Accepted Manuscript

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PII: S0045-7825(18)30148-8
DOI: https://doi.org/10.1016/j.cma.2018.03.023
Reference: CMA 11829

To appear in: *Comput. Methods Appl. Mech. Engrg.*

Received date : 15 December 2017
Revised date : 13 March 2018
Accepted date : 15 March 2018

Please cite this article as: T. Heitbreder, N.S. Ottosen, M. Ristinmaa, J. Mosler, On damage modeling of material interfaces: Numerical implementation and computational homogenization, *Comput. Methods Appl. Mech. Engrg.* (2018), https://doi.org/10.1016/j.cma.2018.03.023

On damage modeling of material interfaces: Numerical implementation and computational homogenization

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Abstract

A novel constitutive framework suitable for material interfaces undergoing large deformations in a geometrically exact setting was developed in [1]. In contrast to previous works, it permits the description of arbitrary material anisotropies by fulfilling all fundamental balance laws in physics as well as the principle of material objectivity. This paper deals with an efficient finite element implementation of the aforementioned framework in terms of the natural basis vectors. To be more precise, a different, more compact and more direct derivation of this framework is outlined first. It relies on the variational structure of the underlying problem. Subsequently, the aforementioned finite element approximation is elaborated which is finally embedded into a computational homogenization scheme. This scheme allows the analysis of the influence of the novel interface model on the resulting macroscopic (effective) material response. It is shown by numerical examples that the interaction of bulk energies and interface energies leads, in a very natural manner, to a complex size effect. It includes the frequently observed "the smaller the stiffer" relation, but also the less often observed "the smaller the softer" relation. However, since the overall response is usually a superposition of such relations, the effective properties cannot generally be characterized by one of the aforementioned limiting relations.

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Preprint submitted to Computer Methods in Applied Mechanics and EngineeringMarch 15, 2018