Mesh-independent Crack Propagation under Mixed-Mode Loading using Remeshing and Dynamic Insertion of Cohesive Elements

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ABSTRACT

Crack propagation through a finite element mesh for arbitrary crack paths is one of the most challenging issues in computational fracture mechanics. In this work we present a method based on an advanced remeshing technique[1] that allows to propagate a crack using cohesive elements. Crack propagation direction is computed using the maximal strain energy release rate criterion[2], which is implemented using finite elements and the $G\theta$ method[3]. The remeshing procedure used here is composed of 2 stages. In the first one, a conforming mesh is obtained over the computed direction, assuring that edges are placed over the sought direction. In the second stage, cohesive elements[4] are dynamically inserted at the conforming edges previously remeshed. The combination of this advanced remeshing technique with the dynamic insertion of cohesive elements lead to a mesh-independent crack propagation method. Additionally, the cohesive elements ensure the control of the fracture energy.

An overview of crack propagation in brittle materials will be presented for a given mixed mode configuration. Also, a sensitivity analysis on some parameters related with the cohesive zone model (i.e., maximum cohesive stress, critical opening displacement) is discussed. Perspectives of this work are oriented to handle multiple cracks and to simulate the fracture of different kind of materials like comets or asteroids. The interest in space objects comes from the fact that recently, it has been shown that temperature cycles on airless bodies of our Solar System can cause damaging of surface materials[5]. Nevertheless, propagation mechanisms in the case of space objects are still poorly understood.

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