Advanced Strength of Materials

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Chapter 3 – Strain and Material Properties

Question 1. Determine whether the following strain fields are possible in a continuous material:

a) $\begin{bmatrix} c(x^2+y^2) & cxy \\ cxy & y^2 \end{bmatrix}$ b) $\begin{bmatrix} cz(x^2+y^2) & cxyz \\ cxyz & y^2z \end{bmatrix}$

Question 2. The following descries the state of strain at a point in a structural member:

$$[\varepsilon_{ij}] = \begin{bmatrix} 200 & 300 & 200 \\ 300 & -100 & 500 \\ 200 & 500 & -400 \end{bmatrix} \mu$$

Determine the magnitudes and directions of the principal strain.

Question 3. The displacements in an elastic material are given by

$$u = -\frac{M(1-\nu^2)}{EI}xy, \quad v = \frac{M(1+\nu)\nu}{2EI}y^2 + \frac{M(1+\nu^2)}{2EI}\left(x^2 - \frac{l^2}{4}\right), \quad w = 0$$

Where M, E, I and l are constant parameters. Determine the corresponding strain and stress fields and show that this problem represents the pure bending of a rectangular bema in the x-y plane.

Question 4. If the elastic constants E, k, and μ are required to be positive, show that Poisson's ratio must satisfy the inequality $-1 < \nu < 0.5$. For most real materials it has been found that $0 < \nu < 0.5$. Show that this more restrictive inequality in this problem implies that $\lambda > 0$.

Question 5. A square bar is subjected to an axial load of 125 KN. It is observed that the bar extends by 1.5 mm and the sides contract by 0.005 mm. The bar has a cross section of 3.5×3.5 cm. Compute the modulus of elasticity, Poisson's ratio and Lamé constants.

Question 6. At a point in the bar from Question 5 the strains are $\varepsilon_x = 500\times10^{-6}$; $\varepsilon_y = -300\times10^{-6}$ and $\varepsilon_z = 0$, $\gamma_{xy} = 100\times10^{-6}$; $\gamma_{xz} = 50\times10^{-6}$, $\gamma_{yz} = -200\times10^{-6}$. Compute the principal stresses.