Crack propagation and coalescence characteristics of rock-like specimen containing preexisting flaws subjected to internal hydraulic pressure and shear force

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Abstract: Based on laboratory direct shear tests and discrete element theory, the crack propagation and coalescence mechanism and numerical simulation of cement mortar specimens considering the combined actions of internal hydraulic pressure and shear force were carried out. We completed the filling of the internal hydraulic pressure in the cement mortar specimens with preexisting flaws, and performed the direct shear tests on the specimens. In the numerical analysis, the pipe domain model in the two dimensional particle flow code (PFC2D) was modified owing to the high brittleness and low permeability of the cement mortar particles in the numerical model. We also modified the calculation rules of the interaction between the fluid and cement mortar particles, and proposed an improved fluid-solid coupling model which is more suitable for the high brittle cement mortar. Under the action of internal hydraulic pressure, a tensile region existed at the tip of the preexisting flaws of the cement mortar specimen, which can also explain the crack initiation and propagation along the horizontal shear direction during the stage of crack initiation. However, the fissure water pressure was not completely dissipated because of the high brittleness of the cement mortar and the existence of a large number of micro-cracks in the failure area, which finally resulted in a relatively concentrated horizontal compressive stress, and roughly formed a compressive region with a smaller stress along the horizontal shear direction.