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Reduced order modeling in solid mechanics: theory and applications

Abstract

The numerical simulation of multiscale or parameter-dependent mechanical systems is a challenging procedure. In order to allow for realistic nonlinear multi-scale simulations involving plasticity, cohesive interfaces and rate-dependent material behavior, the use of model reduction techniques involving micro-mechanics has become a topic of great scientific interest. In this presentation, an overview on potential-based model order reduction is given in terms of the pRBMOR [1, 2, 3]. The pRBMOR extends the nonuniform transformation field analysis (NTFA, [4]) to more general solid materials and to materials containing nonlinear cohesive interfaces [3]. Results ranging from multiscale topology optimization to visco-elastic-visco-plastic composites are considered. Aspects of GPU acceleration required for realistic multi-level FE simulations in the context of the FE Square Reduced approach [1] are also discussed.

References:
[1] Felix Fritzen, Max Hodapp. "The Finite Element Square Reduced (FE2R) method with GPU acceleration: towards three-dimensional two-scale simulations". In: International Journal for Numerical Methods in Engineering (in press) (2016), p. -.

[2] Felix Fritzen, Liang Xia, Matthias Leuschner und Piotr Breitkopf. @Topology optimization of multiscale elastoviscoplastic structures". In: International Journal for Numerical Methods in Engineering 106 (6) (2016), p. 430–453.

[3] Matthias Leuschner and Felix Fritzen. "Reduced order homogenization for viscoplastic composite materials including dissipative imperfect interfaces". In: International Journal of Engineering Sciences (in review) (2016), p. –

[4] Jean-Claude Michel and Pierre Suquet. "Nonuniform transformation field analysis". In: International Journal of Solids and Structures 40 (2003), p. 6937-6955