

Michael Reeves

1905430

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ACHA5015

A-1 B-9 C-0 D-5 E-4 F-3 G-0

li.)

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

$$\nu = 0.28$$

$$\epsilon_x = 20 \times 10^{-6}$$

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

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

$$= \frac{170 \times 10^9}{1-0.28^2} \times (20 \times 10^{-6} - (0.28 \times 13 \times 10^{-6}))$$

$$= 3.018 \times 10^6 \text{ Pa} \text{ is Tensile}$$

$$\sigma_y = \frac{170 \times 10^9}{1-0.28^2} \times (-13 \times 10^{-6} + (0.28 \times 20 \times 10^{-6}))$$

$$= -1.365 \times 10^6 \text{ Pa} \text{ is Compressive}$$

ii.)

$$\sigma_x = 83 \times 10^6 \text{ Pa}$$

$$\sigma_y = -40 \times 10^6 \text{ Pa}$$

$$\epsilon_x = \frac{1}{E} (\sigma_x - \nu \sigma_y) = \frac{1}{170 \times 10^9} (83 \times 10^6 + 0.28 \times 40 \times 10^6)$$

$$= 723.53 \times 10^{-6}$$

$$\epsilon_y = \frac{1}{170 \times 10^9} \times (-40 \times 10^6 - 0.28 \times 83 \times 10^6)$$

$$= -723.53 \times 10^{-6}$$

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(ii.)

$$\sigma_x = 83 \times 10^6 \text{ Pa}$$

$$\sigma_y = -40 \times 10^6 \text{ Pa}$$

$$\nu = 0.28$$

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

$$= \frac{1}{170 \times 10^9} \times (83 \times 10^6 + (0.28 \times 40 \times 10^6))$$

$$\epsilon_x = 554.118 \times 10^{-6} \text{ Pa}$$

$$\epsilon_y = \frac{1}{170 \times 10^9} \times (-40 \times 10^6 + (0.28 \times 83 \times 10^6))$$

$$\epsilon_y = -372 \times 10^{-6} \text{ Pa}$$

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2i.

$$\sigma_x = 104 \times 10^6 \text{ Pa}$$

$$\sigma_y = 203 \times 10^6 \text{ Pa}$$

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

$$\sigma_1 = \frac{(104 \times 10^6 + 203 \times 10^6)}{2} + \frac{\sqrt{(104 \times 10^6 - 203 \times 10^6)^2 + 4 \times 125 \times 10^6}}{2}$$

$$\sigma_1 = 287.94 \times 10^6 \text{ Pa}$$

$$\sigma_2 = 19.056 \times 10^6 \text{ Pa}$$

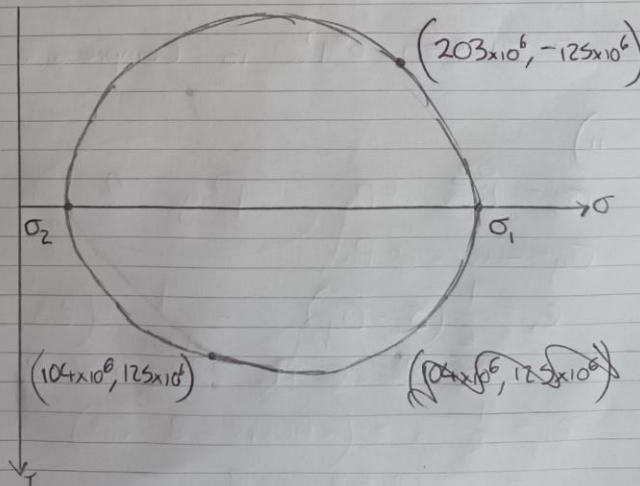
ii.

$$\tau_{\max} = \frac{\sqrt{(104 \times 10^6 - 203 \times 10^6)^2 + 4 \times (125 \times 10^6)^2}}{2}$$

$$\tau_{\max} = 134.4 \times 10^6$$

$$\tau_{\min} = -134.4 \times 10^6$$

2iii.



