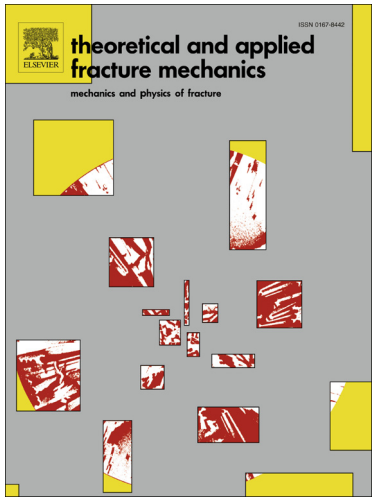

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Multiscale analysis of interaction between macro crack and microdefects by using multiscale projection method

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Abstract: The presence of microdefects near a macro crack tip can induce either amplification or shielding of macro crack propagation. In the present work, microdefects (micro cracks, inclusions, voids) in vicinity of a solitary macro crack tip are numerical simulated by using multiscale projection method. In this method, macro crack and microdefects are efficiently simulated by two scale decomposition and parallelization. The discontinuities are taken into account in the framework of XFEM, and the influence of the microdefects is shown by the stress intensity factor (SIF) calculated at the macro crack tip. The domain contains a macro edge crack along with microdefects is modeled under mode I condition as well as mode II condition. The location of microdefects is varied to study the relation between the location and their effects on the SIF of macro crack. The influence of micro voids on the main crack tip is investigated thoroughly for the first time. The results obtained from these simulations are useful for accurately evaluating the residual strength, and deliberately suppress the main crack propagation.

Keyword: multiscale projection method; XFEM; micro cracks; inclusions; voids

1. Introduction

The evolution of localized phenomena such as cracks, voids, inclusions, shear bands have been recognized as main causes of material failure. Even in ductile materials, accumulation and development of such microdefects in the vicinity of a major crack tip can be observed [1]. The presence of microdefects near a solitary macro crack tip can greatly influence the propagation of the main crack. Each microdefect has either amplification or shielding effect on the macro crack, depending on the microdefect's location, and geometry. Thus, the mechanism of main crack interacting with microdefects is an important problem in material strength analysis and fracture mechanics.

Numerous analytical and numerical studies have been conducted to investigate the effect the micro cracks have on the macro crack. For analytical solutions, several studies using integral equations have been reported concerning interaction between a single macro crack and arrays of micro cracks.

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