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

Proposal for a Master Thesis

FE² Simulation of SMA Fibre-reinforced High Performance Concrete

In classical concrete constructions, tensile loads have to be carried by steel rebars, whose placement requires lots of handy work. Fibres of different materials can be inserted instead to foster automatisation. While passive fibres made from steel or glass do not become active until cracks are formed in the concrete, fibres of shape memory alloys (SMAs) can be activated thermically in advance to prestress the concrete in compression from beginning. The thousands of fibres, however, cannot be resolved discretely within a computation. Rather, it is favorable to tread the fibre-reinforced concrete by a multi-scale framework using finite elements at microscale and macroscale, termed FE².

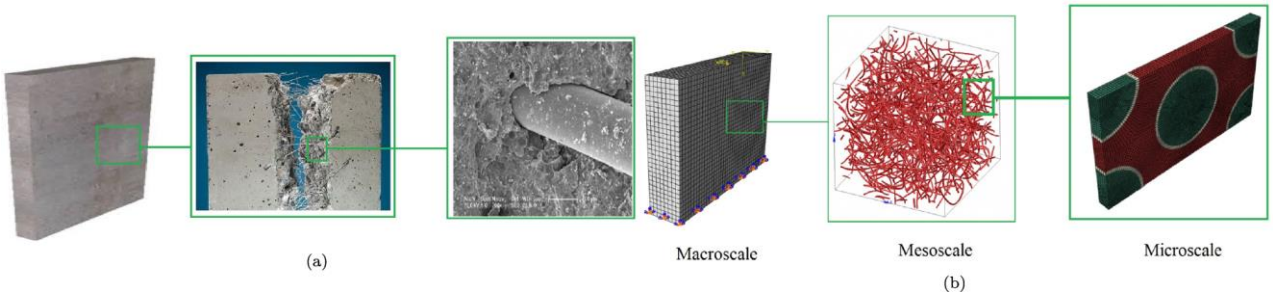

Fig.1: Multi-scale simulation of SMA fibre-reinforced concrete (from: [1])

The aim of this work is to establish, test and verify a multi-scale model for the SMA fibre-reinforced high-performance concrete within the in-house program MonolithFE² [2].

Subtasks:

1. Familiarization with FEM program ABAQUS under Linux and existing FE2 code MonolithFE2
2. Implementation of a rod element for the fibres
3. Verification by means of RVE simulations
4. Coupled FE² simulations of bend specimens and comparison to respective experiments

Requirements:

- Interest in simulative material research
- Excellent or good grading in Nonlinear Finite Element Methods
- Proogramming experience

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References

[1] A. Tabrizikahou, M. Kuczma, C. Czaderski, M. Shahverdi: *From experimental testing to computational modeling: A review of shape memory alloy fiber-reinforced concrete composites*, Composites Part B: Engineering 281, 2024, p. 111530.
[2] N. Lange, G. Hütter, B. Kiefer: *An efficient monolithic solution scheme for FE² problems*, Computer Methods in Applied Mechanics and Engineering 382, 2021, p. 113886.