Transition from damage to fracture with the Thick Level Set model

N. Moës

Ecole Centrale de Nantes, GeM Institute, UMR CNRS 6183
1 Rue de La NOE, 44321 Nantes, France
nicolas.moes@ec-nantes.fr

ABSTRACT

Crack initiation relies mainly on damage mechanics whereas crack propagation relies on fracture mechanics involving displacement discontinuity across a propagating crack. We propose a new model bridging these two mechanisms. Damage is expressed in terms of an evolving level set. In the wake of the front (iso-zero of the level set) damage is directly related to the distance of the front with a function considered as a material data. The new model is coined Thick Level Set because not only the location of the iso-zero is useful but all values up to the critical distance (lc) beyond which the material is considered fully damaged (d=1). In the TLS model, the crack location is defined as the set of points located further than the critical distance to the front. The crack placement in the damage band is thus part of the model.

The TLS was developed both from the theoretical and computational point of view in several papers listed in the references. The presentation will focus on two important new developments in the TLS framework.

The first one is the possibility to drive both diffuse and localizing damage within the TLS. Indeed, damage models often exhibit an initial "hardening" effect inducing diffuse damage zone in structures. The evolving front is now the separation between the diffusive and localizing damage zone. In the localizing zone, damage is computed from the distance to the front whereas in the diffuse zone, this condition is relaxed.

The second development deals with the crack placement. A precise numerical technique was designed to create the iso-lc of the level set allowing an element to be cut twice. This creates fully damage zone which may be really thin and mesh-independent.

Several numerical experiments in 2D and 3D quasi-static simulation of quasi-brittle failure will demonstrate the capabilities of the TLS regarding initiation, branching and propagation of cracks over long distances.

References

[1] N. Moës, C. Stolz, P.-E. Bernard, N. Chevaugeon, A level set based model for damage growth : the thick level set approach. *International Journal For Numerical Methods in Engineering*, **86**, 358–380, 2011.

[2] C. Stolz, N. Moës, A new model of damage : a moving thick layer approach. *International Journal of Fracture*, **174**, 49–60, 2012.

[3] P.-E. Bernard, N. Moës, N. Chevaugeon, Damage growth modeling using the Thick Level Set (TLS) approach: Efficient discretization for quasi-static loadings. *Computer Methods in Applied Mechanics and Engineering*, **233-236**, 11–27, 2012.