

1/6

Robin Williamson-Gillie

1800974

11/1/2021

ACHASOIS

Stress analysis

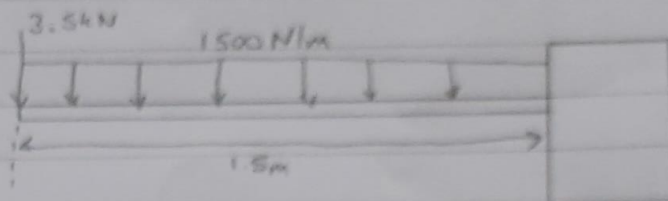
①

a) $L = 1.5 \text{ m}$

$$P = 3.5 \times 10^3 \text{ N}$$

$$w = 1500 \text{ N/m}$$

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



$$\text{Deflection} = \frac{PL^3}{3EI} + \frac{wdL^4}{8EI}$$

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

$$= -2.221 \times 10^{-3} \text{ m}$$

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

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

$$= -5 \times 10^{-3} - (-0.431 \times 10^{-3})$$

$$y_{PL} = -4.569 \times 10^{-3}$$

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

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

$$F = \frac{(-4.569 \times 10^{-3}) \times 3 \times (2.2 \times 10^6)}{1.5^3}$$

$$F = -8934.93$$

$$\Delta F = -8934.93 + (3.5 \times 10^3)$$

$$\Delta F = -5434.93 \text{ N}$$

2/6

Robin Williamson - Gillie

1800974

11/1/2021

ACHA 5015

Stress analysis

②

a) $d_o = 45 \times 10^{-3} \text{ m}$

$d_i = 35 \times 10^{-3} \text{ m}$

$P_i = 115 \times 10^5 \text{ N/m}$

$r_o = 22.5 \times 10^{-3} \text{ m}$

$r_i = 17.5 \times 10^{-3} \text{ m}$

$P_o = 0$

$\sigma_r = -P_o \text{ at } r = r_o$

b)

$\sigma_r = -P_i \text{ at } r = r_i$

b) $A = \frac{P_i r_i^2 - P_o r_o^2}{r_o^2 - r_i^2}$

~~$A = \frac{(115 \times 10^5)(17.5 \times 10^{-3})^2 - 0}{(22.5 \times 10^{-3})^2 - (17.5 \times 10^{-3})^2}$~~

$$A = \frac{(115 \times 10^5) \times (17.5 \times 10^{-3})^2 - 0}{(22.5 \times 10^{-3})^2 - (17.5 \times 10^{-3})^2}$$

$A = 17.609 \times 10^6$

$$B = \frac{(P_i - P_o) r_o^2 r_i^2}{r_o^2 - r_i^2}$$

$$B = \frac{(115 \times 10^5) \times (22.5 \times 10^{-3})^2 \times (17.5 \times 10^{-3})^2}{(22.5 \times 10^{-3})^2 - (17.5 \times 10^{-3})^2}$$

$B = 8.915 \times 10^3$

3/6

Robin Williamson - Gillie

1800974

Stress analysis

11/1/2021

ACHA 5015

③

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

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

$$\nu = 0.2$$

$$E = 165 \times 10^9 \text{ N/m}^2$$

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

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

$$\sigma_x = \underline{\underline{-1.272 \times 10^6 \text{ Pa}}} \quad (\text{compressive})$$

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

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

$$= \underline{\underline{1.891 \times 10^6 \text{ Pa}}} \quad (\text{tensile})$$

$$b) \sigma_{xy} = -15 \times 10^6 \text{ Pa N/m}^2$$

$$\sigma_{yx} = 20 \times 10^6 \text{ N/m}^2$$

$$\epsilon_y = \frac{1}{E} (\sigma_{xy} - \nu \sigma_{yx})$$

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

$$\epsilon_y = \underline{\underline{-0.115 \times 10^{-3}}}$$

4/6

Robin - Williamson - Gillie

11/1/2021

1800974

ACHASOIS

Stress analysis

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

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

$$\epsilon_x = \cancel{1.23} \underline{\underline{0.139 \times 10^{-6}}}$$

(4)

$$d = 200 \times 10^{-3} \text{ m}$$

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

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

$$\nu_L = 90\% = 0.9$$

$$\nu_c = 60\% = 0.6$$

$$p_{\text{max}} = 100 \times 10^6 \text{ N/m}^2$$

$$\sigma_c = \frac{p d}{2 t \nu_L}$$

$$p = \frac{2 t \nu_L \sigma_c}{d}$$

$$p_{\text{max}} = \frac{2 (1.5 \times 10^{-3}) \times 0.9 \times (100 \times 10^6)}{0.2}$$

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

$$\sigma_L = \frac{p d}{4 t \nu_c}$$

$$p = \frac{4 t \nu_c \sigma_L}{d}$$

$$p_{\text{max}} = \frac{4 \times (1.5 \times 10^{-3}) \times 0.6 \times (100 \times 10^6)}{0.2}$$

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

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

5/6

Robin Williamson - Gillie

1800974

Stress analysis

11/1/2021

ACHASOIS

(5)

$$L = 350 \times 10^{-3} \text{ m} = 0.35 \text{ m}$$

$$P = 50 \times 10^6 \text{ N/m}^2$$

$$\nu = 0.3$$

$$E = 165 \times 10^9 \text{ N/m}^2$$

$$\begin{aligned} a) \quad k &= \frac{E}{3(1-2\nu)} = \frac{165 \times 10^9}{3(1-0.6)} \\ &= 137.5 \times 10^9 \text{ N/m}^2 \end{aligned}$$

$$k = \frac{-P}{\epsilon_V}$$

$$\begin{aligned} \epsilon_V &= \frac{-P}{k} \\ &= \frac{(-50 \times 10^6)}{(137.5 \times 10^9)} \end{aligned}$$

$$\begin{aligned} \epsilon_V &= -363.64 \times 10^{-6} \\ \epsilon_V &= -363.64 \times 10^{-6} \end{aligned}$$

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

$$\begin{aligned} \Delta V &= \epsilon_V V \\ &= (-363.64 \times 10^{-6}) \times (0.35)^3 \\ &= -1.56 \times 10^{-5} \text{ m}^3 \\ &= \underline{\underline{-0.156 \times 10^{-6} \text{ m}^3}} \end{aligned}$$

6/6

Robin Williamson-Gillie

11/1/2021

1800974

ACHASOIS

Stress analysis

- b) They have varied elastic constants that act in different directions. This is possibly due to the grain structure of fibre directions. A example of this structure is ^{rolled metal} ~~carbon fibre~~.