

11/10/2021 Stress Analysis & LAE ACHA5015

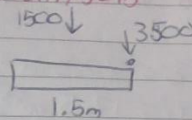
Q1) $l = 1.5m$

$W = 1500 N/m$

$F = 3500 N$

$EI = 2.2 \times 10^6 N/m^2$

i) Deflection = $y = \frac{FL^3}{3EI} + \frac{WL^4}{8EI}$



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

ii) $y = y_{pl} + y_{ucl}$

$y_{pl} = y - y_{ucl}$

$= -5 \times 10^{-3} - (-431.46 \times 10^{-6})$

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

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

Ans on calculator

$F = \frac{y_{pl}(3EI)}{L^3}$

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

$F = -8936.89 N$

$= -8.94 kN$

~~$F = 10.02 kN$~~

$\therefore = 7436.89 N$

Conor McGuinness 1803076

11/01/2021

Stress Analysis & LAE ACHA 5015

Pg 2 of 5

Q2) $d_o = 0.045 \text{ m}$ $r_o = 22.5 \times 10^{-3} \text{ m}$
 $d_i = 0.035 \text{ m}$ $r_i = 17.5 \times 10^{-3} \text{ m}$
 $P = 115 \times 10^5 \text{ N m}^{-2}$

a)

b) $\sigma_r = a - \frac{b}{r^2}$
 ① $0 = a - \frac{b}{(22.5 \times 10^{-3})^2}$
 $0 = b - (22.5 \times 10^{-3})^2 a$

~~$\sigma_r = -115 \times 10^5$~~
 ~~$\sigma_r = a - \frac{b}{r^2}$~~
 ~~$0 = a - \frac{b}{(17.5 \times 10^{-3})^2}$~~
 ~~$0 = b - (17.5 \times 10^{-3})^2 a$~~

② $\sigma_r = -115 \times 10^5$
 $\sigma_r = a - \frac{b}{r^2}$
 $-115 \times 10^5 = a - \frac{b}{(17.5 \times 10^{-3})^2}$
 $201250 = b - (17.5 \times 10^{-3})^2 a$

2-1

$$201250 = -(17.5 \times 10^{-3})^2 a + (22.5 \times 10^{-3})^2 a$$

$$a = \frac{201250}{22.5 \times 10^{-3}^2 - 17.5 \times 10^{-3}^2}$$

$a = 1.01 \times 10^9 \text{ N m}^{-2}$
 $1.01 \times 10^9 \text{ N m}^{-2}$

$$0 = b - (22.5 \times 10^{-3})^2 a$$

$$b = (22.5 \times 10^{-3})^2 a$$

$$b = (22.5 \times 10^{-3})^2 (1.01 \times 10^9)$$

$$b = 509.41 \times 10^3 \text{ N m}^2$$

@ r_i $\sigma_c = a + \frac{b}{r^2} = 1.00625 \times 10^9 + \frac{509.41 \times 10^3}{17.5 \times 10^{-3}^2} = 1.035 \times 10^9 \text{ Pa}$

@ r_o $\sigma_c = a + \frac{b}{r^2} = 1.00625 \times 10^9 + \frac{509.41 \times 10^3}{22.5 \times 10^{-3}^2} = 1.029 \times 10^9 \text{ Pa}$

Connor McGuinness 1803076

11/01/2021

Stress Analysis & LAE ACHA5015

Pg 3 of 5

Q3 $\epsilon_x = -10 \times 10^{-6}$

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

$\nu = 0.2$

$E = 165 \times 10^9$

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

$\sigma_x = -1.27 \times 10^6 \text{ Pa}$

$= -1.27 \text{ MPa compressive}$

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

$\sigma_y = 1.89 \times 10^6 \text{ Pa}$

$= 1.89 \text{ MPa tensile}$

b) $\sigma_x = 20 \times 10^6 \text{ N m}^{-2}$

$\sigma_y = -15 \times 10^6 \text{ N m}^{-2}$

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

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

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

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

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

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

Conor McGuinness 1803076

Pg 4 of 5

11/12/2021 Stress Analysis & PAE ACHA5015

Q4) $D = 0.2 \text{ m}$
 $L = 0.34 \text{ m}$
 $t = 1.5 \times 10^{-3} \text{ m}$
 $n_c = 0.4$
 $n_t = 0.6$
 $\sigma = 100 \times 10^6 \text{ N/m}^2$

$$\sigma_c = \frac{PD}{2t n_c} \rightarrow P = \frac{2t n_c \sigma_c}{D}$$

$$\sigma_t = \frac{PD}{4t n_t} \rightarrow P = \frac{4t n_t \sigma_t}{D}$$

$$P_{\max_c} = \frac{2(1.5 \times 10^{-3})(0.4)(100 \times 10^6)}{0.2}$$

$$P_{\max_t} = \frac{4(1.5 \times 10^{-3})(0.6)(100 \times 10^6)}{0.2}$$

$$P_{\max_c} = 1.35 \times 10^6 \text{ N/m}^2$$
$$= 13.5 \text{ Bar}$$

$$P_{\max_t} = 1.8 \times 10^6 \text{ N/m}^2$$
$$= 18 \text{ Bar}$$

$$\therefore P_{\max} = 13.5 \text{ Bar}$$

Connor McGuinness 180 3076

Pg 5 of 5

11/01/2021

Stress Analysis & CAE ACHA 5015

(05) $L = 0.35\text{m}$ $\nu = 0.35^3$

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

$$\nu = 0.3$$

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

$$a) K = \frac{E}{3(1-2\nu)} = \frac{165 \times 10^9}{3(1-2(0.3))}$$
$$K = 137.5 \times 10^9 \text{ N/m}^2$$

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

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

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

$$\Delta V = \epsilon_v V$$

$$= -363.64 \times 10^{-6} (0.35^3)$$

$$\Delta V = ~~-15.59~~ -15.59 \times 10^{-6} \text{ m}^3$$

- b) An orthotropic material is ~~isotropic~~ a material that has different elastic constant in different directions. This could be due to different structural make-up of different materials

