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Smooth nodal stresses in the XFEM for crack propagation simulations

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ABSTRACT

In this paper, we present a method to achieve smooth nodal stresses in the XFEM without post-processing. This method was developed by borrowing the ideas from the “twice interpolating approximations” (TFEM) [1]. The salient feature of the method is to introduce an “average” gradient into the construction of the approximation, resulting in improved solution accuracy, both in the vicinity of the crack tip and in the far field. Due to the higher order polynomial basis provided by the interpolants, the new approximation enhances the smoothness of the solution without requiring an increased number of degrees of freedom. This is particularly advantageous for low-order elements and in fracture mechanics, where smooth stresses are important when maximum principal stress is used as crack propagation criteria. Since the new approach adopts the same mesh discretization, i.e. simplex meshes, it can be easily extended to various problems and is easily implemented.

We discuss the increase in the bandwidth which is a major drawback of the present method and can be alleviated by using an element-by-element solution strategy. Numerical tests show that the new method is as robust as the XFEM, considering precision, model size and post-processing time. By comparing the results from the present method with the XFEM for crack propagation in homogeneous material, we conclude that for two-dimensional problems, the proposed method tends to be an efficient alternative to the classical XFEM [2,3] especially when local, stress-based propagation criteria is used.

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