



12 Pages

1. Please give the information requested in the boxes below.
2. Enter your name in the space provided to the right, fold over and seal down (using the label provided) to hide your name.
3. The answers must be legibly written. The Examiners can either ignore illegible script or have it typed and the expense of typing charged to the candidate.
4. Write your answers in ink.
5. Begin each answer on a fresh page. Do all rough work in the answer book and cross it through.
6. No part of this book is to be torn out; it must be handed in complete.
7. If more books than one are used, fasten them together using the tags available from the invigilator(s).
8. **Every book must be handed in. In no circumstances may answer books, used or unused, be taken out of the examination venue.**

SURNAME:

Davies

FORENAME(S):

Corey

[illegible]

(Gweler yr ochr arall am y fersiwn Cymraeg)

34

68%

Mark Agreed
W/L

$$i) \epsilon_x = -12 \times 10^{-6}$$

$$\epsilon_y = 16 \times 10^{-6}$$

$$\nu = 0.25$$

$$E = 163 \times 10^9$$

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

$$\sigma_x = \frac{1}{163 \times 10^9} (-12 \times 10^{-6} - (0.25 \times 16 \times 10^{-6}))$$

$$\sigma_x = -9.81 \times 10^{-17} \text{ (compressive) } \text{N/m}^2$$

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

$$\sigma_y = \frac{1}{163 \times 10^9} (16 \times 10^{-6} - (0.25 \times -12 \times 10^{-6}))$$

$$\sigma_y = 1.16 \times 10^{-16} \text{ (Tensile) } \text{N/m}^2$$

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

$$\epsilon_y = -20 \times 10^{-6} \quad \sigma_y = -20 \times 10^6$$

$$\nu = 0.25$$

$$E = 163 \times 10^9$$

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

$$\epsilon_x = \frac{163 \times 10^9}{1 - 0.25^2} (25 \times 10^6 + (0.25 \times -20 \times 10^6))$$

$$\epsilon_x = 6.52 \times 10^{-18} \text{ N/m}^2$$

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

$$E_y = \frac{163 \times 10^9}{1-0.5} (-20 \times 10^6 + (0.25 \times 25 \times 10^6))$$

$$E_y = -4.48 \times 10^{12} \text{ N/m}^2$$

$$2) L = 300 \times 10^{-3}$$

$$P = 55 \times 10^6$$

$$E = 163.2 \times 10^9$$

$$\nu = 0.3$$

$$i) K = \frac{\sigma}{E\nu} \quad K = \frac{E}{3(1-2\nu)} = \frac{163.2 \times 10^9}{3(1-0.6)} = 1.36 \times 10^{11}$$

$$ii) E_v = -\frac{P}{K} = -\frac{55 \times 10^6}{1.36 \times 10^{11}} \quad E_v = -404.41 \times 10^{-6} \text{ mE}$$

$$iii) \Delta L = E_v \times L$$

$$\Delta L = 404.41 \times 10^{-6} \times 300 \times 10^{-3}$$

$$\Delta L = 1.21 \times 10^{-4} \text{ m}$$

iv) The term orthotropic material means that the material has different properties in different directions eg. x, y, z.

Simplification
error
carries

3)

$$i \frac{d^2}{dx^2} EI = -1312.4 (x) - \frac{10000}{2} (x-0.5)^2 + \frac{10000}{2} (x-1.5)^2 - 2000 (x-1.5) - \frac{60000}{2} (x-1.5)^2 + \frac{60000}{2} (x-2.5)^2$$

1 1/2

$$ii \frac{d}{dx} EI = -1312.4 (x)^2 - \frac{10}{6} (x-0.5)^3 + \frac{10}{6} (x-1.5)^3 - \frac{2000}{2} (x-1.5)^2 - \frac{60}{6} (x-1.5)^3 + \frac{60}{6} (x-2.5)^3 + A$$

2

$$iii y = -\frac{1312.4}{6} (x)^3 - \frac{10}{24} (x-0.5)^4 + \frac{10}{24} (x-1.5)^4 - \frac{2000}{6} (x-1.5)^3 - \frac{10}{24} (x-1.5)^4 + \frac{10}{24} (x-2.5)^4 + A(x) + B$$

