

Stress analysis exam

ACHA5012

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1901754

$$A = 1$$

$$B = 9$$

$$C = 0$$

$$D = 1$$

$$E = 7$$

$$F = 5$$

$$G = 4$$

Q1

$$\epsilon_x = (28) \times 10^{-6}$$

$$\epsilon_y = - (15) \times 10^{-6}$$

$$\nu = 0.28$$

$$E = 170 \times 10^9 \text{ Pa}$$

$$i) \sigma_x = \frac{E}{1 - \nu^2} (\epsilon_x + \nu \epsilon_y) = \frac{170 \times 10^9}{1 - (0.28)^2} (28 \times 10^{-6} + (0.28 \times -15 \times 10^{-6}))$$

$$\sigma_x = +43.9 \text{ MPa} \quad (\text{tensile})$$

$$\sigma_y = -13.2 \text{ MPa} \quad (\text{compressive})$$

$$ii) \sigma_x = +85 \text{ MPa}$$

$$\sigma_y = -44 \text{ MPa}$$

$$\epsilon_x = \frac{1}{170 \times 10^9} (85 \times 10^6 - 0.28 \times -44 \times 10^6)$$

$$\epsilon_x = 57.2 \times 10^{-5} \text{ Pa}$$

$$\epsilon_y = -39.9 \times 10^{-5} \text{ Pa}$$

Q2

$$\begin{aligned} \text{i)} \quad \sigma_x &= 107 \times 10^6 \text{ Pa} \\ \sigma_y &= 205 \times 10^6 \text{ Pa} \end{aligned}$$

$$\tau_{xy} = 125 \times 10^6 \text{ Pa}$$

$$\sigma_1 = \left(\frac{107 \times 10^6 + 205 \times 10^6}{2} \right) + \frac{\sqrt{(107 \times 10^6 - 205 \times 10^6)^2 + 4 \times 125^2}}{2}$$

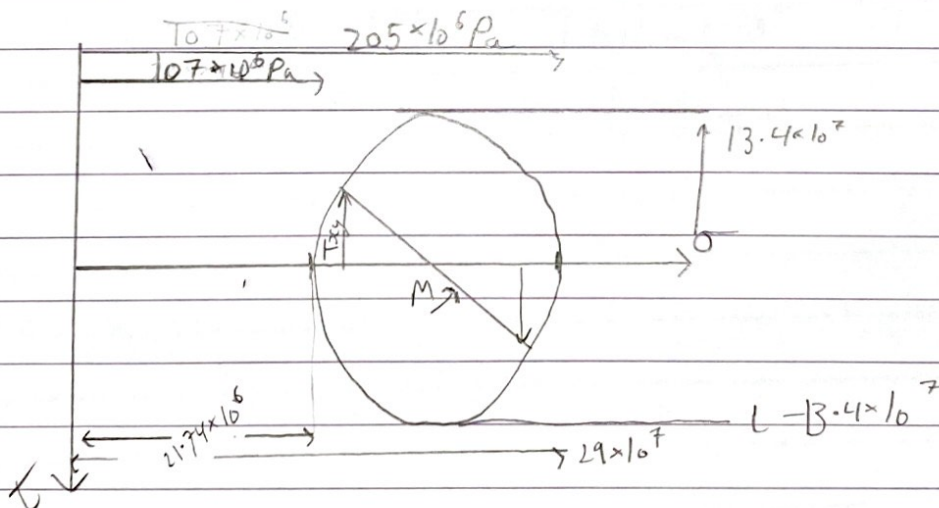
$$\sigma_1 = 29 \times 10^7$$

$$\sigma_2 = 21.74 \times 10^6$$

$$\text{ii)} \quad \tau_{\max} = 13.4 \times 10^7$$

$$\tau_{\min} = -13.4 \times 10^7$$

iii)



Q3

$$R_A = 1969.4 \text{ N}$$

$$R_B = 2580.6 \text{ N}$$

$$i) M = \cancel{R_A x} - R_A [x] - f_1 [x - \overset{1.5}{\cancel{0.5}}] - f_2 [x - \overset{1.25}{\cancel{1.5}}] - f_3 [x - 2] - f_4 [x - 2.5]$$

$$1969.4 [x] - (450 \frac{[x - 0.5]^2}{2}) - 2300 [x - 1.5] - 800 \frac{[x - 1.5]^2}{2} - 1000 [x - 2.5]$$

$$ii) EI \frac{dy}{dx} = 1969.4 [x] - \frac{450 [x - 0.5]^2}{2} - 2300 [x - 1.5] - \frac{800 [x - 1.5]^2}{2} - 1000 [x - 2.5]$$

$$iii) EI y = \frac{1969.4 x^3}{3} - \frac{450 [x - 0.5]^3}{3} - \frac{2300 [x - 1.5]^3}{3} - \frac{800 [x - 1.5]^3}{4} - \frac{1000 [x - 2.5]^3}{3}$$

+ Ax
+ B

$$v) 1.75 \times 10^6 \text{ Pa } y = \frac{1969.4 (1.5)^3}{3} - \frac{450 [1.1]^3}{3} - \frac{2300 (0)^3}{3} - \frac{800 (0)^3}{4} + \frac{1000 [-1]^3}{3}$$

$$= 1769.74$$

$$y = \frac{1769.74}{E} = 1.011 \times 10^{-3}$$

$$= 1.011 \text{ mm}$$

Q4

i)

$$d_o = 280 \times 10^{-3} \text{ m}$$

$$L = 600 \times 10^{-3} \text{ m}$$

$$n_L = 0.55$$

$$n_C = 0.64$$

$$P = 14.7 \times 10^5 \text{ Pa}$$

$$\sigma_c = 150 \times 10^6 \text{ Pa}$$

$$ii) t = \frac{pd}{4\sigma_c n_C}$$

$$t = 1.25 \times 10^{-3}$$

$$t = 1.25 \text{ mm}$$

t?

$$\sigma_c = \frac{pd}{2t n_L}$$

$$\& \& 2t n_L = \frac{pd}{\sigma_c}$$

$$\& t = \frac{pd}{2\sigma_c n_L}$$

$$\cancel{2t} = 4.98 \times 10^{-3} \text{ m}$$

$$t = 2.49 \times 10^{-3} \text{ mm}$$

$$= 2.49 \text{ mm}$$

$$= 2.14 \text{ mm}$$

iii) The minimum thickness is 2.14 mm

Q5

i) $L = 1.35 \text{ m}$

cross section $d = 19.05 \times 10^{-3} \text{ m}$

$t = 1.2 \times 10^{-3} \text{ m}$

$E = 200 \text{ GPa}$

$d_i = 19.05 - 2(1.2) = 16.65$

$$A = \frac{\pi}{4} (d^2 - d_i^2) = 6.73 \times 10^{-5} \text{ m}^2$$

ii) As one end is secure and one is free
 $n = 0.25$

$$\text{iii) } F_{cr} = 0.25 \pi^2 \frac{200 \times 10^9 \times 2.7 \times 10^{-9}}{1.35^2} = \underline{731.08 \text{ N}}$$

$$I = \frac{\pi ((19.05 \times 10^{-3})^4 - (16.65 \times 10^{-3})^4)}{64} = 2.7 \times 10^{-9}$$

$$\text{iv) } SR = \frac{L}{k} \quad k = \sqrt{\frac{2.7 \times 10^{-9}}{6.73 \times 10^{-5}}} = 6.33 \times 10^{-3} = k$$

$$SR = \frac{1.35}{6.33 \times 10^{-3}} = 213.3$$