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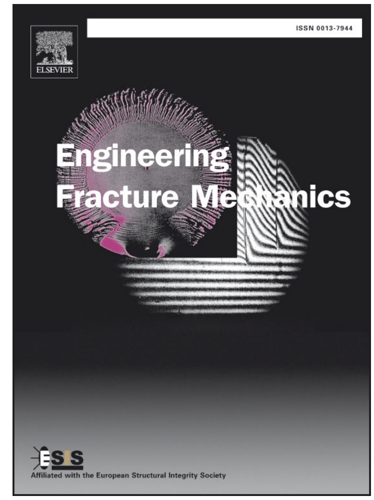

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A review of the scaled boundary finite element method for two-dimensional linear elastic fracture mechanics

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Abstract

The development and the application of the scaled boundary finite element method for fracture analysis is reviewed. In this method, polygonal elements (referred to as subdomains) of arbitrary number of edges are constructed, with the only limitation that the whole boundary is directly visible from the scaling centre. The element solution is semi-analytical. When applied to two-dimensional linear fracture mechanics, any kinds of stress singularities are represented analytically without local refinement, special elements and enrichment functions. The flexibility of polygonal elements in geometric shape leads to simple yet efficient remeshing algorithms to model crack propagation. Coupling procedures with the extended finite element method, meshless method and boundary element method to handle changes in the crack morphology have been established. These developments result in an efficient framework for fracture modelling. Examples of applications are provided to demonstrate their feasibility.

Keywords: crack propagation; interface crack; scaled boundary finite element method; stress intensity factors; T-stress

1. Introduction

Within the framework of linear elasticity, stress singularities exist at crack tips, V-notches, re-entrant corners and free edges formed by dissimilar materials [1, 2, 3, 4]. The best known case of stress singularity is a crack in a homogeneous isotropic body. The asymptotic analytical solution reported in the literature [1, 5] illustrates the proportionality of the stress to $r^{-\frac{1}{2}}$ (square-root singularity), where r is the distance measured from the crack tip. When the crack is on the interface between two dissimilar materials, the stress singularities are of the order $r^{-\frac{1}{2}+i\varepsilon}$ [6, 7, 8], where $i=\sqrt{-1}$ is the imaginary unit and ε is an oscillatory index depending on the ratio of the material properties. Two of the important parameters that describe the state of stress within the framework of two-dimensional linear elastic fracture mechanics are the mode I and mode II stress intensity factors, K_I and K_{II}. In case of interface cracks, the two stress intensity factors are always coupled and often expressed as $K_I + iK_{II}$ [9, 10]. When the two dissimilar materials are isotropic, the singular stress field depends on three parameters: K_I, K_{II} and ε. Furthermore, when the materials are anisotropic [11, 12], two additional parameters are needed to describe the singular stress field. V-notches, free edges,

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