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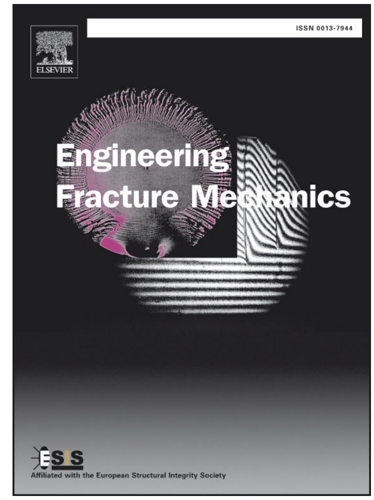

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Thermomechanical peridynamic analysis with irregular non-uniform domain discretization

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Abstract

Irregular non-uniform discretization of the solution domain in models based on peridynamic theory can improve computational efficiency by allowing local refinement and remove mesh bias effects on crack initiation and propagation. However, the use of such discretizations generally requires adjustment of the classical peridynamic material parameters and usage of a variable horizon which results in the so-called *ghost force* effect in the interactions between differing horizons. This study presents a generalization of the original bond-based and ordinary state-based peridynamic models to permit the use of irregular non-uniform domain discretizations, in which the strain energy and thermal potential associated with a bond between two material points is split into two parts based on volumetric ratios. This division is potentially different for each bond due to the presence of irregular non-uniform discretization. The validity and accuracy of this proposed approach is established using several benchmark examples, and its applicability to real engineering problems is demonstrated by modeling thermally induced cracking in a three-dimensional nuclear fuel pellet.

Keywords: Peridynamics, Irregular Discretization, Non-uniform Discretization, Thermomechanical

1. Introduction

An ability to accurately predict crack nucleation and propagation is of paramount concern in assessing the susceptibility of critical structural components to fracture. Continuum theories based on the Finite Element Methods (FEM) are widely used for this purpose. Due to the inherent assumption of continuous deformation in continuum theories, FEM must be modified in order to correctly represent the effect of spatial discontinuities, i.e. cracks must be explicitly represented in FEM in some fashion. This can be achieved by using a variety of techniques, such as cohesive zone elements, which require the mesh to conform to the crack geometry, or by defining mesh-independent discontinuities using the eXtended Finite Element Method (XFEM). Due to the fact that these techniques all rely on characterizing the crack topology, challenges are usually encountered in situations when crack topology is difficult to define, such as in the presence of multiple damage

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