On Phase-Field Modeling of Ductile Fracture

Umberto Perego[1], Alessandro Marengo[2]
[1]*Department of Civil and Environmental Engineering, Politecnico di Milano, Italy*
E-mail: umberto.perego@polimi.it

[2]*Tetra Pak Packaging Solutions, Modena, Italy*
E-mail: alessandro.marengo@tetrapak.com

Keywords: Ductile Fracture, Phase Field, Variational Formulation.

The computational modeling of ductile fracture is a complex problem due to the co-existence of different competing dissipation mechanisms at the microscale resulting in evolving displacement discontinuities at the macroscale. Phase-field modeling of brittle fracture has emerged as one of the more computationally effective smeared approaches to the simulation of crack propagation in solids. After the publication of the first papers about a decade ago, its extension to ductile fracture has attracted growing attention, with the appearance of a rapidly increasing number of contributions proposing different approaches and applications.

Starting from established variational statements of finite-step elastoplasticity for generalized standard materials, a mixed variational statement for the phase-field modeling of ductile fracture is presented, incorporating in a rigorous way a variational finite-step update for both the elastoplastic and the phase-field dissipation. The complex interaction between ductile and brittle dissipation mechanisms is modeled by assuming a plasticity driven crack propagation model, with the addition of a non-variational function of the effective plastic strain that modulates the current value of the critical fracture energy.

Several modeling and computational aspects are discussed and an application to the simulation of ductile fracture of 2D paperboard laminates is presented.