Modeling of Propagation of Multiple Cracks Using Peridynamics

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Abstract

The simulation of propagation of multiple cracks is of great importance, both in research and in various engineering applications. Major numerical methods for modeling crack problems include FEM, XFEM, BEM and various meshless methods. They more or less suffer from additional treatment needed and large amount of computational work, which adds complexity to these complicated problems. It is even more difficult for cases involving modeling multiple cracks and crack initiations.

To be able to model the discontinuities such as cracks more efficiently, the peridynamic theory, which is an alternative theory of continuum mechanics, is introduced by Silling [1]. In this theory, the formulation employs integral equations instead of partial differential equations and it is assumed that particles in a continuum body interact with each other at a distance. Besides, material damage is incorporated in the theory. These attributes permit fracture initiation and propagation to be modeled naturally. Therefore, this theory has particular advantages in problems concerning cracks.

In this work, to model the propagation of multiple cracks using peridynamics, the model of 2-D bond-based peridynamics is established and validated by benchmark problems firstly. Then, several numerical examples with multiple cracks of various type of distributions are given and the results are compared with those obtained by other methods such as the boundary element method. Furthermore, continuous and discontinuous micromoduli are compared to investigate the influence of the form of micromoduli to the results. The impact of effective interaction distance to the result is also investigated. It is concluded that the peridynamics is an effective numerical tool in modeling propagations of multiple cracks in materials.

Keywords: Peridynamics, Multi-crack, Propagation, Simulation.

References

[1] Silling, S. A. (2000) Reformulation of elasticity theory for discontinuities and long-range forces, *Journal of the Mechanics and Physics of Solids* **48**(1), 175-209.