

1903102 Ashley Lane Stress Analysis

09/05/2022 ACHA 5015

Question 1

$$\epsilon_x = 22 \times 10^{-6}$$

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

$$\nu = 0.28$$

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

$$\sigma_1 = \frac{E}{1-\nu^2} (\epsilon_1 + \nu \epsilon_2)$$

~~$$\sigma_1 = \frac{170 \times 10^9}{1-0.28^2} (22 \times 10^{-6} + 0.28 \times -10 \times 10^{-6})$$~~

$$\sigma_1 = \frac{170 \times 10^9}{1-0.28^2} (22 \times 10^{-6} + 0.28 \times -10 \times 10^{-6}) = \boxed{3.54 \times 10^6 \text{ (tensile)}}$$

$$\sigma_2 = \frac{170 \times 10^9}{1-0.28^2} (-10 \times 10^{-6} + 0.28 \times 22 \times 10^{-6}) = \boxed{-708.33 \times 10^3 \text{ (compressive)}}$$

ii) $\sigma_x = 80 \times 10^6$
 $\sigma_y = 42 \times 10^6$

$$\epsilon_1 = \frac{1}{E} (\sigma_1 - \nu \sigma_2)$$

~~$$\epsilon_1 = \frac{1}{170 \times 10^9} (80 - 0.28 \times 42)$$~~
$$\epsilon_1 = \frac{1}{170 \times 10^9} (80 \times 10^6 - 0.28 \times 42 \times 10^6) =$$

$$\boxed{\epsilon_1 = 4.01 \times 10^{-4}}$$

$$\epsilon_2 = \frac{1}{170 \times 10^9} (42 \times 10^6 - 0.28 \times 80 \times 10^6) = 115.29 \times 10^{-6}$$

$$\boxed{\epsilon_2 = 115.29 \times 10^{-6}}$$

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Question 2

$$1) \sigma_1 = \frac{(\sigma_x + \sigma_y)}{2} + \frac{\sqrt{(\sigma_x - \sigma_y)^2 + 4\tau_{xy}^2}}{2}$$

$$\sigma_x = 101 \text{ mpa} \quad 101 \times 10^6$$

$$\sigma_y = 200 \text{ mpa} \quad 200 \times 10^6$$

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

$$\sigma_1 = \frac{(101 \times 10^6 + 200 \times 10^6)}{2} + \frac{\sqrt{(101 \times 10^6 - 200 \times 10^6)^2 + 4 \times (125 \times 10^6)^2}}{2}$$

$$\sigma_1 = 284.94 \times 10^6$$

$$\sigma_2 = \frac{(101 \times 10^6 + 200 \times 10^6)}{2} - \frac{\sqrt{(101 \times 10^6 - 200 \times 10^6)^2 + 4 \times (125 \times 10^6)^2}}{2}$$

$$\sigma_2 = 16.056 \times 10^6$$

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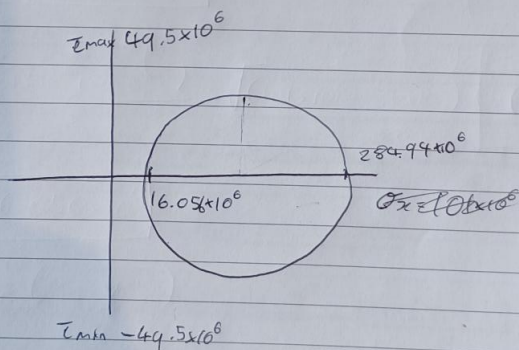
Question 2
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$$ii) \epsilon = \pm \frac{\sqrt{(\sigma_x - \sigma_y)^2 + 4\tau_{xy}^2}}{2} = \frac{\sigma_1 - \sigma_2}{2}$$

$$\epsilon = \pm \frac{\sqrt{(101 \times 10^6 - 200 \times 10^6)^2 + 4 \times 125 \times 10^6}}{2}$$

$$\epsilon_{max} = 49.5 \times 10^6$$
$$\epsilon_{min} = -49.5 \times 10^6$$

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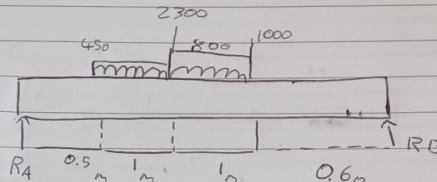


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Question 3

i)



$$M = EI \frac{d^2 y}{dx^2}$$

$$\frac{d^2 x}{dy^2} \frac{1969}{2} [x] - \frac{450}{2} [x-0.5]^2 + \frac{450}{2} [x-1.5]^2 - \frac{2300}{2} [x-1.5] - \frac{800}{2} [x-1.5]^2$$

