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A Phase Field Model for Damage in Elasto-Viscoplastic Materials

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Abstract

A phase field method for brittle fracture is formulated for a finite strain elasto-viscoplastic material using a novel obstacle phase field energy model. The obstacle energy model results in a crack profile with compact support, and thus gives a more physically realistic description of the material behaviour at the vicinity of the crack tip. The resulting variational inequality is discretised by a finite element method, and is efficiently solved using a reduced space NEWTON method. The solution accuracy and numerical performance of this method is compared with a conventional phase field energy model for brittle fracture through representative examples, and a significant reduction in the numerical solution cost is demonstrated.

Keywords: Phase field, Viscoplasticity, Fracture, Finite deformation

1. Introduction

The prediction of crack initiation and propagation in microstructures in relation to its myriad configurations is of critical importance in the design of heterogeneous materials (Bouaziz et al., 2008; Ritchie, 1999; Koyama et al., 2014). Traditional methods to characterise material failure are expensive and slow as they rely heavily on experiments (Requena et al., 2014; Toda et al., 2008; Weiland et al.,

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