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Module name: Stress Analysis and CAE

Module code: ACHA5015

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Stress Analysis and CME
Module code: AC11AS015
2005+00

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Bouagene Pindungi

QUESTION ONE

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

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

$$\nu = 0.28$$

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

i) Calculate the stresses
Formula to use

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

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

$$3.17 \times 10^6 \text{ Pa}$$

$$3.17 \text{ MPa}$$

TENSILE

$$\sigma_2 = \frac{E}{1-\nu^2} (\epsilon_2 + \nu \epsilon_1)$$

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

$$-811.63 \times 10^3 \text{ Pa}$$

$$-811.63 \text{ kPa}$$

COMPRESSIVE

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Bouguere P. 14.4

2005+20

QUESTION ONE

iii) $\epsilon_x = 80 \times 10^6 \text{ Pa}$
 $\epsilon_y = -40 \times 10^6 \text{ Pa}$
 $E = 170 \times 10^9 \text{ Pa}$
 $\nu = 0.28$

Formula to use

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

$$\epsilon_1 = \frac{1}{170 \times 10^9} (80 \times 10^6 - 0.28(-40 \times 10^6)) =$$
$$536.47 \times 10^{-6}$$
$$536 \mu\epsilon$$

$$\epsilon_2 = \frac{1}{E} (\sigma_2 - \nu \sigma_1)$$

$$\frac{1}{170 \times 10^9} (-40 \times 10^6 - (0.28)(80 \times 10^6)) = -367.05 \times 10^{-6}$$
$$-367 \mu\epsilon$$

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Bearing Pulley

2005+00

QUESTION TWO

$$\left. \begin{array}{l} \sigma_x = 107 \text{ MPa} \\ \sigma_y = 200 \text{ MPa} \\ \tau_{xy} = 125 \text{ MPa} \end{array} \right\} \begin{array}{l} x(107, 125) \\ y(200, -125) \end{array}$$

Formula to use

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

$$\sigma_1 = \frac{(107 \times 10^6 + 200 \times 10^6)}{2} + \frac{\sqrt{(107 \times 10^6 - 200 \times 10^6)^2 + 4(125 \times 10^6)^2}}{2}$$

$$\sigma_1 = 153.5 \times 10^6 + 133.37 \times 10^6 = 286.87 \times 10^6$$

286.87 MPa

$$\sigma_2 = 153.5 \times 10^6 - 133.37 \times 10^6 = 20.13 \times 10^6$$

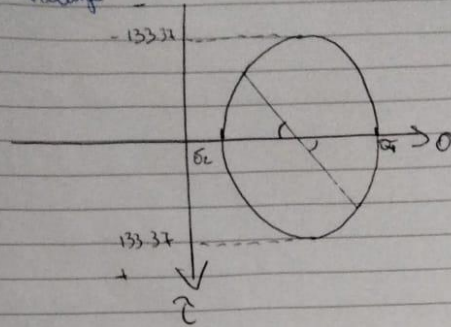
20.13 MPa

iii) $\tau_{max} = 133.37 \times 10^6 \text{ Pa}$

$$\tau_{min} = -133.37 \times 10^6 \text{ Pa}$$

Paragana Pabna

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$$\tan 2\theta_p = \frac{2\tau}{\sigma_x - \sigma_y}$$

$$2\theta_p = \tan^{-1} \left(\frac{2 \times 125 \times 10^6}{107 \times 10^6 - 200 \times 10^6} \right)$$

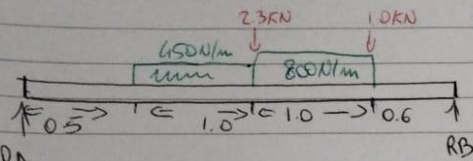
$$\theta_p = -34.80^\circ$$

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Boussinesq's Problem

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QUESTION THREE



$EI = 1.70 \text{ MPa}$
 1.70×10^6

RA

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

RB

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

$$\int EI \frac{d^4 y}{dx^4} = 1969.4(x) - \frac{450(x-0.5)^2}{2} + \frac{450(x-1.5)^2}{2} - 2300(x-1.5) - \frac{800(x-1.5)^2}{2} + \frac{800(x-2.5)^2}{2} - 1000(x-2.5)$$

$$\int EI \frac{d^4 y}{dx^4} = \frac{1969.4(x)^3}{6} - \frac{450(x-0.5)^3}{6} + \frac{450(x-1.5)^3}{6} - \frac{2300(x-1.5)^2}{2} - \frac{800(x-1.5)^3}{6} + \frac{800(x-2.5)^3}{6} - \frac{1000(x-2.5)^2}{2} + A$$

