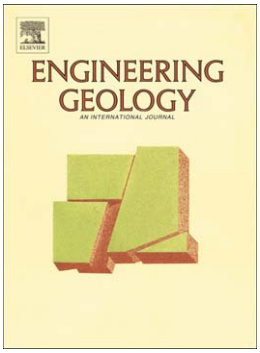

Numerical simulation of time-independent and -dependent fracturing in sandstone

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Numerical simulation of time-independent and -dependent fracturing in sandstone

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Abstract

A grain-based model has been developed to simulate both the time-independent and -dependent damage evolution leading to ultimate failure. The mechanical behaviors of the Coconino sandstone during uniaxial compression, Brazilian splitting and fracture toughness tests were simulated. Simulation results are in satisfying agreement with the lab results. Mode-I, Mode-II and mixed mode subcritical crack growth mechanisms considering randomly distributed initial microcracks have been used in the calibrated time-independent model. One-edged time-dependent crack growth in the sandstone specimen due to stress corrosion has been analysed both theoretically and numerically. It reveals that the lifetime of the specimen decreases nonlinearly with increasing length of the initial microcracks and the applied tensile load. In order to validate the developed numerical simulation scheme, a series of simulations only considering the influence of stress were conducted for a landscape arch which was assumed to be composed by the intact sandstone. The safety factor and the final failure pattern of the arch (time-independent) was determined using the strength reduction method. In parallel, the failure process of the arch due to stress corrosion (time-dependent) was studied in detail. Both approaches revealed similar final failure patterns. The proposed modelling scheme not only exhibits