A phase-field model for cohesive fracture: Formulation and analysis within the isogeometric analysis framework

Yousef Ghaffari Motlagh*, René de Borst†

Department of Civil and Structural Engineering
University of Sheffield
Mappin Street, Sir Frederick Mappin Building, Sheffield S1 3JD, UK
* y.ghaffari-motlagh@sheffield.ac.uk
† r.deborst@sheffield.ac.uk

ABSTRACT

Fracture is one of the main failure mechanisms of engineering materials and structural components. The finite element modelling of fracture propagation in man-made and biological materials can be categorised into two main approaches, namely the discrete crack models and the smeared crack models. The phase-field approach belongs to the latter one. Miehe et al. [1] proposed a thermodynamically consistent framework for phase-field models of crack propagation in elastic solids that completely avoid the resolution of discontinuities. They developed incremental variational principles and considered their numerical implementations by multi-field finite element methods. A phase-field model for cohesive fracture was introduced by Verhoosel & de Borst [2]. In their work, after casting the cohesive zone approach in an energetic framework, which is suitable for incorporation in phase-field approaches, the phase-field approach to brittle fracture is restated. The model incorporates three fields: the displacement field, an auxiliary field that represents the jump in the displacement across the crack, and the phase field.

In the present work the aforementioned framework is recast into an isogeometric framework to improve the accuracy of the method. To this end, an isogeometric Bernstein-Bézier discretisation is utilised. The one point of departure of this discretisation from traditional isogeometric analysis is that their basis functions are not smooth across element boundaries. We use this to improve the modelling of the smeared jump in the displacement across the crack where the $C^0$-continuous functions provide better results. The sensitivity of the results with respect to the orders of the discretisation of the three fields is investigated, as well as the mesh independency.

REFERENCES
