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# Proposed Topic for a Master Thesis

## Inverse Analysis to Determine the Stress-Strain Behavior of Fiber-Reinforced Concretes

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### Motivation

The performance of fiber-reinforced concretes [1, 2] is classified on the basis of displacement-controlled flexural tensile tests, whereby the centric tensile stress-strain relationship can only be inferred indirectly due to the resulting flexural compressive stresses. Centric Tensile tests are not an option, as it is costly and error-prone. The numerical determination of the unknown material behavior as the cause from the load-deformation data of a bending tensile test is called inverse analysis.

The definition of an inverse analysis in the context of fiber concretes and the already developed algorithm is presented in [3]. The parametric description of the material behavior is based on so-called "non-uniform rational B-splines" [4].

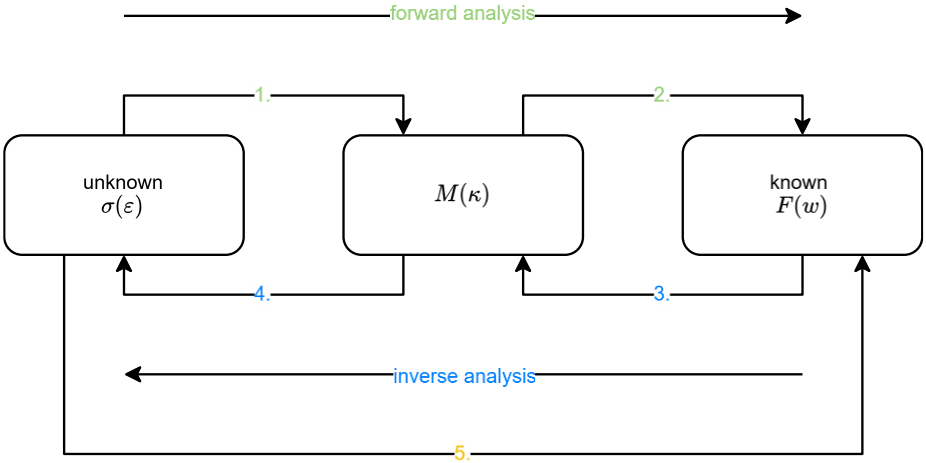
The aim of the thesis is the further development of the already existing algorithm for the inverted analysis of steel fibre concretes, which can be generalized to fibre concretes.

For this purpose, the following procedure is aimed at:

1. Assumption of a material characteristic curve $\sigma(\varepsilon)$ and calculation of the moment-curvature line $M(\kappa)$ by iteration of strain-planes in the cross-section
2. Computation of the load-deformation line $F(w)$ of a bending tensile test on a single-span beam from the moment-curvature line $M(\kappa)$ using the principle of virtual forces
3. Recalculation of the moment-curvature line $M(\kappa)$ required for a given load-deformation line $F(w)$
4. Recalculation of the material characteristic curve $\sigma(\varepsilon)$, which is required for the moment curvature line $M(\kappa)$ resulting from 3.

5. Validation of the results with an independent engineering model or FEM to describe the stress distribution at cross-section level

The following figure visualizes the computation process




**Workflow**

- Further development of the algorithm in close cooperation and coordination with the supervisor

**Knowledge**

- Python, Basics of Numerical Programming
- Finite Elemente Method
- Willingness to learn

**Literatur**


[1] *Fischer, O.; Volkmer, D.; Lauff, P. et al.:* Zementgebundener kohlenstofffaserverstärkter Hochleistungswerkstoff (Carbonkurzfaserbeton), München, 2019.

[2] *Lauff, P.; Fischer, O.:* Effizienter Ultrahochleistungsbeton mit innovativer trajektorienorientierter „Bewehrung“. *In:* ce/papers 3 (2019), Heft 2, S. 82-88.

[3] *Auer, D.; Landler, J.; Fischer, O.:* Bestimmung der zentrischen Nachrisszugfestigkeit von Stahlfaserbetonen aus Biegezugversuchen unter Anwendung von B-Splines. *In:* Bauingenieur 94 (2019), Heft 11, S. 451-460.

[4] *Piegl, L.; Tiller, W.:* The NURBS Book, Monographs in Visual Communications, Springer, Berlin, 1995.