11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20 - 25, 2014, Barcelona, Spain

Three-dimensional fracture analysis with the scaled boundary finite element method using octree mesh

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Key Words: *three dimensional crack, scaled boundary finite element method, stress intensity factor.*

Numerical analyses of three-dimensional fracture typically involve large numbers of degrees of freedom (DOFs) to model the stress singularity along the crack front. To obtain accurate results, enrichment with asymptotic solutions that are known *a priori* is often adopted in the finite element method (FEM) or extended finite element method (XFEM) [1, 2]. In three-dimensional cases, the asymptotic solutions become very complex for problems involving bi-material interface cracks [3].

The scaled boundary finite element method (SBFEM) is a semi-analytical method in which only the boundary is discretised, while the internal domain is described analytically with respect to a scaling centre [4]. Consequently, the SBFEM is well-suited to solve fracture problems as the stress singularity can be represented analytically without enrichment or special treatment around the crack front. A significant reduction in the number of DOFs is therefore attainable. For transient analyses, this reduces the computational effort required for time integration. The SBFEM also enables simple extraction of the stress intensity factors (SIFs) directly from their definitions including that for bi-material interface cracks and multi material junctions [5].

In this study, an octree-based SBFEM is developed to analyse three-dimensional fracture problems. Unlike the FEM, the SBFEM naturally satisfies the compatibility condition between adjacent elements as there are no hanging nodes present. This systematic meshing process also leads to a small number of subdomain configurations for that the stiffness matrices have to be computed. This significantly reduces the computational cost.

The developed method is validated using two numerical examples. These examples demonstrate the accuracy and efficiency of the proposed method in computing the SIFs. At the same time, the number of DOFs is reduced significantly when compared with the FEM.

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