Isogeometric analysis of pressure-loaded phase-field fractures

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ABSTRACT

Phase-field models for fracture (see *e.g.* [1, 2, 3]) have been successfully applied to a wide range of problems, such as dynamic fracturing, large deformation fracturing, fracturing of electro- and thermo-mechanical materials and many more. The primary advantage of these models is the flexibility with which complex fractures can be simulated. On one hand this is due to the diffuse fracture representation, and on the other hand due to the fact that propagation laws generally follow naturally from energy minimization principles.

In this contribution we study the applicability of phase-field models to pressure-loaded fractures. The key idea behind the presented approach is to extract a contour from the phase field and to use it as a pressure-loading boundary. We present a detailed analysis for the solution behavior of this model, including an assessment of the advantages of using higher-order continuous shape functions instead of standard finite elements. Based on the observations for this model we also propose a hybrid model, for which the solid problem is solved on an immersed domain. The advantages of isogeometric analysis are also studied for this hybrid model.

In terms of computational techniques, the essential novel ingredient in our approach is the loading-surface extraction routine, which is inspired by the segmentation technique developed in the context of the isogeometric finite cell method for image-based analysis [4]. Two computational aspects related to the immersed character of the proposed models are discussed, namely the conditioning of the system, and the parametrization of the trimmed elements and extracted loading contour.

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