EOSC 433 – Lab #1

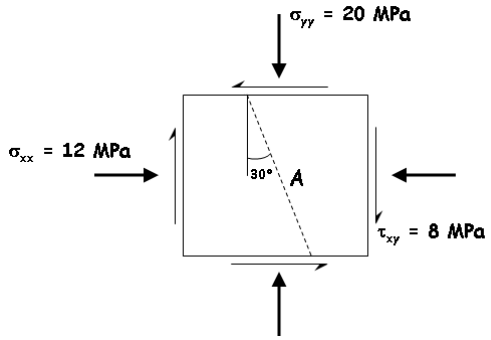
Problem Set Assignment: Stress-Strain Refresher

Term 1 (2017/18) - Due date Sept. 22, 2017

1. For the state of stress shown below, use a Mohr circle construction to determine:

   a) the normal and shear stresses on plane A.

   b) the principal stresses, and the inclination of the major principal stress axis relative to the x-axis.



2. Triaxial compression testing of a porous rock yields a cohesion of 1.0 MPa and a ϕ of 35°. Calculate the unconfined compressive strength and estimate the tensile strength for this rock assuming a linear Coulomb failure envelope.

3. Given that σ_{xx} = 20 MPa, σ_{yy} = 0 MPa, and τ_{xy} = -40 MPa, find the principal stresses in magnitude and direction (in the 2-D plane).

4. A plane is subjected to stresses where σ_{xx} = 10 MPa, σ_{yy} = 2 MPa, and σ_{zz} = 0 MPa.

   a) What condition is this, plane strain or plane stress?
   b) Calculate ε_x where E=65 GPa and ν=0.25.

5. To find the state of stress in the rock, a strain gauge rosette was glued to the flat end of a horizontal borehole. One strain gauge was horizontal, one vertical and one at 45° to the horizontal (bisecting the other two). After overcoring the borehole, the strains induced were measured to be:

   $\varepsilon_{0°}$ = -2.12e-4 $\varepsilon_{45°}$ = -0.86e-4 $\varepsilon_{90°}$ = -5.39e-4

a) Find the principle strains and their directions relative to the horizontal.
b) Determine the principle stresses and their directions at the overcoring location relative to the horizontal. Note that laboratory testing of the rock overcore produced values of E = 10 GPa and ν = 0.25.

6. An equiangular strain gauge rosette attached to the surface of an evenly stressed specimen of rock gave measurements of strain of $\varepsilon_{0°}$ = 1e-4, $\varepsilon_{60°}$ = -4e-4, and $\varepsilon_{120°}$ = 8e-4. Compute the maximum shear strain in the surface.

7. A cylindrical specimen of rock was loaded in a triaxial cell with a confining pressure of 4 MPa and an axial stress of 33 MPa. Strain gauges attached to the specimen indicated an axial strain of 850 μstrain and lateral strain of -20 μstrain.

   a) Calculate the Young's modulus and Poisson's ratio for the rock.
   b) Determine the direction in the sample where the linear strain would be 197.5 μstrain.

8. A CSIRO hollow inclusion strain cell was used in an overcoring experiment to determine the *in situ* stress state. The six components of stress relative to the test configuration were:

σ_{xx} = 15.59 MPa	τ_{xy} = 3.03 MPa
σ_{yy} = 11.08 MPa	τ_{yz} = 3.12 MPa
σ_{zz} = 11.35 MPa	τ_{zx} = 3.99 MPa

   i) Calculate the stress invariants.
   ii) Determine the principal stresses.
   iii) Determine the direction cosines for the major principal stress (σ1).