# Phase-field modeling of fracture in partially saturated porous media

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## ABSTRACT

Porous media such as soil, rocks and concrete are of great importance in the context of civil engineering and environmental geomechanics. They consist of a solid skeleton and pores filled with fluids, e.g. air and water. Complex mechanisms of flow and transport take place within the pore network and can lead to deformation of the solid skeleton and eventually to fracture phenomena [1]. Phase-field modeling of fracture has recently emerged as an alternative to conventional approaches such as remeshing, extended finite element methods or cohesive zone modeling. The phase-field framework can be considered a special type of gradient damage modeling approach, where a diffusive approximation of the crack is taken into account and the continuous phase-field parameter is used to describe the material integrity. The essential advantages are the possibility to describe arbitrarily complicated fracture patterns such as nucleation, branching and merging, without ad-hoc criteria on a fixed mesh, through the solution of partial differential equations derived from variational principles [2, 3, 4, 5]. Phase-field modeling of fracture in porous media has been addressed in some recent publications [6, 7], which however have only focused on the fully saturated case. Objective of this contribution is to describe fracture in partially saturated porous media using a phase-field approach. In this study, the material is described by its linear-elastic properties. The overall balance of linear momentum, the continuity equation and the phase-field evolution equation constitute a nonlinear coupled and time-dependent system of equations, which needs to be discretized and linearized. We formulate the coupled non-linear system of partial differential equations governing the problem with displacements, capillary pressure and crack phase-field as unknowns. The spatial discretization is carried out with finite elements of appropriate order for the different unknowns. We discuss its solution and present some relevant examples.

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