

## Stress Analysis

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ACHA 5015

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i)

$$\epsilon_x = 29 \times 10^{-6}$$

$$\epsilon_y = -19 \times 10^{-6}$$

$$\nu = 0.28$$

$$E = 170 \times 10^9$$

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

$$= \frac{170 \times 10^9}{1-0.28^2} (29 \times 10^{-6} + (0.28 \times -19 \times 10^{-6}))$$

$$\sigma_x = 4.37 \text{ MPa} \quad \therefore \text{Tensile}$$

$$\sigma_y = -2.01 \text{ MPa} \quad \therefore \text{Compressive}$$

ii)

$$\sigma_x = 89 \text{ MPa}$$

$$\sigma_y = -49 \text{ MPa}$$

$$\nu = 0.28$$

$$E = 170 \text{ GPa}$$

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

$$\epsilon_x = \frac{1}{170 \times 10^9} (89 \times 10^6 - (0.28 \times -49 \times 10^6))$$

$$\epsilon_x = 6.04 \times 10^{-4} \quad \text{or} \quad 604 \mu\epsilon$$

$$\epsilon_y = -4.35 \times 10^{-4} \quad \text{or} \quad -435 \mu\epsilon$$

2)

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

$$\sigma_1, \sigma_2 = \frac{(108 \times 10^6 + 209 \times 10^6)}{2} \pm \frac{\sqrt{(108 \times 10^6 - 209 \times 10^6)^2 + 4 \times (125 \times 10^3)^2}}{2}$$

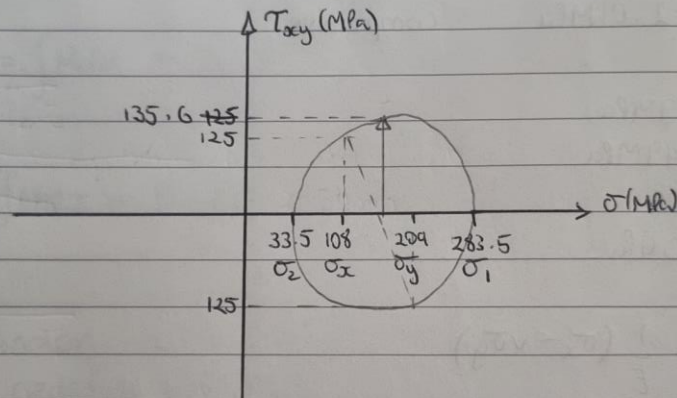
$$\sigma_1 = 283.5 \text{ MPa}$$

$$\sigma_2 = 33.5 \text{ MPa}$$

$$ii) \tau_{max} = \frac{\sigma_1 - \sigma_2}{2} = 125 \text{ MPa} \quad \frac{\sqrt{(\sigma_x - \sigma_y)^2 + 4\tau_{xy}^2}}{2} = 135.6 \text{ MPa}$$

$$\tau_{min} = -\left[\frac{\sigma_1 - \sigma_2}{2}\right] = -125 \text{ MPa} \quad = -135.6 \text{ MPa}$$

iii)



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3)  $R_A = 1969.4 \text{ N}$   $R_B = 2580.6 \text{ N}$

i)

$$EI \frac{d^2 y}{dx^2} = \frac{1969.4[x]}{2} - \frac{450[x-0.5]^2}{2} + \frac{450[x-1.5]^2}{2} - \frac{800[x-1.5]^2}{2} - \frac{2300[x-1.5]}{2} + \frac{800[x-2.5]^2}{2} - 1000[x-2.5]$$

ii)  $EI \frac{dy}{dx} = \frac{1969.4[x]^2}{2} - \frac{450[x-0.5]^3}{6} + \frac{450[x-1.5]^3}{6} - \frac{800[x-1.5]^3}{6} - \frac{2300[x-1.5]^2}{2} + \frac{800[x-2.5]^3}{6} - \frac{1000[x-2.5]^2}{2} + A$

iii)  $EI y = \frac{1969.4[x]^3}{6} - \frac{450[x-0.5]^4}{24} + \frac{450[x-1.5]^4}{24} - \frac{800[x-1.5]^4}{24} - \frac{2300[x-1.5]^3}{6} + \frac{800[x-2.5]^4}{24} - \frac{1000[x-2.5]^3}{6} + Ax + B$

iv)  $y=0, x=0$

$$0 = 0 - 0 + 0 - 0 - 0 + 0 - 0 + A(0) + B$$

$$B = 0$$

$y=0, x=3.1 \text{ m}$

$$3.1A = -\frac{1969.4[3.1]^3}{6} \text{ etc...}$$

$$3.1A = -7224.18 \quad \therefore A = -2330.38$$

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$$v) E = 89 \text{ MPa}$$

$$x = 1.55$$

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$$89 \times 10^6 y = -2412.62$$

$$y = -2.71 \times 10^{-5} \text{ m}$$

$$4) d = 0.28 \text{ m}$$

$$l = 0.6 \text{ m}$$

$$n_c = 0.69$$

$$n_L = 0.59$$

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

$$p_{\max} = 14.8 \text{ Bar} = 14.8 \times 10^5 \text{ Pa}$$

$$i) t = \frac{pD}{2n_L \sigma_c}$$

$$t = 2.0019 \times 10^{-3} \text{ m} \quad t = 2.34 \times 10^{-3} \text{ m}$$

$$\approx 2 \text{ mm} \quad = 2.34 \text{ mm}$$

$$ii) t = \frac{pD}{4n_c \sigma_L}$$

$$t = 1.00097 \times 10^{-3} \text{ m}$$

$$\approx 1 \text{ mm}$$

$$iii) \therefore t_{\min} = 2.34 \text{ mm}$$

$$5) D_{out} = 19.05 \text{ mm}$$

$$D_{in} = 16.65 \text{ mm}$$

$$L = 1.39 \text{ m}$$

$$E = 200 \times 10^9 \text{ Pa}$$

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$$i) I = \frac{\pi ((19.05 \times 10^{-3})^4 - (16.65 \times 10^{-3})^4)}{64} = 2.69 \times 10^{-9} \text{ m}^4$$

$$ii) n = 0.25$$

$$iii) F_{\sigma} = \frac{0.25 \pi^2 \times EI}{L^2} = 687.06 \text{ N}$$

$$iv) SR = \frac{L}{k} \quad k = \frac{I}{A} \quad A = \frac{\pi (D_{out}^2 - D_{in}^2)}{4}$$

$$A = 6.73 \times 10^{-5} \text{ m}^2$$

$$k = 3.9970 \dots \times 10^{-5}$$

$$SR = \frac{1.39}{3.997 \times 10^{-5}} = 34775.84 > 180 \therefore \text{strut}$$