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

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**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 axi-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 is 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 axi-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.

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#### 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