2

iv Boundary conditions

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

$$0 = 0 - 0 + 0 - 0 - 0 + 0 \quad \frac{1}{2} \quad \underline{B=0}$$

$$\psi = v(x)$$

$$y(0) = -\frac{1312.4}{6} (3.1)^3 - \frac{10}{24} (3.1-0.5)^4 + \frac{10}{24} (3.1-1.5)^4 - \frac{2000}{6} (3.1-1.5)^3 - \frac{10}{24} (3.1-1.5)^4 + \frac{10}{24} (3.1-2.5)^4 + A(3.1) + B$$

$$y(0) = -1312.4 - 6.51 \times 10^3 - 19.04 + 2.73 - 1.36 \times 10^3 - 3 + 0.054$$

$$A = ?$$

$$EI = 1.60 \times 10^6 \text{ MPa (Flexural Stiffness)}$$

$$\begin{aligned}
 4) d &= 280 \times 10^{-3} \\
 L &= 600 \times 10^{-3} \\
 \Omega_L &= 55\% \\
 \Omega_C &= 65\% \\
 \sigma_{\max} &= 150 \times 10^6 \\
 P &= 14.6 \times 10^5
 \end{aligned}$$

$$\sigma_E = \frac{PD}{2\Omega_L E}$$

$$\sigma_C = \frac{PD}{4\Omega_C E}$$

$$2\Omega_L \sigma_E = \frac{PD}{2\Omega_L E}$$

$$2\Omega_L \sigma_C = \frac{PD}{2\Omega_C E}$$

$$E = \frac{PD}{2\Omega_L \sigma_E}$$

$$E = \frac{PD}{4\Omega_C \sigma_C}$$

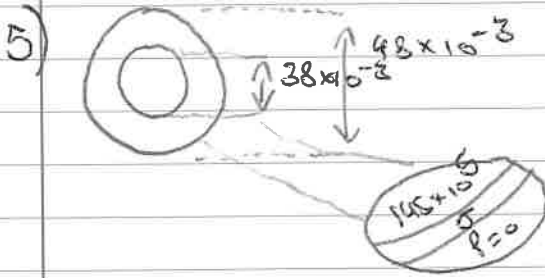
$$E = \frac{14.6 \times 10^5 \times 280 \times 10^{-3}}{2 \times 0.55 \times 150 \times 10^6}$$

$$E = \frac{14.6 \times 10^5 \times 280 \times 10^{-3}}{4 \times 0.65 \times 150 \times 10^6}$$

$$E = 2.47 \times 10^{-3}$$

$$E = 1.048 \times 10^{-3}$$

$$Min = ?$$



radius @ inside surface = 0.019

radius @ outer surface = 0.024

$$\sigma_R = a - b \quad \sigma_C = a + b$$

$$1) E_x = -12 \times 10^{-6}$$

$$E_y = 16 \times 10^{-6}$$

$$\nu = 0.25$$

$$E = 163 \times 10^9$$

$$i) \sigma_x = \frac{E}{1-\nu^2} (E_x + \nu E_y)$$

$$\sigma_x = \frac{163 \times 10^9}{1-0.25^2} (-12 \times 10^{-6} + (0.25 \times 16 \times 10^{-6}))$$

$$\sigma_x = -1.39 \times 10^6 \text{ N/m}^2 \text{ (compressive)}$$

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

$$\sigma_y = \frac{163 \times 10^9}{1-0.25^2} (16 \times 10^{-6} + (0.25 \times -12 \times 10^{-6}))$$

$$\sigma_y = 2.26 \times 10^6 \text{ N/m}^2 \text{ (Tensile)}$$

$$ii) \sigma_x = 25 \times 10^6$$

$$\sigma_y = -20 \times 10^6$$

$$\nu = 0.25$$

$$E = 163 \times 10^9$$

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

$$E_x = \frac{1}{163 \times 10^9} (25 \times 10^6 - (0.25 \times -20 \times 10^6))$$

$$E_x = 184.04 \times 10^{-6} \text{ N/m}^2$$

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

$$\epsilon_y = \frac{1}{163 \times 10^9} (-20 \times 10^6 - (0.25 \times 25 \times 10^6))$$

$$\epsilon_y = -161.04 \times 10^{-6} \text{ m/m}^2$$

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Question No.

Examiner Only

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