Fracture models for elasto-plastic materials as limits of gradient damage models coupled with plasticity: the antiplane case

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We study the asymptotic behavior of a variational model for damaged elasto-plastic materials, when the coefficients of the problem depend on a small parameter ε in such a way that the convergence of ε to 0 forces damage concentration on a set of codimension one. The starting point is a gradient damage model coupled with plasticity introduced by Alessi, Marigo, and Vidoli in the small strain regime, based on the minimisation, under suitable boundary conditions, of the total energy which is the sum of the stored elastic energy, of the energy dissipated by the plastic strain, and of the energy dissipated by the damage process. The last summand contains a gradient term which has a regularising effect and prevents sharp transitions of the damage.

In this context it is convenient to consider the reduced energy, i.e., the energy of the optimal additive decomposition of the displacement gradient into elastic strain and plastic strain, thus reducing to a functional which depends only on the displacement and on the damage variable. In the antiplane shear case we determine the Γ-limit of the reduced energy as ε tends to zero. In this case the displacements belong to the space of generalized functions of bounded variation. We show that the limit functional contains a surface energy term involving the crack opening. The surface energy density has an explicit formula, and it satisfies the following properties: it is concave, nondecreasing, in zero it equals zero and it has a finite derivative, while it is constant for large enough values of the crack opening. Therefore the Γ-limit functional can be interpreted as the total energy of an elasto-plastic material with a cohesive fracture.

The talk is based on joint work with G. Dal Maso and G. Orlando (SISSA, Trieste, Italy).

References:

[1] Alessi, R., Marigo, J.-J., and Vidoli, S. Gradient damage models coupled with plasticity and nucleation of cohesive cracks. *Arch. Ration. Mech. Anal. 214* (2014), 575–615.

[2] Alessi, R., Marigo, J.-J., and Vidoli, S. Gradient damage models coupled with plasticity: Variational formulation and main properties. *Mech. Materials 80* (2015), 351–367.

[3] Dal Maso, G., Orlando, G., and Toader, R. Fracture models for elasto-plastic materials as limits of gradient damage models coupled with plasticity: the antiplane case. Preprint 2015, available online at http://cvgmt.sns.it/paper/2677/