An enhanced phase field approach to cohesive fracture

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Cohesive zone models show great potential for handling non-linear fracture mechanics. In contrast to brittle fracture models, cohesive fracture models include an interface energy not only depending on the geometry of the crack, but also on its opening. The opening of the crack is mathematically defined as displacement jump $[\![\boldsymbol{u}]\!]$. The dependence of the interface energy on the displacement jump results in tractions across the crack, which can be described by a so-called traction-separation-law $\boldsymbol{t}([\![\boldsymbol{u}]\!])$. The probably two most important physical material properties of traction separation laws are the strength of the material and the fracture energy.

As far as the finite element implementation is concerned, several techniques have been proposed for incorporating cohesive fracture laws. The first class of those techniques are based on discrete interfaces — either between bulk elements or within bulk elements (XFEM). The second class of techniques employs diffuse interfaces with a finite thickness such as phase field models. The major advantage of this type of models are the easy tracking of the (evolving) crack geometries.

A promising phase field approach to cohesive fracture was recently introduced by Conti et al. [1] and further investigated by Freddi and Iurlano [2]. For thus framework, Γ-Convergence to a cohesive fracture models was rigorously proven. Within this talk, the model proposed in [1, 2] will be extended with respect to:

- a geometrically exact setting,
- arbitrary hyperelastic material models,
- independent material parameters for the bulk material and the interface (including the strength and the fracture energy of the interfaces)
- the introduction of the Microcrack-Closure-Reopening (MCR) effect (cracks only evolve under tensile stresses)

References

[1] S. Conti and M. Focardi and F. Iurlano, Phase field approximation of cohesive fracture models, Annales de l'Institut Henri Poincaré C, Analyse non linéaire 33 (2016) 1033–1067.

[2] F. Freddi and F. Iurlano, Numerical insight of a variational smeared approach to cohesive fracture, Journal of the Mechanics and Physics of Solids 98 (2017) 156–171.