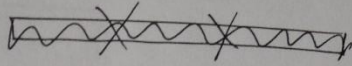


Stressed Analysis Q&E Exam:

9th May 2012

$$A=2 \quad B=0 \quad C=0 \quad D=4 \quad E=2 \quad F=0 \quad G=5$$



Q1:

$$1) \quad \epsilon_x = 25 \times 10^{-6}$$

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

$$\nu = 0.28$$

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

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

$$\sigma_x = \frac{170 \times 10^9}{1-0.28^2} \times (25 \times 10^{-6} + 0.28 \times -10 \times 10^{-6})$$

$$\sigma_x = \frac{1.24 \times 10^6}{4.09 \times 10^6} \text{ Pa (Tensile)}$$

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

$$\sigma_y = \frac{170 \times 10^9}{1-0.28^2} \times (-10 \times 10^{-6} + 0.28 \times 25 \times 10^{-6})$$

$$\sigma_y = -553.39 \times 10^3 \text{ Pa (compressive)}$$

$$2) \quad \sigma_{xc} = 80 \times 10^6 \text{ Pa}$$

$$\sigma_y = 45 \times 10^6 \text{ Pa}$$

$$\nu = 0.28$$

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

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

$$\epsilon_x = \frac{1}{170 \times 10^9} \times (80 \times 10^6 - 0.28 \times 45 \times 10^6)$$

$$\epsilon_x = 396.47 \times 10^{-6}$$

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

$$\epsilon_y = \frac{1}{170 \times 10^9} \times (45 \times 10^6 - 0.28 \times 80 \times 10^6)$$

$$\epsilon_y = 132.94 \times 10^{-6}$$

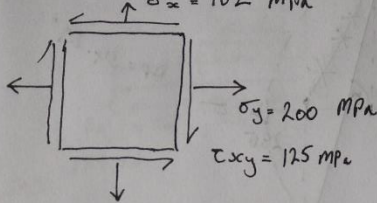
Stress Analysis + CAE Exam:

9th May 2022
(2004205)

Answer All Questions: Student No.

A=2 B=0 C=0 D=4 E=2 F=0 G=5

Question 2:



$$\begin{aligned}\sigma_x &= 102 \times 10^6 \text{ Pa} \\ \sigma_y &= 200 \times 10^6 \text{ Pa} \\ \tau_{xy} &= 125 \text{ MPa}\end{aligned}$$

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

$$1) \quad \sigma_1 = \frac{(102 \times 10^6 + 200 \times 10^6)}{2} + \sqrt{\frac{(102 \times 10^6 - 200 \times 10^6)^2}{4} + (4 \times 125 \times 10^6)^2}$$

$$\sigma_1 = 285.26 \times 10^6 \text{ Pa}$$

$$\sigma_2 = \frac{(102 \times 10^6 + 200 \times 10^6)}{2} - \sqrt{\frac{(102 \times 10^6 - 200 \times 10^6)^2}{4} + (4 \times 125 \times 10^6)^2}$$

$$\sigma_2 = 16.74 \times 10^6 \text{ Pa}$$

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

$$\tau_{\max} = \frac{\sqrt{(102 \times 10^6 - 200 \times 10^6)^2 + (4 \times 125 \times 10^6)^2}}{2}$$

$$\tau_{\max} = 134.26 \times 10^6 \text{ Pa}$$

$$\tau_{\min} = -\frac{\sqrt{(102 \times 10^6 - 200 \times 10^6)^2 + (4 \times 125 \times 10^6)^2}}{2}$$

$$\tau_{\min} = -134.26 \times 10^6 \text{ Pa}$$

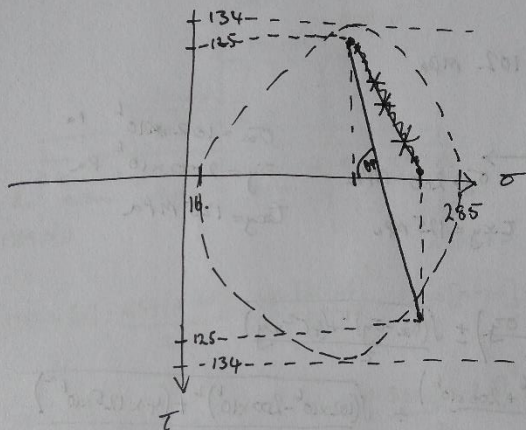
$$\tan 2\theta_p = \frac{2\tau}{\sigma_x - \sigma_y}$$

$$= \frac{2 \times 125 \times 10^6}{(102 \times 10^6 - 200 \times 10^6)}$$

$$= -2.55$$

$$\theta_p = \frac{\tan^{-1}(2.55)}{2}$$

$$\theta_p = -34.27^\circ$$

Bohr's Circle:

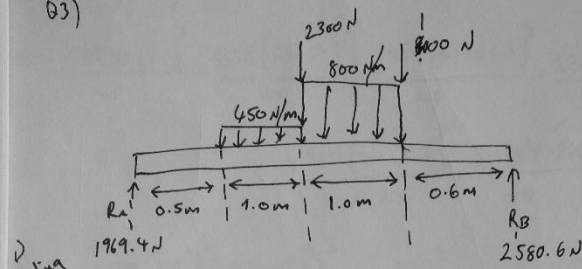
$$\theta P = 34.29^\circ$$

Stress Analysis CPE Course:

