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Coupling Between Permeability and Damage: a Micromechanical Approach

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A self-consistent scheme is used in order to determine the effective permeability of a cracked porous medium. For weak values of the permeability of the uncracked porous solid phase, the order of magnitude of the effective permeability increases beyond a critical value of the crack density (damage) parameter. The self-consistent scheme thus proves to be able to capture the coupling between damage and permeability as well as the concept of percolation threshold. In the asymptotic case of an impervious solid phase, a simple analytical estimate of the effective permeability is derived as a function of the crack aspect ratio, of the crack opening and of the damage parameter. The micromechanical model also shows that both the evolution of the crack opening and the crack propagation process are controlled by Terzaghi's effective stress. The latter is therefore the appropriate parameter for the effect of the mechanical loading on the effective permeability.

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