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Effect of Gap Geometries on the Crack Initiation Stress of Synthetic Rock Material

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The cracking phenomenon of the brittle rock and rock-like materials (concrete, gypsum) have been widely researched. Such long-standing intensive research requirement is due to the fact that crack initiation, propagation and coalescence are some of the most important parameters for evaluating the rock failure behavior and strength properties. Especially defining the crack initiation stress is a fundamental part of crack propagation that leads to the rock material's final failure. However, due to the nature of rocks, they may have complex inherit structures containing various gaps and void with different sizes and numbers. Rocks mostly tend to have circular and ellipsoidal voids as a result of long and complex geological processes. Owing to this limitation, it is always hard to understand and assess the crack initiation stress comprehensively. Especially for a couple of decades, with the help of developing computer science and technology, numerical models were used on this subject. In this study, various two-dimensional numerical rock models created using Distinct Element Method (DEM) based Particle Flow Code (PFC) were used to understand the effect of different gap geometries over crack initiation stress values of rock materials under uniaxial loading conditions. A base numerical model was calibrated using laboratory test results belonging to basalt rocks. In order to calibrate the numerical model, uniaxial, conventional triaxial and in-direct tensile test results were used. A flat-jointed contact model was chosen to create bonded material during the calibration process. Seven different numerical models were used to investigate the gap geometry effect on crack initiation stress under uniaxial conditions. The base model has a circular gap with 5.40 mm diameter. The other models created to understand the effect of geometry on crack initiation stress have different ellipsoidal geometry depending on the initial circular gap, 1.5 (8.10 mm), 2.5 (13.50 mm) and 3.5 (18.20 mm) times the diameter in the vertical and horizontal direction, respectively. The results of numerical models reveal that the crack initiation stress value decreases with the increase of the gap's vertical length while the width of gaps remains constant. Based on numerical models' results, the crack initiation stress value decreases with the increase of the gap's vertical length while the diameter of gaps remains constant.