

Homework Assignment 8 (due Monday March 12, 2007)

1) A transversely isotropic rock has the following five elastic constants: $E=40$ GPa, $E'=20$ GPa, $G=8$ GPa, $\nu=0.25$ and $\nu'=0.2$. Show the variation of the apparent Young's modulus E_y , and apparent Poisson's ratios, ν_{yx} and ν_{yz} defined in equation (27) with the angle θ of Figure 6.

2) A specimen of Indiana limestone was tested in uniaxial compression in the laboratory. The stress was applied in the x direction and normal strains were measured in the x, y and z directions. The measured stresses and strains are as follows:

| Stress σ_x (psi) | Strain ϵ_x (10^{-3} in/in) | Strain ϵ_y (10^{-3} in/in) | Strain ϵ_z (10^{-3} in/in) |
|----------------------------|---|---|---|
| 300 | 0.5244 | -0.0114 | -0.0172 |
| 600 | 0.7761 | -0.0039 | -0.0306 |
| 900 | 0.8722 | 0.0041 | -0.0216 |
| 1200 | 0.9685 | -0.0584 | -0.0251 |
| 1500 | 1.0347 | -0.0747 | -0.0318 |
| 1800 | 1.1073 | -0.0705 | -0.0342 |
| 2100 | 1.1799 | -0.0567 | -0.0273 |
| 2400 | 1.2062 | -0.0744 | -0.0251 |
| 2700 | 1.2198 | -0.0867 | -0.0741 |
| 3000 | 1.2694 | -0.0977 | -0.1015 |
| 3300 | 1.3679 | -0.1098 | -0.1161 |
| 3600 | 1.3974 | -0.1678 | -0.1611 |
| 3900 | 1.4367 | -0.1899 | -0.1933 |
| 4200 | 1.4787 | -0.2546 | -0.2678 |
| 4500 | 1.5727 | -0.3113 | -0.3333 |

Plot the normal stress-normal strain curves. Use the three methods shown in Figure 2 to determine the Young's modulus and Poisson's ratio of the rock.

3) Show that for an isotropic rock, the mean stress and strain σ_m and ϵ_m and the deviatoric stresses and strains s_{ij} and e_{ij} are related as follows

$$\sigma_m = 3K\epsilon_m \quad ; \quad s_{ij} = 2Ge_{ij}$$

where K and G are the bulk and shear moduli, respectively. What is the advantage of using K and G instead of E and ν in describing the rock deformability?