

ED 3160, Make-up Quiz #1 , Oct 8 2010

Instructions

1. If something is not clear, come up and ask in a soft voice; do **not** discuss amongst yourselves.
2. Time limit is 50 minutes.
3. Cheating of any sort will not be tolerated; you will receive zero credit and may face additional consequences.

Questions

1. The stress (in MPa) at a point has the following matrix of components in a suitably chosen coordinate system:

$$\begin{bmatrix} 0 & 100 & 0 \\ 100 & 0 & 0 \\ 0 & 0 & 100 \end{bmatrix}$$

At this point, compute

- (a) the principal stresses **(1)**
 - (b) the maximum shear stress **(1)**
 - (c) the hydrostatic stress **(1)**
 - (d) the traction vector on a plane with normal $(\frac{1}{\sqrt{3}}, -\frac{1}{\sqrt{3}}, -\frac{1}{\sqrt{3}})$ **(1)**
 - (e) the normal stress acting on this plane **(1)**
2. Using the definition of the infinitesimal strain tensor, argue whether it is a good measure of strain when rotation at a point is significant. Do not just state results, develop a rational argument. **(2)**
 3. An elastic layer is sandwiched between two perfectly rigid plates, to which it is bonded. The layer is compressed between the plates, the direct (i.e. normal) stress being σ_{33} . Supposing that the attachment to the plates prevents lateral strain ϵ_{11} and ϵ_{22} completely, find the *apparent Young's modulus* ($\sigma_{33}/\epsilon_{33}$) in terms of E and ν . **(2)**
 4. An aluminium bar of square cross-section is subject to a tensile load along its axis. The length of the bar is 100 mm and the cross-section is a square of side 10 mm. Using $E = 70$ GPa and $\nu = 0.33$, calculate the following:
 - (a) the extension in the loading direction **(1)**
 - (b) the reduction in cross-sectional area **(1)**
 - (c) the percentage reduction in volume **(1)**
 5. For a homogeneous, isotropic, linear-elastic material,
 - (a) show that the principal directions of the stress and strain tensor coincide. **(2)**
 - (b) express the principal stresses in terms of the principal strains and appropriate material constants. **(1)**

A useful formula

$$\sigma_{ij} = \frac{E}{1+\nu} \left[\epsilon_{ij} + \frac{\nu}{1-2\nu} \epsilon_{kk} \delta_{ij} \right]$$