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3D CRACK PROPAGATION WITH COHESIVE ELEMENTS IN THE EXTENDED FINITE ELEMENT METHOD

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In this talk, a model is presented that accurately describes the brittle failure of components, with particular emphasis on the prediction of the 3D crack path. It therefore includes the determination of a crack bifurcation angle and a crack advance, possibly non uniform in 3D, along the front. Hence, we appeal to the X-FEM for modelling arbitrary cracks and cohesive zone models to naturally determine the crack advance. A procedure in four steps is adopted here (see fig.1): computation of the equilibrium state in the presence of cohesive forces with a given potential crack surface, detection of the updated crack front on the surface from the computed cohesive state, determination of bifurcation angles along the front, and update of the potential crack surface accordingly.

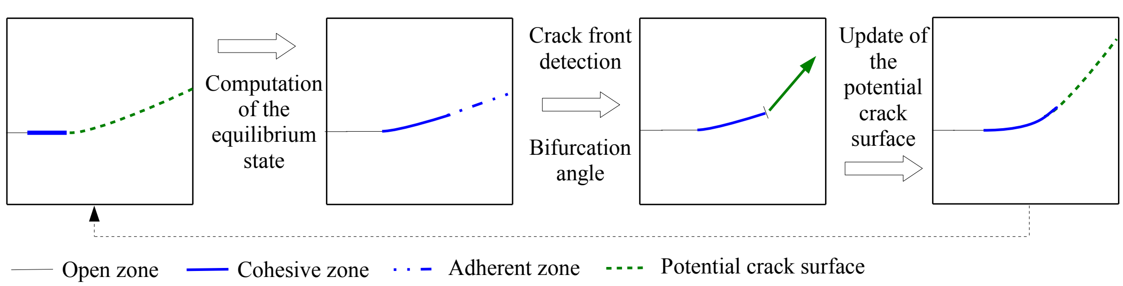

Figure 1: Procedure for computing 3D brittle failure.

In this view, a way of introducing in the X-FEM a cohesive law with initial perfect adherence and sudden switch to dissipation is presented. It relies on the use of the XFEM-suited reduced space of Lagrange multipliers by [1], a mortar formulation to write the cohesive law from quantities defined over this space in an appropriate manner, and a discretization with static condensation.

The originality of the approach lies in the a posteriori computation of the crack advance that is naturally embedded in the cohesive model, while in most of the literature it is determined beforehand based on the stress state ahead of the front. A first rough updated crack front is computed from the internal variables of the cohesive law. This rough crack front is then converted into a smooth crack advance, itself converted back into a new smooth crack front location with help of the level-set formalism.

Finally, a crack bifurcation angle is determined along the front, based on the criterion in [2] from the equivalent stress intensity factors, as was done in [3]. A new way of computing these equivalent stress intensity factors is suggested, from the cohesive fields exclusively. Finally, the potential crack surface is updated accordingly based on the explicit level-set update algorithm by [4].

Several numerical tests have been carried out and showed good accordance with previous results from the literature. Figure 2 shows the computation with our method of the 3-point bending test with the initial oblique crack of [4].

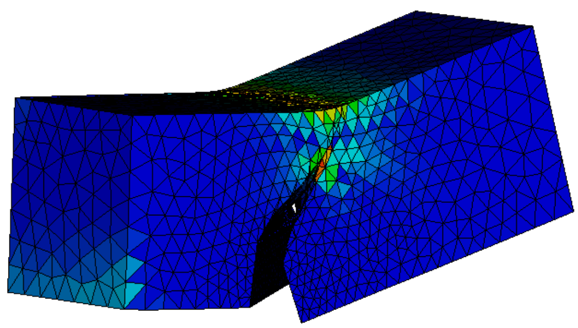

Figure 2: Complex crack path with X-FEM and a cohesive zone model.

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