Strength-based phase-field approach to cohesive fracture

Corrado Maurini*[1], Blaise Bourdin[2], and Jean-Jacques Marigo[1]

[1]Institut Jean Le Rond d'Alembert – Sorbonne Universite, Centre National de la Recherche Scientifique, Centre National de la Recherche Scientifique : UMR7190 – France
[2]McMaster University [Hamilton, Ontario] – Canada

Abstract

The fundamental phenomenological properties in fracture mechanics are the critical stress required to nucleate a crack in a pristine material (the strength) and the energy required to propagate it (the toughness).

Cohesive-fracture models and gradient damage models have been shown to capture these main features of fracture mechanics, but with different limitations. On one side, sharp interface cohesive-fracture models pose mathematical and numerical difficulties when the crack path is left to evolve freely. On the other side, formulating damage models with arbitrary strength surfaces under multi-axial loading while preserving Griffith's criterion for crack propagation is challenging.

We introduce here a novel variational approach for building phase-field fracture models with a strength-based formulation.

The fundamental idea is to consider undamaged energies with linear growth at infinity and let the damage (or phase-field) variable affect its slope. This allows us to introduce an explicit strength criterion in the model and to recover Griffith's criterion for crack propagation.

We will present in detail the case of antiplane shear, introducing an original numerical solution scheme based on the use of convex-optimization tools. Finally, the extension to the 3D case will be outlined.

*Speaker