TECHNISCHE UNIVERSITÄT DRESDEN

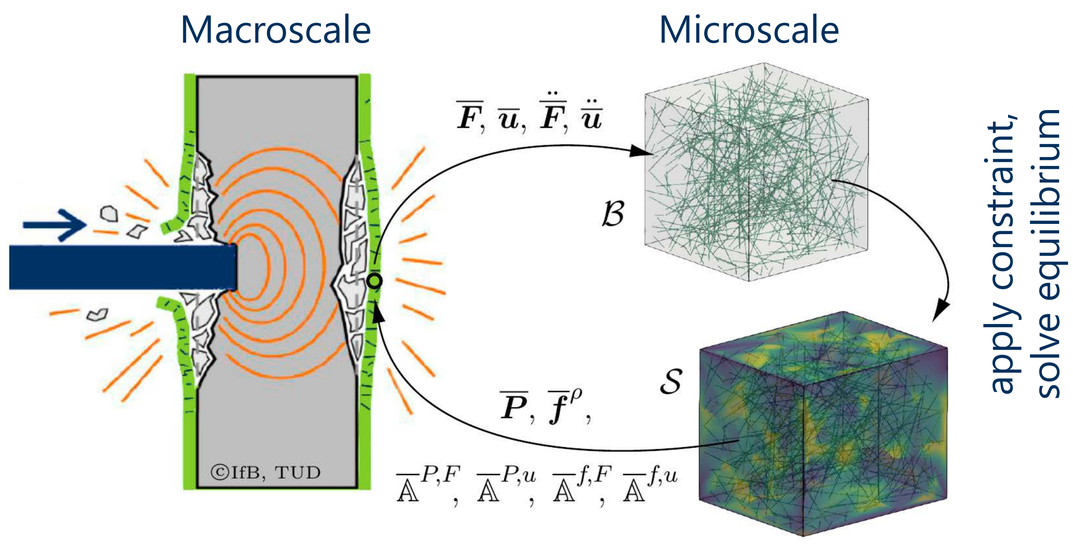
DFG GRK 2250 – Mineral-bonded composites for enhanced structural impact safety

Erik TAMSEN – Doctoral Project B1/I

A FULLY COUPLED DYNAMIC FAMEWORK FOR TWO-SCALE SIMULATIONS OF STRAIN-HARDENING CEMENTITIOUS COMPOSITES (SHCC)

1 OBJECTIVES

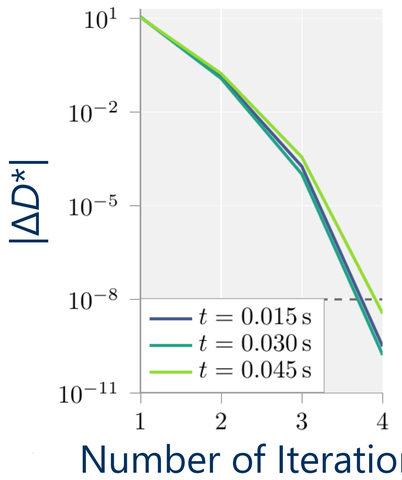
- Development of a numerical scale-bridging homogenization method for impact loading, taking into account inertia forces at the microscale
- Analysis of the influence of microscopic inertia effects on the macroscopic material response
- Statements regarding quality of the two-scale framework for the prediction of macroscopic properties of SHCC



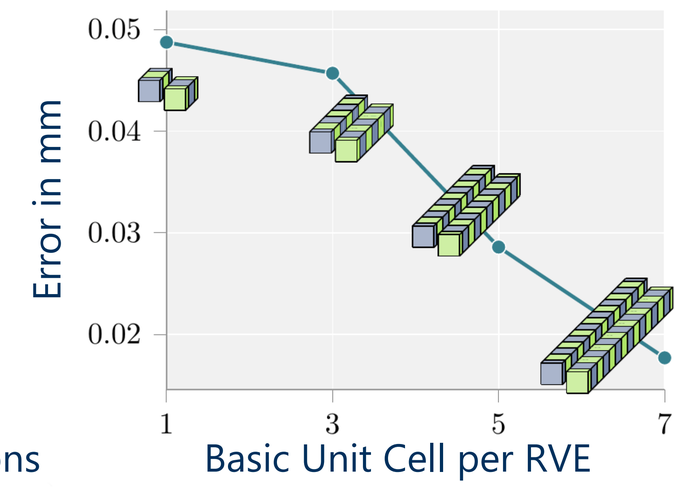
2 METHODS

- Implementation of a new computational two-scale homogenization method incorporating dynamics and finite deformations at micro- and macroscale
- Derivation and implementation of consistent, algorithmic tangent moduli enabling quadratic convergence of the Newton-Raphson scheme
- Development and implementation of new kinematic boundary conditions showing a lower sensitivity for varying periodic unitcells
- Numerical test calculations to validate the approach
- Development of a simplified effective fiber pullout material model and calibration using data of fiber pullout experiments

