Strength and fracture of heterogeneous materials by peridynamic simulations

Xavier Frank*[1], Jean-Yves Delenne[2], Saeid Nezamabadi[3], and Farhang Radjai[4,5]

[1]Ingénierie des Agro-polymères et Technologies Émergentes – Centre de Coopération Internationale en Recherche Agronomique pour le Développement : UMR62, Institut National de la Recherche Agronomique : UMR1208, Université de Montpellier, Institut national d'études supérieures agronomiques de Montpellier – France

[2]INRA – Institut National de la Recherche Agronomique – France

[3]Université de Montpellier – Laboratoire de Mécanique et Génie Civil (LMGC), Université de Montpellier, CNRS, 34090 Montpellier, France – France

[4]Laboratoire de Mécanique et Génie Civil (LMGC) – Université de Montpellier, Centre National de la Recherche Scientifique : UMR5508 – CC 048 Place Eugène Bataillon, 34095 MONTPELLIER CEDEX 5, France

[5]Multiscale Material Science for Energy and Environment – United States

Abstract

Strength and fracture behaviors of heterogeneous materials depend on local stress concentrations, which appear in the vicinity of the pores or the interfaces. Consequently, it is of crucial interest to understand the impact of the small-scale microstructure on the elastic and failure properties of these materials. This problem concerns many industrial applications such as concrete failure, particle-filled composites, cereal milling...
Numerical approaches are relevant tools to address such issues, especially when material texture is complex or exhibit long-range correlations. Among available numerical methods, peridynamics rely on a non local alternative framework of continuum mechanics and provide a straightforward and versatile description of discontinuities such as cracks.

We applied a simple peridynamic approach called bond-based to the study of the quasi-static failure of heterogeneous materials. A parallel (MPI) computer code was developed and both mesh convergence and numerical efficiency were tested. Then failure behavior of three materials were studied: porous, cemented granular and cellular materials. We focus on one aspect of each system.

Silling, S.A. (2000). Refromulation of elasticity theory for discontinuities and long-range forces. Journal of Mechanics and Physics of Solids, 48 (1): 175-209.

Ha, Y.D., Bobaru, F. (2011) Dynamic brittle fracture captured with peridynamics. Pengineering Fracture Mechanics 78(6): 1156–1168.

Keywords: Peridynamics, fracture

*Speaker