Peridynamic study of particle fracture under impact loading

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ABSTRACT

Comminution is a complex process that consists in reducing (by crushing, grinding, cutting…) solid particles to a smaller average particle size. While dynamic fracturing is the elementary process involved in comminution, most of the variability may be attributed to the broadly distributed stress transmission through the granular assembly and to the internal microstructure including defects of the raw material.

In this study, we investigate the basic mechanisms of comminution by means of a peridynamics homemade code [1]. From a theoretical point of view, peridynamics is an alternative approach to the classical continuum mechanics based on integral equations [2]. The major benefits of this approach are its ability to account for highly heterogeneous distribution of mechanical properties and to avoid singularities in the vicinity of discontinuities as failures.

We use a simple bond-based approach [3] in which samples are single or small assemblies of particles considered as a mass-spring system composed of brittle linear springs (with a yield strain). The samples are discretized on rectangular grids. The stress tensor is computed at each node by considering long-range interactions in a bounded neighbourhood domain. As the algorithm is based on a non-local approach, failure occurs in the form of damaged zones of characteristic thickness related to the size of the neighbourhood. Various loading paths can be applied to the particle by controlling the displacement or the force at the boundary nodes. A parametric study will be performed in which the dynamic loading and the probability density of defects are varied. The particle fragmentation is then analysed in terms of crack orientation and fragment size distribution.

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