Mechanical Characterization of Building Materials – From Nano Scale to Structural Scale

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ABSTRACT

The requirements for building structures and building elements, respectively, in civil engineering are increasing constantly. This motivates the development of more accurate material models and advanced simulation tools for improved design of such sophisticated structures. Moreover, the variability of the material properties has to be understood and suitably described in order to prevent exaggerated safety factors, resulting in an uneconomic over-dimensioning of building elements. Such an understanding and an appropriate resolution of the origin of the observed material behavior require insight into the microstructural processes of these materials. For this reason, multi-scale models for different building materials have been developed at the Institute for Mechanics of Materials and Structures, allowing us to relate the material properties at the structural scale (macro-scale) to finer-scale characteristics such as material composition and behavior of the constituents. Recent developments in finer-scale characterization of materials, on the one hand, and micromechanics, on the other hand, provide the basis for the formulation of material models incorporating several scales of observation.

In this presentation, multi-scale models for wood, asphalt concrete, and cementitious materials are presented. Leading, on the one hand, to a better understanding of the complex behavior of these materials and, on the other hand, providing accurate sets of macroscopic properties as input for structural simulation tools. In the following, the key feature of each multi-scale approach is briefly outlined and the link to a structural application is indicated. In order to derive a proper understanding of the material behavior, to identify material parameters, and to validate the obtained material models at various length scales, experimental investigations are obligatory and an integral part of each presented model.