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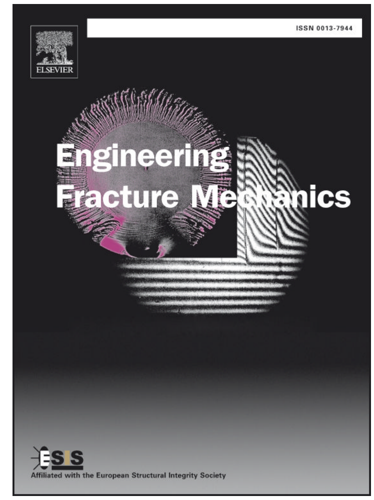

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A State-Based Peridynamic Analysis in a Finite Element Framework

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Abstract
This study presents a PeriDynamic (PD) element to perform deformation and fracture analysis within a finite element framework. The PD interactions among the finite element nodes are achieved through a truss element. This element permits non-uniform discretization with an irregular shape domain of interaction and a variable horizon. The size and shape of the interaction domain dictates the element connectivity. Such connectivity results in a sparsely populated global system stiffness matrix. The solution of such a system of equations is achieved by employing the BiConjugate Gradient Stabilized (BICGSTAB) method within the in-house program. The explicit analysis is performed by constructing a global lumped mass matrix along with a hybrid implicit/explicit time integration scheme. The solution of resulting system of equations is achieved through an implicit solver until crack initiation, and it continues with an explicit time integration algorithm during crack growth. Crack nucleation and its growth occur when the maximum principal stress in an element exceeds the uniaxial tensile strength of the material or the visibility criteria is not satisfied. The capability of this truss element and failure criteria is established by considering four distinct geometric configurations with and without a crack, and loading conditions. In the absence of crack propagation, the peridynamic truss element predictions are compared with those of analytical and finite element results. In presence of crack propagation, the PD damage predictions are compared with the available experimental observations.

Keywords: truss element, peridynamics, state-based, visibility, cracking

1. Introduction

The finite element method is computationally robust and very effective for modeling structures with complex geometries and different materials under general loading conditions. Its computational model requires explicit representation of cracks for the prediction of crack growth and propagation. However, the stresses at the crack tips are mathematically singular because of the undefined spatial derivatives of displacements. Techniques such as the eXtended Finite Element Method (XFEM) by Moës et al. [1] or its extensions can facilitate the prediction of onset of crack initiation and its propagation path in conjunction with multiple external criteria. However, the choice of such criteria for injection of discontinuous displacement enrichment

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