VIRTUAL LAB FOR MECHANICAL TESTING OF STEEL- AND STEEL-FIBER REINFORCED CONCRETE

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This thesis proposes a computational framework for a virtual laboratory that enhances traditional simulations by integrating realistic concrete mesostructure, including fibers and aggregates, directly into numerical models. The mesostructure can either be artificially generated or derived from the actual physical experiments utilizing CT images. This approach provides insights into material behavior that is difficult to achieve with conventional methods.

Key contributions of this research include the development, robust implementation, and extensive validation of models for fracture, fibers, and bonds at meso- and structural scales. These models facilitate computational experiments that lead to a better understanding of fiber-reinforced concrete behavior under various loading conditions. Detailed numerical analyses of tensile, compressive, and bending tests reveal insights into crack-bridging mechanisms and the effects of fiber content and orientation on material behavior.

Additionally, the thesis explores the practical application of developed models through size effect tests on reinforced concrete beams. These tests demonstrate the capability of the proposed computational framework to calculate size-dependent peak forces and failure modes. They also show the potential of the developed modeling framework to be applied to complex structural engineering problems.

The work in the scope of this thesis strives to improve the robustness and applicability of numerical models for computational fracture mechanics in concrete and concrete structures, contributing valuable tools and insights to the field of concrete modeling.

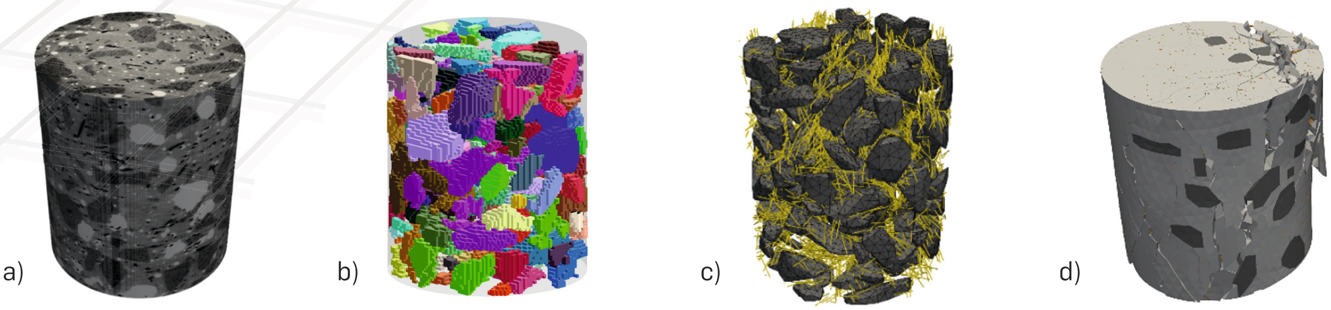

Fig.: Generation of the computational model from a CT image: (a) Original CT image of an actual sample showing four phases: fibers (black), aggregates (dark gray), mortar matrix (gray), and air voids (light gray). (b) Identification of individual aggregates. (c) Isolated aggregates (dark gray) and fibers (yellow). (d) Numerically obtained fracture pattern.

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