

PGE 334 – Homework #3

Instructor: DNE

1. Twelve triaxial tests on cylindrical plugs of Berea sandstone are reported below (Bernabe and Brace, 1990):

Confining pressure P_c [MPa]	Pore pressure P_p [MPa]	Peak deviatoric stress (at failure)* S_1-S_3 [MPa]
10	0	116
50	0	227
20	8	119
45	8	183
60	8	206
75	8	228
50	37	120
50	32	141
90	64	161
90	55	187
130	96	186
130	84	207

(*) This is the axial stress that a load cell measures inside a pressurized vessel (S_1-S_3). For example, the value would be zero for hydrostatic loading ($S_1=S_3 \rightarrow S_1-S_3=0$).

- Plot all data points in a σ_1 VS σ_3 plot and draw respective Mohr Circles (in Matlab, Python or Excel).
- Fit the data to Mohr-Coulomb criterion to compute unconfined compressive strength UCS and the parameter q through a linear regression. Then, calculate the cohesive strength S_0 and internal friction coefficient μ_i .
- Based on this information, compute the failure angle of the shear fracture you would expect to see in this sample after failure. Draw a sketch indicating the orientation with respect to the axial and radial stress.
- Did pore pressure significantly change the effective stress failure criterion?
Hint: figure out first how to calculate the effective radial and axial stresses.

2. The file “Triaxial-1500psi-raw.xlsx” in the ‘homework’ folder contains data from a triaxial test performed on a sandstone in dry conditions ($P_p = 0$ psi). P_c is the confining pressure, SigD is the deviatoric stress (S_1-S_3), E_x is the axial strain, and E_y is the radial strain.

- Plot deviatoric stress and strains as a function of time (two plots). Mechanical experiments are usually performed at constant strain rate or constant stress rate. Which case is this? What is the rate?
- Plot deviatoric stress as a function of axial strain. Compute loading Young modulus at 25% of peak stress and the unloading Young moduli for the two unloading cycles. Comment on the difference.
- Plot radial strain VS axial strain and compute loading Poisson ratio.
- Plot deviatoric stress VS volumetric strain. Does the sample contract, dilate, or both? Explain.
- If $q=5.3$, what is the UCS of this rock?