3}$$

$$= -2978.96\text{N}$$

$$\Delta F = -3500 + -2978.96$$

$$= -6478.96\text{N}$$

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$$a) G_0 = \frac{115 \text{ Bar}}{r} \text{ at } r = 45 \text{ mm}$$

$$G_0 = -P_0 \text{ at } r = 35 \text{ mm}$$

$$b) 0 = a - \frac{b}{(35 \times 10^{-3})^2} \quad 0 = b - (35 \times 10^{-3})^2 a$$

$$115 \times 10^5 = a - \frac{b}{(45 \times 10^{-3})^2} \quad (-115 \times 10^5) = a - \frac{b}{(45 \times 10^{-3})^2}$$

$$0 = a - b \quad 517.5 \times 10^3 = b - (45 \times 10^{-3})^2 a$$

$$517.5 \times 10^3 = a - b$$

$$517.5 \times 10^3 = \frac{b}{(45 \times 10^{-3})^2} a + (35 \times 10^{-3})^2 a$$

$$a = \frac{517.5 \times 10^3}{0.035^2 - 0.045^2} = -646.875 \times 10^6$$

$$G_0 = a - \frac{b}{r^2}$$

$$G_0 + \frac{b}{r^2} = a$$

$$a - G_0 = \frac{b}{r^2}$$

$$(a - G_0)r^2 = b = [(-646.875 \times 10^6) - (-115 \times 10^5)] \times 0.045^2$$

$$= -1.29 \times 10^6$$

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c) @ $r_i = 35\text{mm}$

$$G_c = a + \frac{b}{r^2} = (-646.875 \times 10^6) + \frac{(-1.29 \times 10^6)}{0.035^2}$$

$$= -1.7 \times 10^9 \text{ Pa}$$

@ $r_o = 45\text{mm}$

$$G_c = a + \frac{b}{r^2} = (-646.875 \times 10^6) + \frac{(-1.29 \times 10^6)}{0.045^2}$$

$$= -1.28 \times 10^9 \text{ Pa}$$

3

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

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

$\nu = 0.2$

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

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

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

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

$$\sigma_y = \frac{E}{1 - \nu^2} \times [\epsilon_y + \nu \epsilon_x]$$

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

$$= 1.89 \times 10^6 \text{ (Tensile)}$$

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b) $G_x = 20 \times 10^6 \text{ Pa}$
 $G_y = -15 \times 10^6 \text{ Pa}$

$$\epsilon_x = \frac{1}{E} \times (G_x - \nu G_y)$$

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

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

$$\epsilon_y = \frac{1}{E} \times (G_y - \nu G_x)$$

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

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

4) $D = 200 \times 10^{-3} \text{ m}$

$L = 390 \times 10^{-3} \text{ m}$

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

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

$\eta_L = 0.9$

$\eta_c = 0.6$

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

$$P_{\max_c} = \frac{G_c \times 2t\eta_L}{D}$$

$$= \frac{(100 \times 10^6) \times 2 \times (1.5 \times 10^{-3}) \times 0.9}{200 \times 10^{-3}}$$

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

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4 continued) $\epsilon_L = \frac{PD}{4t\eta_c}$

$$P = \frac{\epsilon_L \times 4t\eta_c}{D} = \frac{(100 \times 10^{-6}) \times 4 \times (1.5 \times 10^{-3}) \times 0.6}{(200 \times 10^{-3})}$$

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

$$\therefore P_{\max} = 18 \text{ Bar}$$

5

a) $L = 350 \times 10^{-3} \text{ m}$ $K = \frac{E}{3(1-2\nu)} = \frac{(165 \times 10^9)}{3 \times (1 - (2 \times 0.3))}$
 $P = 50 \times 10^6 \text{ Pa}$

$$\nu = 0.3$$

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

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

$$\epsilon_v = \frac{-P}{K} = \frac{-(50 \times 10^6)}{137.5 \times 10^9} = -363.64 \times 10^{-6}$$

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

$$\Delta V = \epsilon_v V = (-363.64 \times 10^{-6}) \times [(350 \times 10^{-3})^3]$$

$$\Delta V = -1.56 \times 10^{-5} \text{ m}^3$$

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- b) Orthotropic materials have different elastic constants in different direction. An example of an orthotropic material is a composite like carbon fibre.