Quadratic convergence

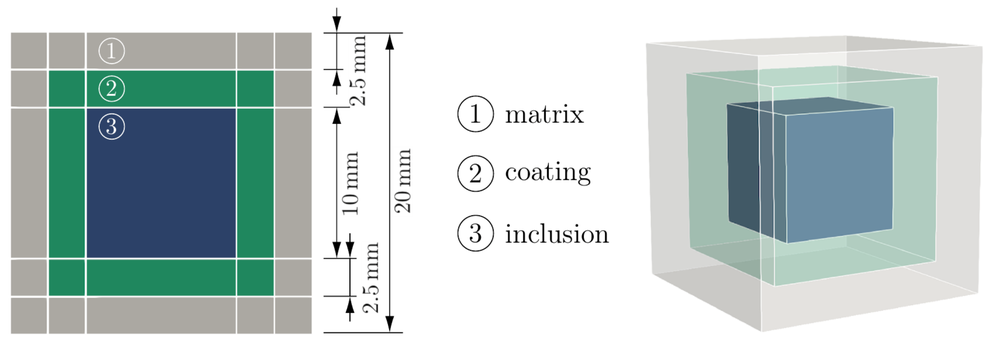


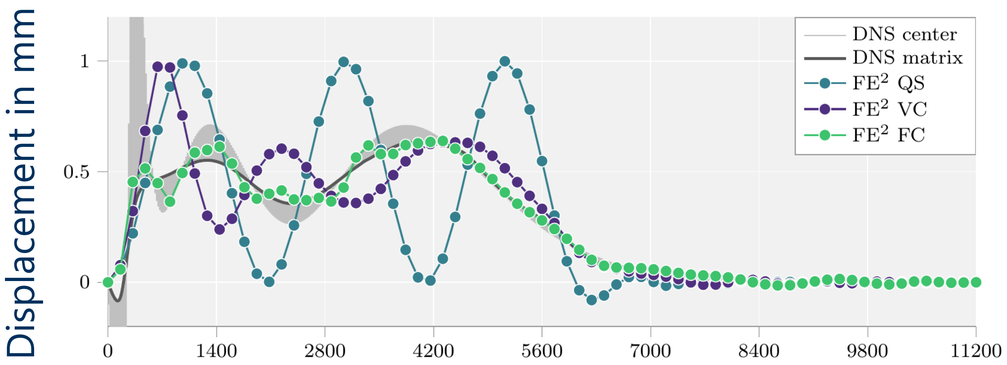
Effect of multiple unit cells under dynamic loading



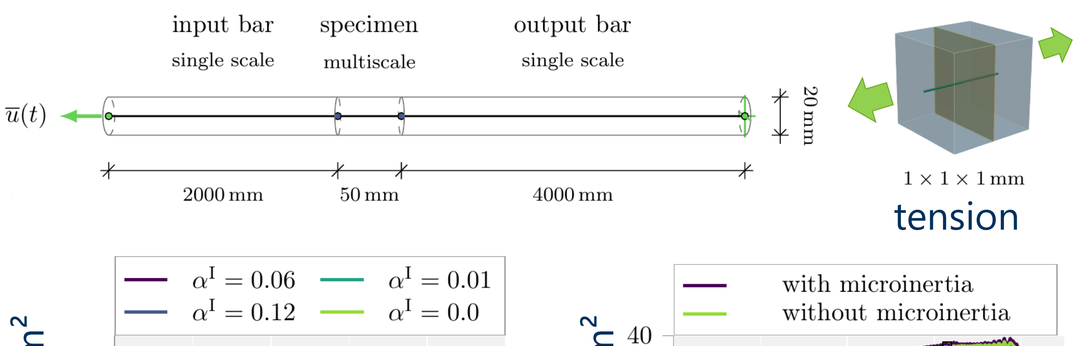
3 RESULTS

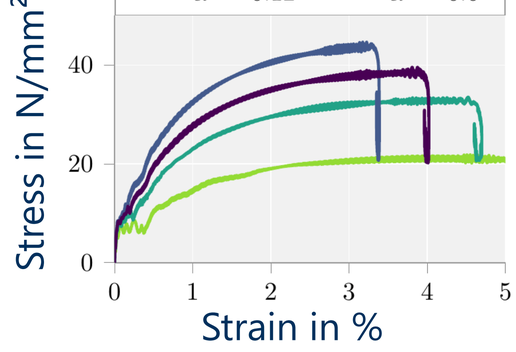
- Applicability of the approach to different material classes including SHCC and locally resonant metamaterials was shown.
- The consistent incorporation of microscopic inertia effects was established.



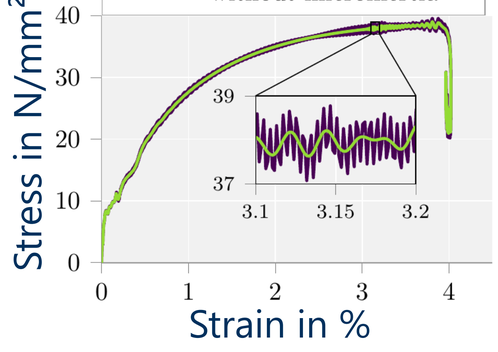


- Split Hokinson tension test simulation of SHCC using a simplified microstructure
- Parameter study to analyze dynamic influences
- Further multiscale simulations with advanced micromechanical material models are required to analyze the full influence of inertia.





Influence of the strain-rate sensitivity of the fibers



Influence of microinertia on the macroscale

4 COLLABORATIONS

- I. CUROSU (POSTDOC): multiscale simulation of SHCC
  Tamsen, Curosu, Mechtcherine, Balzani,
  in: Materials, MDPI (2020)