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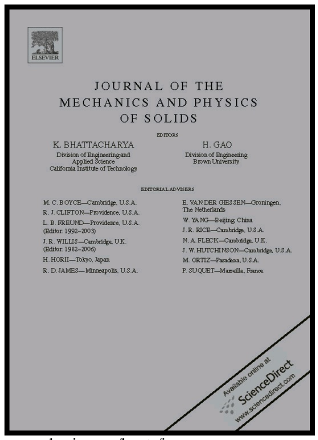

Numerical insight of a variational smeared approach to cohesive fracture

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Numerical insight of a variational smeared approach to cohesive fracture

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Abstract. In the present paper we numerically investigate and validate a variational smeared model for cohesive crack, recently proposed and theoretically justified by Γ-convergence. To achieve this main goal, we first analyze the response of a bar subjected to traction. Possible solutions are discussed, reconstructing the classical cohesive fracture energy and its related stress-crack opening law through a backtracking procedure. Preliminary 2D investigations are also conducted by using a regularized version of the adopted formulation. This permits to explore the transition phase of the damage evolution and to determine the peculiarities of the model, such as mesh-objectivity and Γ-convergence as damage concentration is forced. Therefore, the numerical simulations confirm the analytical results and put the basis for further engineering applications and possible improvements of the model.

Keywords: Cohesive fracture, Phase field model, Variational approach.

1 Introduction

Cohesive models in Fracture Mechanics are based on the idea that fracture energy is gradually released with the growth of the crack opening, reflecting the progressive weakening of the bound between the lips [10]. In contrast, in Griffith's brittle model the fracture energy is instantaneously dissipated at crack initiation [35], the surface energy is proportional to the crack area and there is no mechanical interaction between the fracture lips.

In the last years fracture problems have been revisited taking advantage of tools and techniques from the calculus of variations [16, 28, 25]. Although with some limits, a consistent and rigorous treatment of the subject has been built, so that numerical simulation and implementation have required appropriate methods. A standard approach consists in studying a regularized version of the fracture model.

Phase field models have recently found widespread popularity for simulating brittle crack propagation in a smeared manner [14, 15, 39, 41, 24]. Some phenomena, which are difficult to catch using discrete crack models, are easily captured by phase field models. This is the case of crack nucleation, propagation, and bifurcation, whose identification now requires no specific criterions.