XFEM formulation for discontinuities in fractured rock masses

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ABSTRACT

Discontinuities play an important role in many types of geomechanical problems, especially in quasi-brittle materials. The Extended Finite Element Method (XFEM) is a relatively recent method used to model discontinuities, which was introduced as an enriched finite element approach that combines the standard FEM and the Partition of Unity Method (PUM) [1].

Most of the XFEM literature describes the application to model opening tensile cracks [2], although the approach should be in principle capable of modeling shear compression mechanisms as observed for instance in the geo-mechanical context, e.g. fractures in rock masses. To this end, the XFEM discontinuity should incorporate general standard traction-separation/sliding constitutive laws similar to those used for instance in traditional zero-thickness interface elements in rock mechanics.

In the paper, one such formulation is described and the results are verified with examples. The proposed formulation seem to lead to smooth results in general, although that requires to solve a number of implementation aspects that otherwise generate numerical oscillations in the results [3].

In addition, the XFEM formulation developed is compared with the more traditional FEM with interface element [4]. Only under some special circumstances both formulations turn out totally equivalent, although with adequate remeshing and node relocation both approaches lead to very similar results.

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