

Ulrich Häussler-Combe

# Computational Structural Concrete

## Theory and Applications

- guidance for the direct application of numerical methods to concrete structures
- the book is suitable for beginners in the profession and for practicing engineers
- state of the art concrete material models are presented

Basic concepts of numerical methods in particular the FEM are summarized. The theory is explicated for structural concrete parts like beams plates, slabs and shells. Thus the operation of complex software is made transparent incl. opportunities and pitfalls. With 42 examples.

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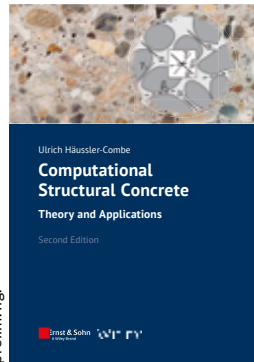
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### ABOUT THE BOOK

Concrete is by far the most used building material due to its advantages: it is shapeable cost-effective and available everywhere. Combined with reinforcement it provides an immense bandwidth of properties and may be customized for a huge range of purposes. Thus concrete is the building material of the 20th century. To be the building material of the 21st century its sustainability has to move into focus. Reinforced concrete structures have to be designed expending less material whereby their load carrying potential has to be fully utilized. Computational methods such as Finite Element Method (FEM) provide essential tools to reach the goal. In combination with experimental validation they enable a deeper understanding of load carrying mechanisms. A more realistic estimation of ultimate and serviceability limit states can be reached compared to traditional approaches. This allows for a significantly improved utilization of construction materials and a broader horizon for innovative structural designs opens up. However sophisticated computational methods are usually provided as black boxes. Data is fed in the output is accepted as it is but an understanding of the steps in

between is often rudimentary. This has the risk of misinterpretations not to say invalid results compared to initial problem definitions. The risk is in particular high for nonlinear problems. As a composite material reinforced concrete exhibits nonlinear behaviour in its limit states caused by interaction of concrete and reinforcement via bond and the nonlinear properties of the components. Its cracking is a regular behaviour. The book aims to make the mechanisms of reinforced concrete transparent from the perspective of numerical methods. In this way black boxes should also become transparent. Appropriate methods are described for beams plates, slabs and shells regarding quasi-statics and dynamics. Concrete creeping temperature effects prestressing, large displacements are treated as examples. State of the art concrete material models are presented. Both the opportunities and the pitfalls of numerical methods are shown. Theory is illustrated by a variety of examples. Most of them are performed with the ConFem software package implemented in Python and available under open-source conditions.

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