FAST MARCHING METHOD FOR THREE-DIMENSIONAL CRACK PROPAGATION

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In recent years, numerical modeling of 3D fracture problems has attracted growing interest. In the context of the X-FEM method [1], the use of two level sets allows a localization and representation of the crack and its front to be achieved regardless of the mesh. The crack surface is characterized as the zero of one of these level set functions while the crack front is localized as the iso-zero of both level sets.

The simulation of crack propagation is based on updating both level sets. The main difficulty associated with the method involves rebuilding them while keeping the important property of being a signed distance function, at each propagation step.

Several techniques exist in the literature to deal with the evolution of the level set functions: the resolution of Hamilton-Jacobi equations [4], implicit geometrical approach [5] and a mesh evolution tracking method which uses an auxiliary discretization of the crack surface [6] independent of the structural mesh in which it is embedded. We propose here a method based on fast marching [2,3] that consists in propagating the information «distance» from the points of lowest distance with respect to the iso-zero to the furthest regions on a neighbor to neighbor basis.

The method is applied to 2D and 3D meshes and valid for all types of elements (triangles, quadrangles, tetrahedrons, hexahedrons, pentahedrons) of a standard finite element library, which constitutes an interesting contribution for a generalized industrial free software in mechanical engineering such as Code_Aster (http: //www.code-aster.org) developed by EDF R&D. Moreover it is compared with the other techniques cited above in terms of robustness, numerical efficiency and quality of the results and shows very nice properties.

We test the method with known examples from the literature such as the torsion of a concrete beam performed by Barr and Brokenshire in the mid 1990s on a notched prismatic pillar [7]. The crack path matching the experiment is represented figure 1.

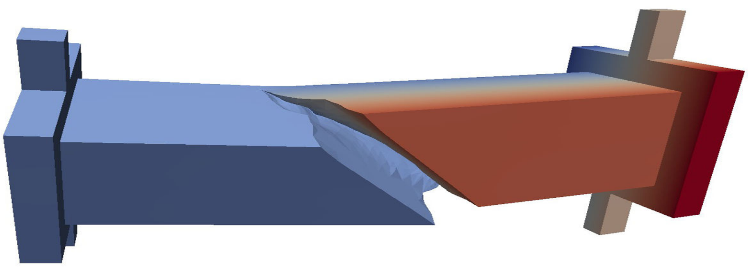

Figure1: Brokenshire, Torsional fracture tests

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