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DAMAGE PROPAGATION MODELING USING THE TLS MODEL : NUMERICAL ASPECTS.

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Abstract : The thick level set model for damage growth is described and numerical representation of the crack is refined to improve the numerical results.

Keywords : Damage modeling, Thick Level Set, Fracture Mechanics

In this communication, we present the Thick Level Set (TLS) approach to model damage growth, first presented in Moës et al. [1, 2]. In this approach, a level set is used to separate the undamaged zone from the damaged zone. In the damaged zone, the damage variable is an explicit function of the level set. This function is a parameter of the model. Beyond a critical length, we assume the material to be totally damaged.

The model has several advantages. It provides a natural transition from damage to fracture, and allows for a simple modeling of crack branching and merging, while being able to reproduce size effect. The part of the domain for which non local computations are needed are clearly defined by the interior of the level set, and the boundary of the fully damaged zone is simply an iso-value of the level set function, that we call the iso- l_c .

Using Xfem technologies, an enrichment strategy has been developed [3] to properly describe the discontinuous displacement field over the crack in the TLS model. This enrichment strategy relies on a proper geometrical description of the iso- l_c . In theory as well as in our numerical experiment, the fully damaged domain can be reduced to a surface enclosing no volume : the skeleton of the iso-zero. The discretized version of this surface can be tricky to track since it is characterized by a kink of the level set function, which can not be detected with a simple nodal interpolation of the level set function. With such a simple discretization of the level set function, the iso- l_c can become very badly defined if the thickness of the crack is of the order of the element size and result into strong mesh dependencies on its shape.

To illustrate this point we computed the damage growth using the TLS model in the following setting : a square plate is loaded by a uniaxial stress and the center of the plate is initially slightly damaged. The damage zone propagates and a crack appears perpendicularly to the loading axis. Figure 1, left side, is a plot of the distribution of the damage in the plate at a stage where the crack is fully developed. As can be seen the crack (white area) is quite thick and its boundary is jagged.

In the present contribution, we will describe an algorithm that we call the double cut algorithm, which permits to obtain a proper discretized description of the boundary of the fully damaged zone. On figure 1, right side, the previous experiment was reproduced using the new algorithm. The boundary of the crack zone is now smooth and its thickness can be much smaller than the element size.

This new development is crucial for the robustness of a TLS implementation and could also have application for the representation of volume of small thickness embedded in a larger domain using Xfem technologies.

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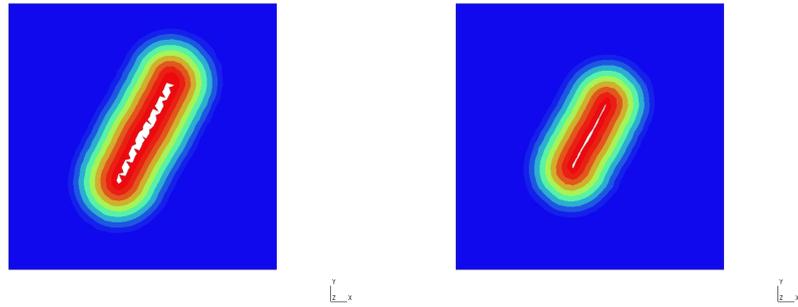


Figure 1: Damage propagation result. Left: using the initial algorithm. Right: using the double-cut algorithm

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