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A phase-field model for ductile fracture with shear bands: A parallel implementation(Article)

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Abstract

Modeling complex material failure with competing mechanisms is a difficult task that often leads to mathematical and numerical challenges. This work contributes to the study of localized failure mechanisms by means of phase fields in a variational framework: in addition to the treatment of brittle and ductile fracture, done in previous work, we consider the case of shear band formation followed by ductile fracture. To achieve this, a new degradation function is introduced, which distinguishes between two successive failure mechanisms: (i) plastic strain localization and (ii) ductile fracture. Specifically, the onset of elastic damage is delayed to allow for the formation of shear bands driven by plastic deformations, thus accounting for the mechanisms that precede the coalescence of voids and microcracks into macroscopic ductile fractures. Once a critical degradation value has been reached, a phase-field model is introduced to capture the (regularized) kinematics of macroscopic cracks. To tackle the issue of potentially high computational cost, we propose a parallel implementation of the phase-field approach based on an iterative algorithm. The algorithm was implemented within the Alya system, a high performance computational mechanics code. Several examples show the capabilities of our implementation. We pay special attention to the ability to capture different failure mechanisms.

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