A non-intrusive global/local approach applied to phase-field modeling of brittle fracture

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The variational approach to fracture by Francfort and Marigo and the related regularized formulation of Bourdin et al. which is also commonly referred to as a phase-field model of fracture is a widely accepted framework for modeling and computing the fracture failure phenomena in elastic solids. The formulation is non-linear and calls for the resolution of small length scales. Its single-scale treatment is nowadays well-established and shown to be computationally demanding. As such, an idea of multiscale approach that enables to "send" the non-linearity to a lower (local) scale, while dealing with a purely linear problem at an upper (global) one, seems particularly appealing.

Clearly, this cannot be realized via standard homogenization techniques due to a strongly localized phenomenon inherited by the model. In this talk, we propose a concurrent multiscale approach combining the "Localized Lagrange Multipliers method" and the so-called "non-intrusive re-localization formulation".

A successful extension of the non-intrusive global/local approach for the phase-field modeling of fracture for the rate-independent crack propagation in rubbery polymers at finite strains are also investigated.

With numerous numerical examples, we show that the proposed two-scale procedure indeed yields results similar to the reference single-scale solution (this includes the entire failure process simulation, as well as the load-displacement curves), yet they are obtained with much superior efficiency.