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3.)

$$EI \frac{d^2 y}{dx^2} = 1969.4x - \frac{450x(x-0.5)^2}{2} + \frac{450x(x-1.5)^2}{2} - 2300(x-1.5)^2$$

$$- \frac{800x(x-1.5)^2}{2} + \frac{800x(x-2.5)^2}{2} - 1000(x-2.5)^2$$

$$+ 25806(x-3.1)^2$$

$$3ii) EI \frac{dy}{dx} = \frac{1969.4x^2}{2} - \frac{450x(x-0.5)^3}{6} + \frac{450x(x-1.5)^3}{6} - \frac{2300(x-1.5)^3}{6}$$

$$- \frac{800x(x-1.5)^3}{6} + \frac{800x(x-2.5)^3}{6} - \frac{1000(x-2.5)^3}{6}$$

$$+ \frac{25806(x-3.1)^3}{6} + a$$

$$3iii) EI y = \frac{1969.4x^3}{6} - \frac{450x(x-0.5)^4}{24} + \frac{450x(x-1.5)^4}{24}$$

$$- \frac{2300(x-1.5)^4}{24} - \frac{800x(x-1.5)^4}{24} + \frac{800x(x-2.5)^4}{24}$$

$$- \frac{1000(x-2.5)^4}{24} + \frac{25806(x-3.1)^4}{24} + ax + b$$

$$3iv) y=0 \text{ when } x=0 \text{ \& \; } 3.1$$

$$y = \frac{1969.4(0)^3}{6} + a(0) + b = 0$$

$$y = 0 + 0 + b \quad b = 0$$

$$x = 3.1$$

$$0 = -8196.86 + 3.1a$$

$$a = -2644.15$$

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3v. Centre beam is $3.1/2 = 1.55$
 $x = 1.55$

$$1.43 \times 10^6 y = \frac{1969.4(1.55)^3}{6} - \frac{450 \times (1.05)^4}{24} + \frac{450 \times (0.05)^4}{24} \\ - \frac{2300(0.05)^4}{24} - \frac{800 \times (0.05)^4}{24} - \cancel{2644.15(1.55)}$$

$$1.43 \times 10^6 y = -2257.66$$

$$y = \frac{-2257.66}{1.43 \times 10^6} = -1.58 \times 10^{-3} \text{ m}$$

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4.1.

$$\sigma_c = \frac{pD}{2t\eta_L} \quad \sigma_L = \frac{pD}{4t\eta_c}$$

$$p = 14.4 \text{ Bar} \quad 14.4 \times 10^5 \text{ Pa}$$

$$D = 0.28 \text{ m}$$

$$\eta_c = 60\% \quad 0.6$$

$$\eta_L = 53\% \quad 0.53$$

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

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

$$t = \frac{pD}{2\sigma_c\eta_L} = \frac{14.4 \times 10^5 \times 0.28}{2 \times 150 \times 10^6 \times 0.53} = 2.54 \times 10^{-3} \text{ m}$$

ii)

~~$$t = \frac{pD}{2\sigma_L\eta_c} = \frac{14.4 \times 10^5 \times 0.28}{2 \times 150 \times 10^6 \times 0.6} = 2.24 \times 10^{-3} \text{ m}$$~~

iii) $2.54 \times 10^{-3} \text{ m} / 2.54 \text{ mm}$

$$t = \frac{pD}{4\sigma_L\eta_c} = \frac{14.4 \times 10^5 \times 0.28}{4 \times 150 \times 10^6 \times 0.6} = 1.12 \times 10^{-3} \text{ m}$$

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5i. $I = \frac{\pi d^4}{64} = \pi$

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

$$d = 0.01905 \text{ m}$$

$$d_i = 0.01665$$

$$I = \frac{\pi}{64} (0.01905^4 - 0.01665^4) = 2.69 \times 10^{-9}$$

ii.) $n = 0.25$

iii.) $F_{cr} = \frac{n\pi^2 EI}{L^2}$

$$= \frac{0.25 \pi^2 \times 200 \times 10^9 \times 2.69 \times 10^{-9}}{1.33^2} = 750.44 \text{ N}$$

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

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

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

$$= \frac{\pi}{4} (0.01905^2 - 0.01665^2) = 6.73 \times 10^{-5} \text{ m}^2$$

$$K = \sqrt{\frac{2.69 \times 10^{-9}}{6.73 \times 10^{-5}}}$$

$$K = \sqrt{\frac{2.69 \times 10^{-9}}{6.73 \times 10^{-5}}} = 6.32 \times 10^{-3}$$

$$SR = \frac{1.33}{6.32 \times 10^{-3}} = 210$$

210 > 120 so slender ratio confirms its a strut