Adaptive Isogeometric Phase-Field Modelling of Fracture

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ABSTRACT

The phase-field method has become a powerful tool for the modelling of fracture. Its essential idea is to smear the discrete crack in terms of a crack density which is used as phase-field order parameter. Due to the diffuse representation of the crack, topological updates of the analysis mesh are avoided which is particularly helpful for the analysis of crack branching and three-dimensional problems.

Starting from the variational formulation of the classical Griffith theory of facture this presentation will first review the phase-field modelling of brittle fracture. The discussion involves in particular the influence of the choice of different potentials, irreversibility criteria and mesh size on the accuracy of the predicted crack surface and the associated fracture energy [1]. In the following the theory is extended to the modelling of interface cracks in heterogeneous materials [2], ductile fracture [3], and the simulation of fatigue crack growth [4].

As the versatility of the phase-field approach comes at the cost of highly refined meshes that have to resolve strong gradients across the internal characteristic length scale, adaptive local refinement is essential to the successful application of the approach. Therefore, procedures for adaptive local refinement and coarsening based on hierarchical meshes with spline basis functions that can be incorporated into any existing finite element code will be presented [3,5,6]. It is found that the adaptive meshes produce the same results but significantly reduce the number of used elements and the required computation time when compared to uniform mesh refinement.

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