

HARVEY BOATLAND (1402072)

ACHA5015

9/5/22

$$\begin{aligned} \epsilon_x &= 22 \times 10^{-6} \\ \epsilon_y &= -17 \times 10^{-6} \\ E &= 170 \text{ GPa} = 1.7 \times 10^{11} \text{ Pa} \\ \nu &= 0.28 \end{aligned}$$

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

$$= \frac{1.7 \times 10^{11}}{1 - 0.28^2} ((22 \times 10^{-6}) + (0.28 \times (-17 \times 10^{-6}))) = \frac{3180121 \text{ Pa}}{(kPa)}$$

$$= \cancel{3180121 \text{ Pa}} \quad \text{or} \quad \cancel{318.0121 \text{ MPa}} \quad \text{or} \quad \cancel{318.0121 \text{ MPa}}$$

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

$$= \frac{1.7 \times 10^{11}}{1 - 0.28^2} ((-17 \times 10^{-6}) + (0.28 \times (22 \times 10^{-6})))$$

$$= -1499565 \text{ Pa} \quad (\text{compressive})$$

$$\begin{aligned} \text{ii} \quad \sigma_x &= 87 \text{ MPa} = 87 \times 10^6 \\ \sigma_y &= 42 \text{ MPa} = 42 \times 10^6 \end{aligned}$$

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

$$= \frac{1}{1.7 \times 10^{11}} \times (87 \times 10^6 - (0.28 \times 42 \times 10^6))$$

$$= 4.2426 \times 10^{-4}$$

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

~~in 1000000~~

$$= \frac{1}{1.7 \times 10^{11}} ((42 \times 10^6) - (0.28 \times (607 \times 10^6)))$$

$$= 1.038 \times 10^{-4}$$

2i.

$$\sigma_1 = \frac{(\sigma_x + \sigma_y)}{2} + \sqrt{\frac{(\sigma_x - \sigma_y)^2}{4} + \tau_{xy}^2}$$

~~in 1000000~~

$$= 183500000 + 279954460.6$$

$$= 463454460.6 \text{ Pa}$$

$$\sigma_2 = \frac{(\sigma_x + \sigma_y)}{2} - \sqrt{\frac{(\sigma_x - \sigma_y)^2}{4} + \tau_{xy}^2}$$

$$\begin{aligned} \sigma_x &= 100 \text{ MPa} \\ \sigma_y &= 207 \text{ MPa} \\ \tau_{xy} &= 125 \text{ MPa} \end{aligned}$$

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$$2i. \sigma_1 = \frac{(\sigma_x + \sigma_y)}{2} + \frac{\sqrt{(\sigma_x - \sigma_y)^2 + 4\tau_{xy}^2}}{2}$$

$$= \frac{(100 \times 10^6 + 207 \times 10^6)}{2} + \frac{\sqrt{(100 \times 10^6 - 207 \times 10^6)^2 + 4(125 \times 10^6)^2}}{2}$$

$$= 153500000 + 135967827.1$$

$$= 289467827.1 \text{ Pa}$$

$$\sigma_x = 100 \text{ MPa}$$

$$\sigma_y = 207 \text{ MPa}$$

$$\tau_{xy} = 125 \text{ MPa}$$

$$\sigma_2 = \frac{(\sigma_x + \sigma_y)}{2} - \frac{\sqrt{(\sigma_x - \sigma_y)^2 + 4\tau_{xy}^2}}{2}$$

$$= 153500000 - 135967827.1$$

$$= 17532172.9 \text{ Pa}$$

MPa

MPa

MPa

$$ii \tau_{max} = \frac{\sigma_1 - \sigma_2}{2}$$

$$= \frac{289467827.1 - 17532172.9}{2}$$

$$= 135967827 \text{ Pa}$$

$$\tau_{min} = -\left(\frac{\sigma_1 - \sigma_2}{2}\right)$$

$$= -135967827 \text{ Pa}$$

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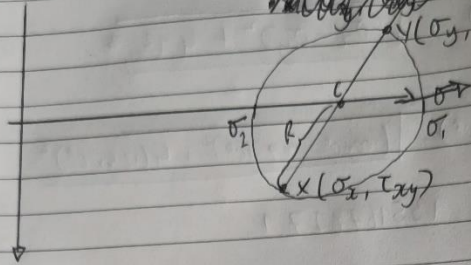
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AEHA5615

HARVEY

iii



$$C = \left(\frac{\sigma_x + \sigma_y}{2} \right)$$

$$= 1535.00000$$

$$R = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2} \right)^2 + \tau_{xy}^2}$$

$$= 197457.697.5$$

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$$3a. EI \frac{d^2y}{dx^2} = M = R[x] - F_1[x-a] - F_2[x-b] - F_3[x-c]$$

$$\therefore \frac{dy}{dx} = R \frac{x^2}{2} - F_1 \frac{[x-a]^2}{2} - F_2 \frac{[x-b]^2}{2} - F_3 \frac{[x-c]^2}{2} + A$$

$$EI = R \frac{x^3}{6} - F_1 \frac{[x-a]^3}{6} - F_2 \frac{[x-b]^3}{6} - F_3 \frac{[x-c]^3}{6} + Ax + B$$

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$$4. d = 0.28$$

$$l = 0.34$$

$$\lambda_L = 0.57$$

$$\lambda_C = 0.62$$

$$P = 14.0 \times 10^5 \text{ N/m}^2$$

$$\sigma_{\max} = 150 \times 10^6 \text{ N/m}^2$$

$$\sigma_L = \frac{PD}{2\lambda_L l}$$

$$\sigma_L = \frac{PD}{4\lambda_C l}$$

$$\therefore A = \frac{Pd}{2\sigma_L \lambda_L}$$

$$A = \frac{Pd}{4\sigma_L \lambda_C}$$

$$= \frac{(14 \times 10^5 \times 0.28)}{2 \times (150 \times 10^6) \times 0.57}$$

$$= \frac{(14 \times 10^5 \times 0.28)}{4 \times (150 \times 10^6) \times 0.62}$$

$$= 0.002292 = \text{or } \underline{2.292 \text{ mm}} \quad = 0.001053 = 1.053 \text{ mm}$$

$$\therefore l_{\min} = \underline{2.292 \text{ mm}}$$

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5. $L = 1.37 \text{ m}$
 $D_o = 0.01905 \text{ m}$
 $D_i = 0.01665 \text{ m}$
 $E = 2 \times 10^{11} \text{ Pa}$

~~Answer~~

$$A = \frac{\pi}{4} (d^2 - d_i^2)$$

ii. $n = 0.25$

$$I_{xx} = \frac{\pi}{64} (d^4 - d_i^4)$$

$$I = 2.69224 \times 10^{-9} \text{ m}^4$$

$$A = 6.72929 \times 10^{-5} \text{ m}^2$$

iv. $S.R = \frac{L}{K}$, where $K = \sqrt{\frac{EI}{n}}$

$$K = 6.32517 \times 10^{-3}$$

$$\therefore S.R = \frac{L}{K} = 216.594$$

iii. $FCR = \frac{n\pi^2 EI}{L^2}$

$$= \frac{0.25 \times \pi^2 \times (2 \times 10^{11}) \times (2.69224 \times 10^{-9})}{1.37^2}$$

$$= 707.852 \text{ N}$$

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