X-FEM for Abaqus (XFA) Toolkit for Automated Crack Onset and Growth Simulations

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Abstract: *A software tool for automated crack onset and growth simulations based on the eXtended Finite Element Method (X-FEM) has been developed. For the first time, this tool is able to simulate arbitrary crack growth and composite delamination without remeshing. The automated tool is integrated with Abaqus/Standard and Abaqus/CAE via the customization interfaces. It seamlessly works with the Commercial, Off-The-Shelf (COTS) Abaqus suite. Its unique features include: 1) CAE-based insertion of 2D or 3D multiple cracks with arbitrary shape of crack front independent of an existing mesh; 2) simulation of crack growth inside or between solid elements, and potentially along a shell/solid interface or along a shell/shell interface; 3) simulation of non self-similar crack growth along an arbitrary path or a user-specified interface; 4) extraction of near tip strain energy release rates via the modified VCCT; and 5) CAE-based data processing and visualization. The levelset method coupled with X-FEM is used to enrich the displacement field with jump and asymptotic near-tip solutions and track the crack geometry as it grows. A penalty-based formulation is developed within the UEL framework to simulate crack closure and frictional contact. To account for energy dissipation associated with the frictional contact, a modified VCCT approach is employed for an arbitrary crack front element with a partial contact zone. A fracture front tracking and levelset update module is used for either a user-specified growth size or a Paris-type fatigue law. Both the validity and applicability of the toolkit have been demonstrated via numerical examples.*

Keywords: *X-FEM, VCCT, Fatigue, Fracture & Failure, Crack Growth, Delamination, Abaqus/Standard, UEL*

1. Introduction