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PROCEEDINGS

Numerical Modeling for Crack Propagation Based on a Multifunctional Super Singular Element

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ABSTRACT

The traditional finite element method (FEM) often requires a large number of refined meshes to analyze the mechanical behavior of geometric discontinuities, its computational efficiency and convergence speed are affected. A FEM for crack propagation based on the combination of an adaptive remeshing technique with the multifunctional super singular element (MSSE) at the crack tip is proposed for the fracture process simulation of two-dimensional (2D) materials. The adaptive FEM for crack propagation divides the crack tip neighborhood into the MSSE region, the protection element (PE) region and the background element (BE) region. The MSSE is established based on the numerical eigen-solution of the singular stress field near the crack tip, and can be used for anisotropic material and interfacial crack problems. The PE and BE regions are still discretized by the conventional finite element meshes. Since the node degrees of freedom between MSSE and conventional finite element are unified, they can be assembled directly without transition element. The MSSE can be used to solve the crack tip stress intensity factor (SIF) directly without refining the crack tip mesh. The adaptive meshing technique reduces the difficulty of remeshing during crack growth, thus facilitating the simulation of crack propagation processes. The adaptive crack propagation algorithm is used to analyze the crack propagation problems in isotropic materials, anisotropic materials and bi-materials. The calculated results demonstrate the effectiveness and universality of the crack tip MSSE. The method has potential for application in the simulation study of residual strength and fatigue fracture of complex mechanical structures.

KEYWORDS

Multifunctional super singular element; singular stress field; crack propagation; fatigue life; anisotropic material; bi-material

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