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Analysis of Permeability Characteristics along Rough Walled Fractures using a Homogenization Analysis

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ABSTRACT

This study is conducted to calculate the permeability coefficient in a single fracture considered with true fracture geometry. The fracture geometry is measured using the confocal laser scanning microscope (CLSM). The CLSM geometry data are used to reconstruct a fracture model for numerical analysis using a homogenization analysis (HA) method.

The HA is a new type of perturbation theory developed to characterize the behavior of a micro-inhomogeneous material that involves periodic microstructures (Sanchez-Palencia, 1980; Ichikawa et al., 1999). The computation using the 2-D fracture models is performed assuming a temperature condition of 300K. The water viscosity, η is equal to 0.8×10^{-3} Pa · sec and the mass density, ρ is equal to 0.99651g cm^{-3}. The HA permeability characteristics are shown under various roughness and aperture conditions That is, under various types of observed roughness features the upper fracture wall is displaced at intervals of every 1 mm in the shearing direction. This shear displacement is introduced for five stages, which results in various aperture values along the fracture Permeability coefficient is calculated at every stage of the displacement.

The calculation results and the relationships between the square of the mean aperture, b^2, and the calculated permeability coefficients are drawn in Fig. 1. It is found that the permeability coefficients are irregularly ranged from 10^{-4} to 10^{-1} cm/sec, while the coefficients of the previous parallel plate models are uniformly distributed in some range. This is due to the complicated change of the aperture as increasing the shear

displacement in the current models. In this figure it is not possible to find any relationship, so the cubic law is not suitable for the rough fracture case.

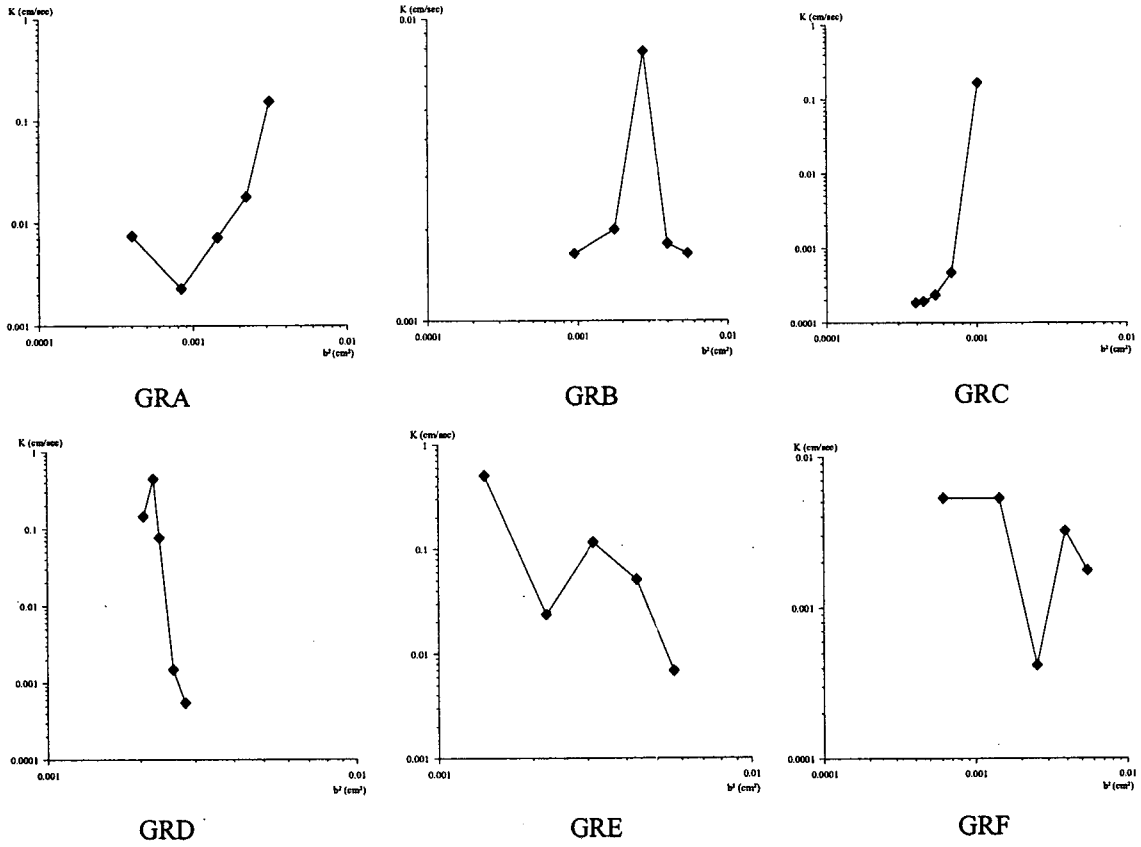

Fig. 1. Relationship between permeability coefficients and aperture square.

Key words: Permeability coefficients, Homogenization analysis, Change of aperture Cubic law, Rough fracture