$$\int EI \frac{d^4 y}{dx^4} = \frac{1969.4(x)^3}{6} - \frac{450(x-0.5)^4}{24} + \frac{450(x-1.5)^4}{24} - \frac{2300(x-1.5)^3}{6} - \frac{800(x-1.5)^4}{24} + \frac{800(x-2.5)^4}{24} - \frac{1000(x-2.5)^3}{6} + Ax + B$$

$$x = 0 \quad y = 0$$

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

$$= 0$$

$$\therefore B = 0$$

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Bouguer Pendulum

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$$x = 3.1$$

$$\frac{1969.4(3.1)^3}{6} - \frac{450(2.6)^4}{24} + \frac{450(1.6)^4}{24} - \frac{2300(1.6)^3}{6}$$

$$- \frac{800(1.6)^4}{24} + \frac{800(0.6)^4}{24} - \frac{1000(0.6)^3}{6} + A(3.1)$$

$$A = 9778.40 - 856.83 + 122.88 - 1570.13 - 218.45$$

$$+ 4.32 - 36 =$$

$$A = \frac{-7224.19}{3.1} = 2330.38$$

center $x = 1.55$

$$EI = y = \frac{1969.4(1.55)^3}{6} - \frac{450(1.05)^4}{24} + \frac{450(0.05)^4}{24} - \frac{2300(0.05)^3}{6}$$

$$- \frac{800(0.05)^4}{24} - 2330.38(1.55) =$$

$$y = 1222.3 - 22.79 + 117.19 \times 10^{-6} - 47.92 \times 10^{-3}$$

$$- 208.33 \times 10^{-6} - 3612.089$$

$$y = \frac{-2412.63}{1.7 \times 10^6} = -1.42 \times 10^{-3} \text{ m}$$

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Bougeuse Picking:

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QUESTION FOUR

$$D = 0.280 \text{ m}$$

$$L = 0.600 \text{ m}$$

$$m_L = 50\% = 0.50$$

$$m_C = 60\% = 0.60$$

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

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

Circumferential
Formula

$$\sigma_c = \frac{pD}{2tm_L}$$

$$t = \frac{pD}{2\sigma_c m_L}$$

$$\frac{(14.7 \times 10^5) \cdot (0.280)}{2 \times 150 \times 10^6 \times 0.50} =$$

$$t = 2.764 \times 10^{-3} \text{ m}$$

Longitudinal

Formula

$$\sigma_L = \frac{pD}{4tm_C}$$

$$t = \frac{pD}{4\sigma_c m_C}$$

$$\frac{14.7 \times 10^5 \times 0.280}{4 \times 150 \times 10^6 \cdot 0.60} =$$

$$t = 1.433 \times 10^{-3} \text{ m}$$

$$t_{\min} = \underline{\underline{2.764 \times 10^{-3} \text{ m}}}$$

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Bougie Pinduz

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$$d_o = 19.05 \times 10^{-3} \text{ m}$$

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

$$d_i = 17.85 \times 10^{-3}$$

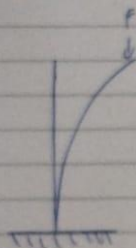
$$L = 1.30$$

$$I = \frac{\pi}{4} (d_o^4 - d_i^4) = \frac{\pi}{4} ((19.05 \times 10^{-3})^4 - (17.85 \times 10^{-3})^4) = 3.77 \times 10^{-6} \text{ m}^4$$

$$I = \frac{\pi}{64} (d_o^4 - d_i^4) = \frac{\pi}{64} ((19.05 \times 10^{-3})^4 - (17.85 \times 10^{-3})^4) = 1.48 \times 10^{-9} \text{ m}^4$$

$$K = \frac{1.48 \times 10^{-9}}{3.77 \times 10^{-5}} = 42.57 \times 10^{-6} = 0.00042565$$

ii]



$$M = 0.25$$

$$iii] F_{cr} = \frac{m \cdot \pi^2 \cdot E \cdot I}{L^2} = \frac{0.25 \times \pi^2 \times 200 \times 10^9 \times 1.48 \times 10^{-9}}{1.30^2}$$

$$F_{cr} = 432.16 \text{ N}$$

$$iv] SR = \frac{L}{K} = \frac{1.30}{0.00042565} = 30541.52$$

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