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Experimental and Numerical Studies on Earthquake Shear Rupture Generation

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Abstract : En-echelon fractures are commonly found in rocks, which appear as a special set of regularly oriented and spaced fractures. By using both experimental and numerical approaches, this study investigates the interaction among them, and how this interaction finally contributes to the development of a shear rupture (fault), especially in brittle natural rocks. Firstly, uniaxial compression tests are conducted on marble specimens containing en-echelon flaws. The latter is cut by using the water abrasive jet into the rock specimens. The fracturing processes of these specimens leading to the formation of a fault are observed in detail by the use of a high speed camera. The influences of the flaw geometry on the production of tensile cracks and shear cracks, which in turn dictate the coalescence patterns of the entire set of en-echelon flaws are comprehensively studied. Secondly, a numerical study based on a recently developed contact model, flat-joint contact model using the discrete element method (DEM) is carried out to model the present laboratory experiments. The numerical results provide a quantitative assessment of the interaction of en-echelon flaws. Particularly, the evolution of the stress field, as well as the characteristics of new crack initiation, propagation and coalescence associated with the generation of an eventual shear rupture are studied in detail. The numerical results are found to agree well with the experimental results obtained in both microscopic and macroscopic observations.

Keywords : discrete element method, en-echelon flaws, fault, marble
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