9th May 2022

$$A=2 \quad B=0 \quad C=0 \quad D=4 \quad E=2 \quad F=0 \quad G=5$$

(3)



1) Bending

$$EI \frac{dy}{dx} = 1969.4 [x] - \frac{450 [x-0.5]^2}{2} + \frac{450 [x-1.5]^2}{2} - 2300 [x-1.5] - \frac{800 [x-1.5]^2}{2} + \frac{800 [x-2.5]^2}{2} - \frac{1000 [x-2.5]}{1}$$

2) Slope

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

3) Deflection:

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

4) $x = 0 \quad y = 0$

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

$$\therefore B = 0$$

Moment/eq's (continued):

$$0.5 + 1 + 1 + 0.6 = 3.1$$

$$x = 3.1 \quad y = 0$$

$$0 = \frac{1969.4 [3.1]^3}{6} - \frac{450 [3.1 - 0.5]^4}{24} + \frac{450 [3.1 - 1.5]^4}{24} - \frac{2300 [3.1 - 1.5]^3}{6} - \frac{800 [3.1 - 1.5]^3}{24} + \frac{800 [3.1 - 2.5]^4}{24} - \frac{1000 [3.1 - 2.5]^3}{6} + 3.1A$$

$$3.1A = \frac{450 [2.6]^4}{24} + \frac{2300 [1.6]^3}{6} + \frac{800 [1.6]^4}{24} + \frac{100 [0.6]^3}{6} - \frac{800 [0.6]^4}{24} - \frac{450 [1.6]^4}{24} - \frac{1969.4 [3.1]^3}{6}$$

$$3.1A = -7.26 \times 10^3 \text{ m}$$

$$A = \frac{-7.26 \times 10^3}{3.1}$$

$$A = -2.34 \times 10^3 \text{ m}$$

5) 1.20 MPa

EI 1.2 × 10⁶ Pa

F = 2300 N W = 450 + 800 = 1250 N/m

L = 3.1

$$\frac{FL^3}{48EI} + \frac{SWL^4}{384EI} = \frac{2300 \times 3.1^3}{48 \times 1.2 \times 10^6} + \frac{5 \times 1250 \times 3.1^4}{384 \times 1.2 \times 10^6}$$

$$= 2.44 \times 10^{-3} \text{ m}$$

Stress Analysis CAE Exam:

9th May 2022

$$A=2 \quad B=6 \quad C=0 \quad D=4 \quad E=2 \quad F=0 \quad G=5$$

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

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

$$\eta_L = \cancel{0.5} \times 50\% = 0.5$$

$$\eta_C = 65\% = 0.65$$

$$P_i^{\text{max}} = 14.2 \times 10^5 \text{ Pa}$$

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

$$t = ?$$

$$1) \quad \sigma_c = \frac{PD}{2t\eta_L}$$

$$t = \frac{PD}{2\eta_L \sigma_c}$$

$$t = \frac{14.2 \times 10^5 \times 0.28}{2 \times 0.5 \times 150 \times 10^6}$$

$$t = \frac{2.65 \times 10^{-3} \text{ m}}{2.65 \text{ mm}}$$

$$2) \quad \sigma_L = \frac{PD}{4t\eta_C}$$

$$t = \frac{PD}{4\eta_C \sigma_L} = \frac{14.2 \times 10^5 \times 0.28}{4 \times 0.65 \times 150 \times 10^6}$$

$$t = \frac{1.02 \times 10^{-3} \text{ m}}{1.02 \text{ mm}}$$

3) $\therefore$ the minimum thickness is $2.65 \times 10^{-3} \text{ m}$ (2.65 mm).

Stress Analysis CAE Exam:

9th May 2022

$$A=2 \ B=0 \ C=0 \ D=4 \ E=2 \ F=0 \ G=5 \quad (19.05 - 1.2 = 17.85)$$

$$L = 1.30 \text{ m}$$

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

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

$$t = 1.2 \times 10^{-3} \text{ m}$$

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

$$1) A = \frac{\pi}{4} (d_o^2 - d_i^2)$$

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

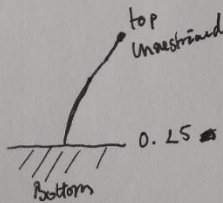
$$A = \frac{\pi}{4} (19.05 \times 10^{-3})^2 - (17.85 \times 10^{-3})^2$$

$$I = \frac{\pi}{64} (19.05 \times 10^{-3})^4 - (17.85 \times 10^{-3})^4$$

$$A = 942.48 \times 10^{-6} \text{ m}^2$$

$$I = 1.48 \times 10^{-9} \text{ m}^4$$

2)



$$\therefore n = 0.25$$

$$3) F_{cr} = \frac{n \pi E I}{L^2}$$

$$F_{cr} = \frac{0.25 \times \pi \times 200 \times 10^9}{1.3^2}$$

$$F_{cr} = 9.29 \times 10^{10} \text{ N}$$

4) Slenderness Ratio:

$$k = \frac{1}{A}$$

$$k = 1.57 \times 10^{-6}$$

$$SR = \frac{L}{k}$$

$$k = \frac{1.48 \times 10^{-9}}{942.48 \times 10^{-6}}$$

$$SR = \frac{1.3}{1.57 \times 10^{-6}}$$

$$SR = 828.03 \times 10^3$$