Evaluation of Mohr-Coulomb Failure Criterion Using Unconfined Compressive Strength

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Abstract

Several rock deformation mechanisms are involved in the oil and gas reservoir formations and the overlaying strata. These deformations may occur during drilling, production, fracturing, stimulation, or enhanced oil recovery (secondary and tertiary). The evaluation of Mohr-Coulomb failure criterion as well as other mechanical properties for reservoir rocks is essential for well planning, development and characterization of oil and gas reservoirs. This is because the understanding of the rock-stress relationship can solve many reservoir problems and avoid cost of remedial work. For example, a Mohr-Coulomb failure criterion may be used for borehole instability analysis, water injection design, production optimization techniques, compaction and sand production prediction, etc. A Mohr-Coulomb failure criterion is a function of the apparent cohesion and the angle of internal friction. The evaluation of these two parameters requires testing of many rock samples using an expensive and time-consuming triaxial testing set-up. In this study, a correlation between the apparent cohesion and the unconfined compressive strength was developed based on laboratory measurement data of more than 300 rock samples of different types obtained from the literature. The correlation coefficient of the developed correlation equals to 0.88. Verification of the developed correlation using literature data from sources other than those used in the correlation development has shown average error of estimation values ranging from 0.85% to 17.28% for the unconfined compressive strength predictions and from 0.71% to 17.6% for the apparent cohesion predictions. For the angle of internal friction predictions, values of the error of estimation ranging from 0.88% to 7.14% were observed based on the examined data. Therefore, the Mohr-Coulomb failure criterion's parameters can be roughly estimated using the developed correlation based on fast and cheap measurements of the unconfined compressive strength.