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Analysis of hydraulic fracturing in concrete dam considering fluid-structure interaction using XFEM-FVM model

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Abstract: High-pressure hydraulic fracturing (HF) of cracks is the crucial factor in the safety-assessment of high concrete dams, and fluid-structure interaction in HF is the key to accurately calculate the fluid pressure within cracks. In this study, a hybrid approach combining the extended finite element method (XFEM) and the finite volume method (FVM) is introduced to simulate HF in concrete dams. Through the hybrid approach XFEM-FVM, we can obtain water pressure distribution within cracks, which reflects the coupling relationship between water pressure and fracture width. This approach is verified by an example, and the numerical results agree well with the corresponding analytic solutions. Then, we use it to simulate the HF in a concrete gravity dam. Results show that, in contrast to the constant water pressure distribution within cracks, the distribution calculated by XFEM-FVM varies with time and leads to the bigger crack extension angle, contrary to growth length. It also illustrates the significance of considering fluid-structure interaction in HF progress. This study reveals that the approach is a very efficient tool for HF simulation in concrete dam.

Keywords: Fluid-structure interaction; Gravity dam; Hydraulic fracturing; XFEM; FVM; Crack growth

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