SAMPLE SIZE IN TRIAXIAL LOADS

How sample size affects the frictional behavior

Photo by H. Roshan et al.
STUDY OVERVIEW

• The rate of brittle-ductile transition varies based on sample size
• The sample size influences the angle of the shear plane
• Friction coefficient of shear plane is size-dependent
Experiment Setup

- Experiments conducted on Gosford Limestone (NSW, Australia)
- Samples were selected to be as homogenous as possible
- Oven dried for 24 hours at 105°C
- Cores were ground flat to .003mm

A: Hydraulic Pump  B: Computer to collect data  C: Loading frame  D: Loading frame control
Brittle-Ductile Transition

- 3 sample sizes
- 25mm diameter samples transition faster from brittle to ductile
- All sizes exhibit ascending-descending behavior
  - Level of brittleness increases as size increases up to a characteristic point, after which ductility increases as size increases
  - (in this case, 50mm)
Shear Band Angle

- Decreases as confinement increases
- 25mm diameter is much lower than 50mm and 96mm
- 50mm and 96mm show similar trend to Brittle-Ductile Transformation
Friction coefficient of formed fractures

- Studies in the past used saw-cut samples, as opposed to solid samples.
- Saw-cuts do not represent early stages of brittle fault formation.
- “From peak stress onward during the softening stage rock will experience disintegration towards the residual stress” (Byerlee, 1967)
- Friction coefficient increases as sample size increases up to a characteristic point.
Brittle-ductile transition, shear band angle, and friction coefficients are size-dependent.

Theory of thermodynamics is reached before ultimate failure of the rock, meaning rock mechanics can be used to extrapolate large scale deformation from small.
Future studies

- Define the characteristic point at which rocks of a larger size act more ductility
- Look closer at the thermodynamic limits of small samples
  - Small samples have multiple shear bands that are not much closer than the total diameter of the sample (<55mm)
  - Explore the grain-grain interactions in these small samples using simulations or other theoretical means
Questions?