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Numerical simulation of damage evolution by the level set method

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ABSTRACT

This paper is devoted to the numerical simulation of the evolution of damage in brittle materials following the Francfort-Marigo model. This model is based on a Griffith energy criterion for the competition between the two phases, healthy and damaged, separated by a sharp interface. In a quasi-static and irreversible framework, the damage configuration is obtained by minimizing a total energy using a gradient descent method. Following the ideas developped for example in [1] in the context of structural topology optimization, the interface is modeled by a level set function which is advected by the energy gradient issued from a shape derivation. The nucleation new damaged zones is obtained by using the so-called topological derivative. The efficiency of this approach will be demonstrated through several numerical examples in 2d and 3d. For a large contrast between the healthy and damaged phases our numerical simulations show that the Francfort-Marigo damage model is able to simulate crack propagations.

The figure bellow shows successive steps of the damage evolution of a 3d beam, simply supported at its two lower extremities, submitted to a vertical loading on the center of its top face. The intensity of the loads is increasing with time.

REFERENCES

[1] G. Allaire, F. Jouve and A.-M. Toader, "Structural optimization using sensitivity analysis and a level-set method", *J. Comput. Phys.* **194** (1), 363-393, (2004).

[2] G. Allaire, F. Jouve and N. Van Goethem, "A level set method for the numerical simulation of damage evolution", *Internal report of CMAP Ecole Polytechnique 629* (dec 2007).

[3] G. Francfort and J.-J. Marigo, "Stable damage evolution in a brittle continuous medium", *Eur. J. Mech., A/Solids*, **12** (2), 149-189 (1993).

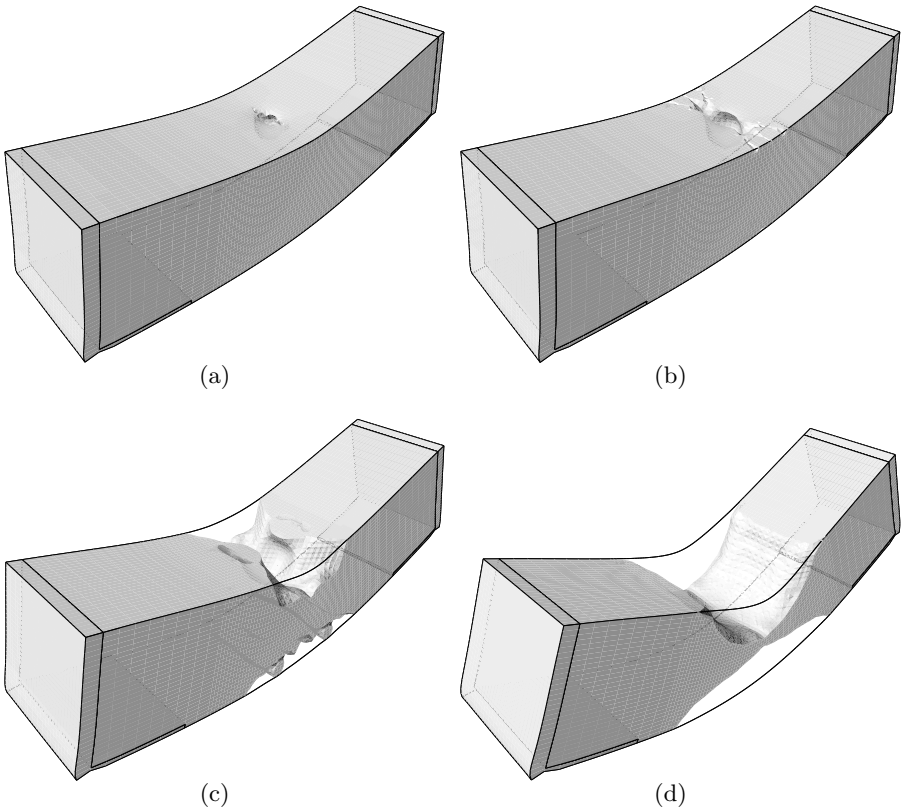

Figure 1: Simply supported beam. Damage evolution for a load intensity $g = 1$. (a), $g = 1.27$ (b), $g = 2.60$ (c), $g = 3.30$ (d).