ICCES, 2023, vol.25, no.1
DOI: 10.32604/icces.2023.45718

PROCEEDINGS

Peridynamic Material Correspondence Models: Bond-Associated and Higher-Order Formulations

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ABSTRACT

The conventional peridynamic material correspondence model suffers from the well-known issue of material instability. The material instability in peridynamics can be understood as the existence of non-unique mapping between deformation states and the resultant force state. This instability poses practical difficulties while using the correspondence model in computational modeling. One consequence of this instability is the oscillation in the predicted displacement field, i.e., existence of zero-energy modes. Bond-associated correspondence formulations have been proposed to inherently remove the material instability. Different from the conventional formulation, bond-associated formulations are developed based on the concept of bond-associated deformation gradient that constructed based on the deformation states of a subset of the family.

On the other hand, although peridynamics can capture material length-scale effect by calibrating the horizon size, it is only limited to the stiffness softening effect. In the limit of infinitesimal horizon size, the peridynamics theory converges to the local continuum theory. To capture both stiffness softening and hardening effects, strain gradient parameter has been introduced by developing higher-order material correspondence between peridynamics and strain gradient theory. In the peridynamic strain gradient model, both horizon and strain gradient parameter are used to capture the material length-scale effects.

This presentation will focus on both aspects of the material correspondence models in peridynamics, the bond-associated formulations to inherently remove material instability and the higher-order formulation to enable modeling both stiffness softening and hardening length-scale effects. Formulation details will be discussed, and numerical results will be presented.

Funding Statement: The author(s) received no specific funding for this study.

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.