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Multi-phase field approach for crushing and fracture in porous bone-like and grained heterogeneous materials

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Abstract

The variational phase-field approach to brittle fracture is extended to deal with the simultaneous interplay of two failure mechanisms characterizing a large class of heterogenous materials, namely fracture in tension and crushing in compression. A new multi-phase field variational approach is presented, with two independent damage variables and two different fracture energies associated to each failure mechanism [1]. The computational framework is implemented in the open source finite element software FEniCS and applied to mesoscale models of a wide class of heterogeneous materials ranging from concrete samples to human bones. The proposed multi-phase field approach is able to describe and correctly predict the well-known load-displacement curves observed in compression experiments of concrete samples. Applications to biomedical engineering are presented as well, especially in relation to the problem of evaluating the evoultion of damage under different loading physiological conditions inside the trabecular part of a human vertebra after screw fixation surgical procedures [2].

Keywords:

Finite element method Phase-field method Fracture mechanics Heterogeneous materials

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