Classical and phase-field models for fracture

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Abstract

In classical models for fracture, cracks are viewed as surfaces of discontinuity whose evolution can be described within the theory of configurational forces. In phase-field approaches, cracks are, to the contrary, viewed as narrow, three-dimensional zones in which material degradation accumulates. In this case, crack propagation is described in terms of the evolution of an additional field variable, the phase field.

We begin this talk by providing background on the configurational-forces and phase-field approaches to fracture. Then, we show how to formulate a phase-field model that can be interpreted as a regularization of the classical theory of crack propagation in elastic materials. We next turn the attention to the problem of crack propagation in non-elastic materials. In this case, it is well known that the classical approach may produce physically unacceptable results, which is often attributed to lack of information concerning the small zone around the crack tip where separation processes take place. To circumvent this, one should approach fracture in a way that accounts for the process zone in an explicit way, as in the case of phase-field models. In this regard, we point out that the phase-field approach has superior predictive capability compared to the classical approach. We conclude by presenting a continuum model for the interaction of elasto-plastic deformation, species migration, and fracture in solids. This topic appears in many areas of investigation, including hydraulic fracture, hydrogen embrittlement, and fracture in polymer gels.

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