



HAL
open science

The thick level-set model for damage growth and transition to fracture

Nicolas Moes, Claude Stolz, Nicolas Chevaugeon

► **To cite this version:**

Nicolas Moes, Claude Stolz, Nicolas Chevaugeon. The thick level-set model for damage growth and transition to fracture. ISDMM13, C. Stolz, Jul 2013, Nantes, France. hal-01154931

HAL Id: hal-01154931

<https://hal.science/hal-01154931>

Submitted on 17 Mar 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

The Thick Level Set Model for damage growth and transition to fracture

Nicolas Moës¹, Claude Stolz^{1,2} and Nicolas Chevaugeon¹

¹Ecole Centrale de Nantes,

GeM, UMR CNRS 6183 1 Rue de la Noe, France

e-mail: {nicolas.moes,claudio.stolz,nicolas.chevaugeon}@ec-nantes.fr

²LAMSID, EdF-CEA-CNRS UMR 2832, Clamart, France

Abstract : A damage model allowing smooth transition to fracture is presented. It embeds both local and non-local damage behaviours. The rate boundary value problem is detailed. An analytical solution is given for the axis-symmetric pull-out of a fiber.

Keywords: damage, fracture, level set, non-locality, size effect.

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 evolution is prescribed by local relationship away from strain localization whereas damage evolution is non-local and tied to the evolution of a level-set in localizing areas. The crack is simply the set of point for which the level set values are above a critical distance.

The TLS was developed both from the theoretical and computational points of view in several papers [1-3]. The focus of this paper is the writing of the rate boundary value problem in the spirit of [4]. The evolution of the boundary between local and non-local damage zones is determined by a variational inequality.

The pull-out of a fiber under axis-symmetric conditions is considered and solved analytically. The damage constitutive model considered exhibits some hardening. The load displacement curve obtained shows an elastic part followed by a non-linear stable hardening part. A third part with still a growing loading mixes a local damage evolving zones and a non-local damage evolving zone. Finally, the loading decreases as (only) non-local damage progresses.

Acknowledgement

This work was supported by the grant project ERC.

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.
- [4] Pradeilles-Duval, R. M., & Stolz, C. (1995). Mechanical transformations and discontinuities along a moving surface. *Journal of the Mechanics and Physics of Solids*, *43*(1), 91–121. Retrieved from <http://linkinghub.elsevier.com/retrieve/pii/0022509694000619>