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Numerical modeling of confinement effects on failure pattern of brittle rocks

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Abstract

One of the most important goals of rock experiments is to determine deformation and strength of specimen under applying load, the status of failure condition is one of the subjects which can be used in soil mechanic and foundation engineering applications. To investigate the effect of confining pressure, the rock has been considered as bonded-particles method and simulated by particle flow code 3 dimensions (PFC3D). To compare numerical and experimental results, Young's modulus, Possion's ratio as well as maximum axial stress have been considered. The comparison of the numerical and experimental results of maximum axial stress and the Possion's ratio revealed good accordance. The initial number density of microcracks at the model was zero and increased while microcracking. In all uniaxial and triaxial tests with different confining stresses, the number density of microcracks during the failure remains almost constant which can be considered as a proof of failure occurring in the model.

Keywords: Rock mechanic, Failure pattern, Confining pressure, Microcracking, Number density of microcracks

1. INTRODUCTION

The ongoing growth of constructing underground structures and various exploitations of them in rocky beds have made the study of mechanical behavior of rock environments significant for engineers in such a manner that exploring this field would provide valuable criteria for design. In order to understand the mechanical behavior of the rock in different conditions, laboratory and field tests should be used. The main purposeofmechanical tests is to find the mechanical parameterssuch as moduli and strenghts of rock samples. In this way, triaxial test has always been of high importance due to its innumerable uses in understanding the mechanical behavior of the rock. To increase accuracy, it is recommended that mechanical experiments be compared with applying numerical method, and for further applications. This will lead to a correct and correspondent to reality result with an acceptable accuracy.

Fakhimi (2004) stated that there are two general numerical approaches for modeling of rock: continuum and distinct element model. One of the problems in resembling the brittle behavior of the rock using the continuum approach is that the results depend on the mesh resolution and that in this approach no attention is paid to the phenomenon of tensile failure of rock. The solution to this problem is to use distinct element methods. This method was first proposed by Cundall (1971) to analyze the mechanical behavior of blocky rock system and then was used by Cundall and Strack (1979) for the soil mechanics and interaction of spherical rigid particles. Then, Cundall and Potyondy (2004) introduced bonded particle model in which the rock is represented as grainy cement materials that are bonded together through certain joints and the particles interact through normal and shear springs. Applying this method, the micro mechanisms which cause microscopic behavior in rock are obtained and also the mechanical behaviors under different conditions are anticipated. In this field, the most well-known code for resembling particle mechanics approach are the particle flow codes (PFC) introduces by Itasca Company, Jing (2003).