Faculty of Mechanical, Process and Energy Engineering
Institute of Mechanics and Fluid Dynamics
Chair of Engineering Mechanics – Solid Mechanics

Proposal for a Master Thesis

Implementation of an element-based hyperintegrated model-order-reduction for RVE problems in Abaqus

Besides the purely phenomenological modeling of material behavior at the structural level, micromechanical models are suitable if the observed effects are to be described precisely. This is particularly useful for complex, irreversible behavior, if the properties of the microstructural constituents are well known, e.g. in the case of fiber-reinforced composites, and a clear scale separation is present [1,2,3]. If the microstructure is represented by a representative volume element (RVE) and the finite element method (FEM) is used as a solver tool at both scales, the computationally expensive FE²-scheme emerges, see Fig. 1.

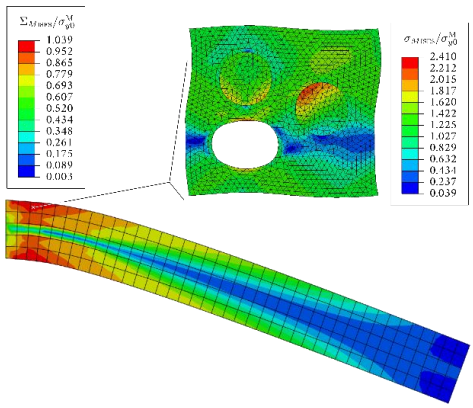

Fig. 1: *FE² model, beam with RVE [2]*

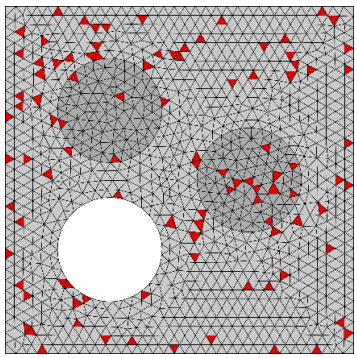

Fig. 2: *Hyperelements [3]*

Hyperintegrated model order reduction (MOR/ROM) is an efficient way to reduce the computational effort of, e.g., RVE simulations [2]. So far, an implementation can only be achieved using special FE solvers [1]. Therefore, an element-based hyperintegration method (EHEIM) was developed, which is compatible with commercial codes such as Abaqus in theory, which, however, has not yet been tested.

Subtasks:

1. Familiarization with FEM program ABAQUS and existing FE²-implementations
2. Development of an automated simulation-pipeline for the creation and analysis of hyper ROM RVE simulations in Abaqus using Python
3. Evaluation of the results and preparation of a written thesis

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References

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[2] N.Lange, G.Hütter, B.Kiefer: *An efficient monolithic solution scheme for FE² -problems*, Computer Methods in Applied Mechanics and Engineering, August 2021, https://doi.org/10.1016/j.cma.2021.113886.
[3] N.Lange, *Modular Methods for Efficient FE² Simulations*, Dissertation, submitted.