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Introduction to Particle Methods in LS-DYNA®

Instructors: Bo Ren (Ph.D.) Peridynamics Hailong Teng (Ph.D.) DEM
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3 Day - $600, Students $300 w/student ID
Includes on-site continental breakfast, lunch, breaks, class notes, class dinner
Includes 30-day demonstration license

Prerequisite: Students should be familiar with LS-PrePost, understand the basic LS-DYNA keywords and be able to run LS-DYNA simulations.

Objective: The objective of this three-day class is to offer attendees a comprehensive review on four particle methods in LS-DYNA®, which include the discrete element method (DEM), the peridynamics, the smoothed particle Galerkin (SPG) method and the smoothed particle hydrodynamics (SPH) method.

Particle methods in this class can be roughly categorized into discontinuous and continuous approaches. The DEM is a representative discontinuous particle method based on the contact interactions between discrete grains to model the motion of granular materials. In contrast to the DEM that describes the problem at particle scale, the rest of three particle methods belong to the continuous approach that discretizes the problem at a field-scale level.

Contents: The class will provide the theoretical background, numerical advantages and disadvantages, and implementations of these methods. LS-DYNA keywords for these methods will be elaborated in detail so that users can set up LS-DYNA simulations using these methods properly. In-class computer practice will be offered.

1. DEM

DEM uses bonded particle and/or contact model to construct the forces on the assumed rigid particles. DEM has been applied to various dynamic problems including granular mechanics, soil-related interaction problems, geotechnical engineering, power production, pavement engineering, structural engineering, et al. DEM can also be bonded together to model continuum such as rock materials.

2. Peridynamics

The LS-DYNA peridynamics is developed for brittle fracture analysis in three dimensional solids. The method was implemented under the discontinuous Galerkin finite element framework. Currently, the major application is fracture analysis in car windshields, window glass and composite materials.

3. SPG

The SPG method is developed for semi-brittle and ductile failure analyses in three dimensional solid structures. A bond-based failure mechanism is introduced to model material failure in various manufacturing and impact penetration processes, such as metal friction drilling, metal machining, and high velocity impact on concrete and metal targets.

4. SPH

SPH is a Lagrangian particle method for modeling fluid flows and solid bodies. It can avoid the mesh distortion issue in the conventional FEM in extremely large deformation analysis. It is very suitable to model the complex free surface and material interface behavior, including break-up into fragments naturally. It has been applied extensively to incompressible flows, heat conduction and high explosive problems.