A Multiscale Microstructure-informed Model of Distributed Fractures to Simulate Laboratory Tests on Rocks

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Modelling the behaviour of confined rocks in laboratory tests, through reliable analysis, is still a challenging task. Several concurrent issues, among which the marked anisotropic response (related to the onset and evolution of faults), and the strong hydro-mechanical coupling, contribute to the complexity of the involved phenomena. In this framework, we propose a coupled hydro-mechanical multiscale model of brittle damage [2-3], characterized by nested cohesive/frictional faults, according to hierarchical structures [1], and based on the definition of a reduced number (seven) of material constants. The model turns out to be a very effective tool in capturing several important features observed in rocks [2-4], such as the reduction of the overall stiffness as the material deterioration increases, fragile to ductile transition, strain localization, shear band formation, and more general size-effect. The model satisfactorily reproduces both the behaviour of the rocks at the material point scale and at the laboratory scale as a boundary value problem. A key aspect of the model is the capability to directly linking the evolution phenomena, occurring at the actual microstructure scale, and the macroscopic geometry of shear bands. This results in simulations at the full scale able to model strain localization with the formation of single or multiple shear bands.

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