Chair of Computational Modeling and Simulation
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Modeling:
Mathematics:
Programming:
Science:

Software Lab:

Inverse Analysis of additively manufactured Fiber – Reinforced Concretes based on NURBS

Description

The tensile stress-strain behaviour of concretes cannot be determined directly in practice, therefore flexural tensile tests are carried out on concrete beams and the material behaviour is investigated afterwards by means of models (FEM, surrogate models) and numerical optimisation strategies. Based on a parametric description of the material by means of NURBS, a quasi-displacement-controlled simulation of the flexural load-bearing behaviour is carried out on a single-span beam. The load required for this is either calculated using the principle of virtual forces and equilibrium considerations on the cross-section or the finite element method. This procedure is carried out for each load step and at the end of the simulation the numerically calculated load-deformation relationship is compared with the experimental data. By means of an optimisation algorithm, the control points of the NURBS curve (material behaviour) are adjusted until the numerical results match the experimental data.

Task

- Understand the concept of inverse analysis with respect to fiber reinforced concrete
- Familiarize with the existing source code
- Implement new features of algorithm in Python 3.9+ (and/or C++) under close supervision and quick feedback
    - NURBS – Integration to obtain cross-sectional forces
    - Sensitivity – Analysis
    - Automated parameter studies
    - Initial Variable Estimation
- Monitor code performance and optimize runtime
- (optional & voluntary) participation in the 3D printing of concrete test specimens with a KUKA industrial robot

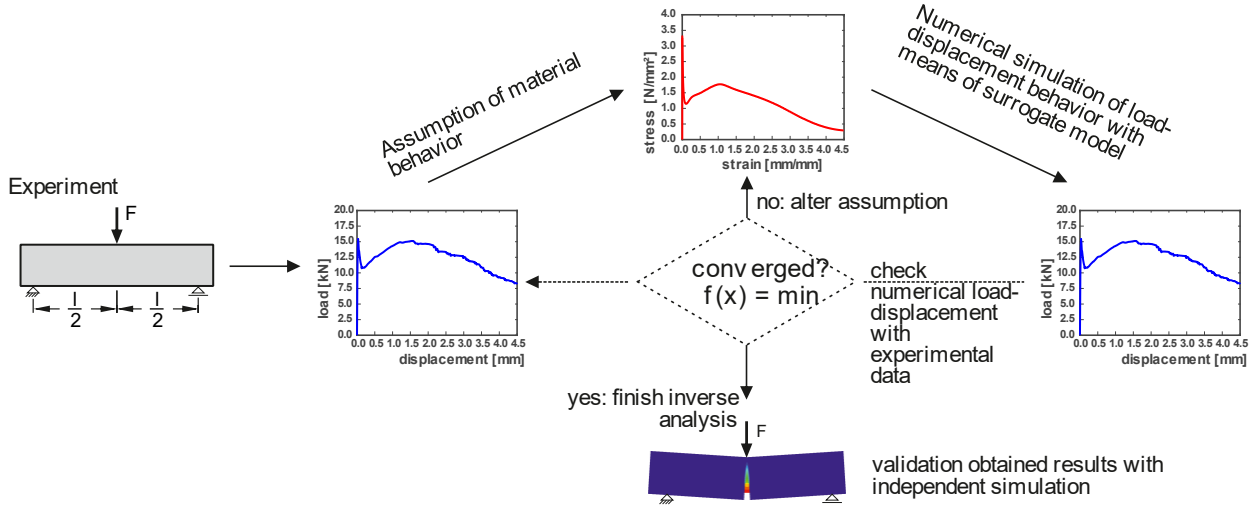

Figure 1: Simplified overview of the optimization routine

Figure 2: Manufacturing of concrete beams with an industrial robot by KUKA

Supervisor

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References

[1] D. Auer, J. Landler and O. Fischer, "Derivation of the centric tensile stress-crack width relationship of steel fiber reinforced concrete from flexural tensile tests using B-Splines", Bauingenieur, vol. 94, no. 11, pp. 451-460, 2019, doi: doi.org/10.37544/0005-6650-2019-11-65.

[2] D. Auer, “Holistic approach of an inverse analysis for the determination of the crack-width-dependent load-bearing behaviour of steel fibre concretes based on B-splines” , M.Sc. Thesis, pp. 1 – 147, 2019.