Master Thesis Project at the Division of Material and Computational Mechanics

Numerical model reduction for FE analysis of the visco-plasticity problem

Background

In-spite of the increase in computational power, there is still a need to speed-up numerical analyses (finite element simulations). In particular, this holds true for so-called multi-query problems, where a similar problem is solved numerous times for slightly different data. Examples of multi-query problems are structural optimization (where the performance is evaluated for a large set of geometry variations), parameter identification (where the response is sought for a large set of material parameters) and situations with a large set of load combinations.

In linear structural dynamics, it is very common to adopt model reduction in terms of modal superposition. In its most standard format, the original finite element problem is replaced by a small set of decoupled scalar equations for the predominant displacement modes. For non-linear problems, a similar approach can be adopted. The degrees of freedom for the system can be reduced by considering only the most important modes of the solution. However, for a nonlinear problem the procedure for computing the mode shapes becomes more involved. Furthermore, the reduced system will be of that of a fully coupled non-linear set of equations that needs to be solved iteratively.

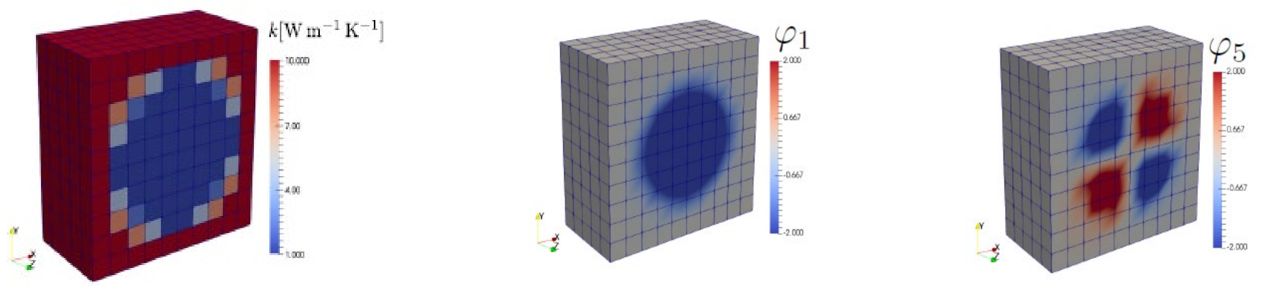

Figure: *Illustration of numerical model reduction for a heat flow problem in a heterogeneous structure: micro-structure (left) and two example modes (middle and right). (Ekre et al. 2019)*

Purpose and project description

This master thesis aims at implementing numerical model reduction for the prototype non-linear problem of visco-plasticity. The main ingredients of the project concern (i) implementation of a finite element solver for visco-plasticity, (ii) development and evaluation of procedures for extracting the most important mode shapes, and (iii) implementation of the reduced problem. The numerical model reduction will be evaluated in terms of accuracy, computational efficiency and robustness for a set of suitably chosen benchmark problems. The numerical implementation can be carried out in, e.g., Matlab, Python or Julia, depending on the experience of the candidate(s).

The project will be carried out in close collaboration with an ongoing PhD-project at the division of Material and Computational Mechanics.

Student background

This project is suitable for one or two students who are interested in computational mechanics and finite element analysis. Students with strong interest and good experiences in programming are encouraged to apply.

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