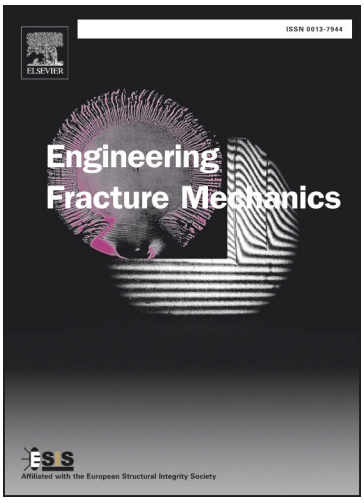

An analytical study of wave propagation in a peridynamic bar with nonuniform discretization

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PII: S0013-7944(17)31005-6
DOI: https://doi.org/10.1016/j.engfracmech.2017.12.019
Reference: EFM 5800

To appear in: *Engineering Fracture Mechanics*

Received Date: 28 September 2017
Accepted Date: 11 December 2017

Please cite this article as: Kulkarni, S., Tabarraei, A., An analytical study of wave propagation in a peridynamic bar with nonuniform discretization, *Engineering Fracture Mechanics* (2017), doi: https://doi.org/10.1016/j.engfracmech.2017.12.019

An analytical study of wave propagation in a peridynamic bar with nonuniform discretization

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Abstract

In this paper, we use an analytical approach to study the propagation of a plane wave and its spurious reflection in a peridynamic bar using two different methods. In the first method, a coupled peridynamic–finite element approach is used in which peridynamic formulation is used in one part of the domain and finite element is used in the other part. In the second method, peridynamic formulation is used in the entire domain but the bar is discretized by two grids of different sizes. In both cases, the size of the grid of each zone does not change and the two grids share one node with each other. The incident wave travels from the finer grid toward the coarser grid. For the case when peridynamics is used on the entire domain, the size of the peridynamics horizon changes based on the size of the gird. For both cases, we investigate the impact of the relative size of the girds on the amplitude and energy of the transmitted and reflected waves. Our analytical and numerical results show that more spurious reflections occur when the size mismatch between the two grids is larger. In both cases, the issue of spurious wave reflection becomes more severe when the peridynamic horizon size increases. For the case of coupled peridynamic–finite element, even when the size of the two grids are the same, spurious wave reflection occurs which is due to the change in the formulation from a nonlocal to a local continuum. The spurious reflection reduces when the wavelength of the incident wave is large compared with the coarse grid.

Keywords: Spurious wave reflection, peridynamics, finite element method, coupled local–nonlocal continuum

1. Introduction

Peridynamics theory [1, 2] has been introduced to overcome the difficulties associated with local continuum methods in modeling fracture and damage in materials. The main issue of using classical continuum theory in modeling crack nucleation and propagation is related to the presence of the

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