

Multi-Stage Triaxial Compressive Strength Testing – A comparison of methods to conventional failure envelope generation

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Summary

In the realm of industrial rock mechanics the availability of sample for laboratory tests can be quite limited, particularly when the only available material is from cores that are expensive to collect, and where competition for other testing is high. In such cases the small amount of core material must be used judiciously to examine rock properties ranging from mineralogy & geochemistry, to porosity & permeability, and also rock mechanics. One sequence of rock mechanics tests that can be extremely useful is to perform multiple single-stage triaxial compressive strength tests at different confining pressures, and to use those results to create a Mohr-Coulomb failure envelope to determine the coefficient of friction and cohesive strength of the intact rock. Given the competition for other types of analysis and the frequent difficulty in collecting multiple high-quality specimens from the same depth, this conventional methodology can be difficult to facilitate. In cases where rock sample is precious, multi-stage triaxial compressive strength tests can be a valuable tool to provide rock mechanical data using limited material. Many different methodologies for performing multi-stage tests have been utilized over the years, in this paper we examine two methodologies: the first a relatively conventional method wherein a single sample is brought very close to failure at several increasing confining pressures, and a second method that utilizes concurrent observation of volumetric strain during loading in order to halt loading of the specimen during each stage prior to significant rollover of the Differential Stress v. Axial Stress curve, thereby mitigating the risk of premature failure of the specimen and also avoid damage done to the specimen by repeatedly bringing it close to failure. Preliminary results are promising that this methodology can be utilized to provide accurate estimates of the Coefficient of Friction and Cohesive Strength in brittle rocks, though more testing should be performed on rocks that undergo significant amounts of plastic deformation prior to failure, and also to examine what rock types, if any, are not amenable to this methodology (for example very high porosity rocks that do not exhibit a transition from volumetric compression to dilation during loading).

Results, Observations, Conclusions

Early results indicate that the method produces Mohr-Coulomb failure parameters that are well matched with both conventional Mohr-Coulomb testing and also with more conventional multi-stage testing, with the added benefit of avoiding premature failure and damage to the specimen during repeated loading it close to failure.

Novel/Additive Information

A complete description of a methodology of performing Multi-Stage Triaxial Compressive Strength tests done with the intention of avoiding premature failure and also avoiding damage to the specimen during loading to the extent that is possible.

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