A discontinuous approach to fracture based on the phase-field and the virtual element method

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Abstract

A brittle crack propagation based on the phase-field approach to fracture and the cutting techniques of the virtual element method (VEM) will be outlined within this work. The recently developed VEM is a competitive discretization scheme for meshes with highly irregular shaped elements and arbitrary number of nodes [1]. In the last few years there has been a growing interest in the use of the phase-field approach to simulate cracks and their propagation. The phase-field approach regularizes sharp crack surfaces within a pure continuum setting by a specific gradient damage modeling with constitutive terms rooted in fracture mechanics. In general, the method needs a very fine mesh to accurately capture the crack path. Most of the investigations use a global refinement strategy, which usually leads to very large time-consuming and the need for high-performance computing. If the crack path is known, a local mesh refinement can be used to overcome the aforementioned computation costs.

In this contribution, the phase-field method is used to predict the crack growth direction. For the accuracy of the solution, the expected damaged zone is locally refined similar to the work of Heister et al. [2]. Once the direction of the propagation is known, the crack is introduced geometrically at the origin mesh by using robust cutting techniques described in Hussein et al. [3]. Note that the mesh now does not contain the refined elements anymore, which leads to decrease the computation time. After presenting the governing equations, the functionality and efficiency of the model is underlined by means of representative examples.

Keywords: VEM; Phase-Field Modeling; Brittle Fracture; Cutting Techniques.

References

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