LS-DYNA® Peridynamics for Brittle Fracture Analysis

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Abstract

Peridynamics is a new nonlocal theory that provides the ability to include displacement discontinuities in a continuum body without explicitly modelling the crack surface. In comparison to the classical weakly nonlocal or strictly nonlocal models, the peridynamics equation of motion is free of spatial derivative of displacement. The peridynamics also does not require sophisticated book keeping of degrees of freedom or jump conditions in tracking the moving discontinuities. Those features of peridynamics offer significant advantages over other advanced numerical methods for the brittle fracture analysis particularly in three-dimensional problems.

The explicit dynamics version of bond-based peridynamics model has been implemented in LS-DYNA® using the Discontinuous Galerkin (DG) finite element approach to enforce the boundary conditions, constraints, contacts as well as to handle the non-uniform mesh in the engineering practice. The classic material parameters, such as elastic modulus and fracture energy release rate are employed for the determination of material response and failure in brittle material. The LS-DYNA® Peridynamics supports 8, 6 and 4-noded solid elements with the ability to handle multiple and branching cracks. Several numerical benchmarks are utilized to demonstrate the effectiveness and accuracy of the LS-DYNA® peridynamics in brittle fracture analysis.

Key Words: Bond-Based Peridynamics, Discontinuous Galerkin, Finite Element Method, Meshfree Method