

**THE INFLUENCE OF WATER CONTENT TO STRENGTH CHARACTERISTIC
OF SANDSTONE USING APPARATUS TRIAXIAL TEST**
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ABSTRACT

One of the external factors must be considered in underground opening works is water content of rock in area of excavation. Although it can not be measured, quantitatively, with qualitative analysis it can be said that water content significantly induces physical and mechanical properties of rock.

Hypothesis tests using Wilcoxon Sign and Rank method on data of UCS and Brazilian tests show that increasing water content from oven dried to saturated condition will decrease the values of σ_c , Modulus Elasticity and Tensile Strength as much as, 44,57%, 25,98% and 42,60% respectively the values of percent reduction are based on 99,98% range of validity.

Ultrasonic test shows that the water in rock will increase the sonic velocity. During a triaxial test, the sonic velocity changes with the applied load and this is an indicative of the failure behavior of dried rock specimen is dependent on the confining pressure. On the other hand, the failure behavior of saturated rock specimen is independent of the confining pressure and the behavior comprises of crack closure, elastic range, crack development – failure.

Failure criteria based on Mohr Coulomb, Bieniawski and Hoek & Brown are developed using data obtained from UCS and triaxial tests and the result are as follows:

Condition	Oven dried	Saturated
Failure Criteria		
Mohr-Coulomb	$\tau = \sigma_n \tan 47^\circ + 9.90$	$\tau = \sigma_n \tan 23^\circ + 16.72$
Bieniawski I	$\sigma_{1n} = 4.9 \sigma_{3n}^{0.98} + 1$	$\sigma_{1n} = 1.52 \sigma_{3n}^{0.25} + 1$
Bieniawski II	$\tau_{mn} = 0.92 \sigma_{mn}^{0.99} + 0.1$	$\tau_{mn} = 0.75 \sigma_{mn}^{0.44} + 0.1$
Hoek & Brown	$\sigma_{1n} = \sigma_{3n} + (15.75 \sigma_{3n} + 1)^{0.5}$	$\sigma_{1n} = \sigma_{3n} + (8.03 \sigma_{3n} + 1)^{0.5}$

From the equations of the mentioned failure criteria, It is obvious that rock strength decreases as water content increases.

In order to show the influence of water in the stability of underground opening, a numerical modeling was conducted. The stability constraint was based on yield condition in the failure criteria of Mohr Coulomb, Bieniawski I, Bieniawski II and Hoek & Brown. The numerical modeling was based of finite element method and used the Rheo-Staub computer program.

Calculation Result of 249 elements model in area of excavation shows that failure area gets larger as water content increases. Bieniawski II recommended the biggest number of failure element in the opening model. Otherwise, Mohr-Coulomb criteria sound more optimistic than other criteria, which recommended less number of failures.