Carried on below

$$+ \frac{800}{2} [x-2.5]^2 - 1000 [x-2.5]$$

$$\frac{d^2 x}{dy^2} \frac{d^2 x}{dy^2} EI = \frac{1969.4}{2} [x]^2 - \frac{450}{6} [x-0.5]^3 + \frac{450}{6} [x-1.5]^3 - \frac{2300}{2} [x-1.5]^2$$

carried on below

$$- \frac{800}{6} [x-1.5]^3 + \frac{800}{6} [x-2.5]^3 - \frac{1000}{2} [x-2.5]^2 + A$$

$$y^4 EI = \frac{1969.4}{6} [x]^3 - \frac{450}{24} [x-0.5]^4 + \frac{450}{24} [x-1.5]^4 - \frac{2300}{6} [x-1.5]^3$$

$$- \frac{800}{24} [x-1.5]^4 + \frac{800}{24} [x-2.5]^4 - \frac{1000}{6} [x-2.5]^3 + Ax + b$$

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Question 3

IV) @ $x=0$ $y=0$

$$0 = 0 - 0 + 0 - 0 - 0 + 0 - 0 + A$$

$$\boxed{A=0}$$

@ $x=3.1$ $y=0$

$$0 = \frac{1969.4 [3.1]^3}{6} - \frac{450 [3.1-0.5]^4}{24} + \frac{450 [3.1-1.5]^4}{24} - \frac{2300 [3.1-1.5]^3}{6}$$

Carried on below

$$\frac{-800 [3.1-1.5]^4}{24} + \frac{800 [3.1-2.5]^4}{24} - \frac{1000 [3.1-2.5]^3}{6} + b$$

$$\boxed{b = 7157.83}$$

V) $x=1.5 \dots$

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Question 4)

$$\begin{aligned} \text{i)} \quad d &= 280 \text{ mm} = 0.28 \text{ m} \\ L &= 600 \text{ mm} = 0.6 \text{ m} \\ n_c &= 50 = 0.5 \\ n_c &= 62 = 0.62 \\ P &= 14.1 \text{ bar} = 14.1 \times 10^5 \text{ N/m}^2 \\ \sigma_{\text{max}} &= 150 \text{ MPa} = 150 \times 10^6 \text{ N/m}^2 \end{aligned}$$

$$\sigma_c = \frac{PD}{2enL} \quad \epsilon = \frac{PD}{2\sigma_c nL}$$

$$\epsilon = \frac{14.1 \times 10^5 \times 0.28}{2 \times 150 \times 10^6 \times 0.5} = \boxed{2.63 \times 10^{-3}}$$

$$\text{ii)} \quad \sigma_c = \frac{PD}{4enL} \quad \epsilon = \frac{PD}{4\sigma_c nL}$$

$$\epsilon = \frac{14.1 \times 10^5 \times 0.28}{4 \times 150 \times 10^6 \times 0.62} = \boxed{1.06 \times 10^{-3}}$$

$$\text{iii)} \quad \boxed{1.06 \times 10^{-3} \text{ m}}$$

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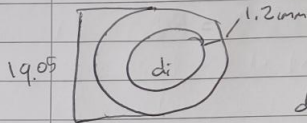
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Question 5)

iv) $SR = \frac{L}{K}$

$$K = \sqrt{\frac{I}{A}}$$

$$I = \frac{\pi d^4}{64}$$



$$d_i = 19.05 - (1.2) = 16.65 \text{ mm}$$

$$I = \frac{\pi d_1^4}{64} - \frac{\pi d_2^4}{64} \quad I = \frac{\pi (19.05)^4}{64} - \frac{\pi (16.65)^4}{64}$$

$$I = 5.26 \times 10^3$$

$$K = \sqrt{\frac{5.26 \times 10^3}{67.29}}$$

$$A = \frac{\pi d_1^2}{4} - \frac{\pi d_2^2}{4}$$

$$K = 8.84$$

$$A = \frac{\pi (19.05)^2}{4} - \frac{\pi (16.65)^2}{4}$$

$$SR = \frac{1.30}{8.84}$$

$$A = 67.29$$

$$SR = 0.15$$

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Question 5

i) $A = \frac{\pi}{4} (d^2 - d_1^2)$

$$A = \frac{\pi}{4} (19.05^2 - 16.65^2) = 67.29 \text{ mm}^2$$

iii) $k = \frac{F}{A} = \frac{5.26 \times 10^3}{67.29} = 78.17$