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# Characterization and Multiscale Modeling of Asphalt - Recent Developments in Upscaling of Viscous and Strength Properties

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## ABSTRACT

The assessment and prediction of the performance of multi-composed materials, such as e.g. asphalt, requires suitable procedures for identification of their mechanical properties. In case of asphalt used for trafficked pavements, these properties vary with the underlying mix design (volume fractions and used constituents) and additives (e.g., polymers). In the past, the mix design and the allowance of additives were optimized, aiming at (a) a low viscosity at high temperatures (T > 135 °C) for the construction and compaction process of high-quality asphalt layers, (b) a significantly higher viscosity at medium temperature in order to minimize the development of permanent deformations (rutting), and (c) sufficient relaxation behavior at sub-zero temperatures, avoiding low-temperature cracking (see failure modes in Figure (left)). Motivated by the large variety of asphalt mixtures resulting from this optimization process and the necessity of predicting the future performance of pavements, a multiscale model for asphalt is currently developed at TU Wien. It relates macroscopic properties to finer-scale information (such as volume fractions, morphology, and the behavior of material phases) by introducing, in addition to the so-called *macro*scale (i.e., the scale at which prediction analyses are performed), four finer scales of observation, ranging down to the so-called *bitumen*-scale (see Figure (right)).


**Figure:** (left) failure modes in asphalt pavements and (right) multiscale model for asphalt

In this lecture, recent results on upscaling information from finer observation scales towards the macroscale are presented. For this purpose, both analytical methods (continuum micromechanics) and numerical schemes (limit analysis) are employed. In addition to the theoretical work, the presented multiscale model for asphalt requires a significant amount of experimental work, covering both the *identification* of properties of material phases at the different observation scales and the *validation* of the employed upscaling schemes. Test results as well as advanced test methods employed at the Christian Doppler Laboratory for “Performance-based optimization of flexible pavements” at TU Wien for the characterization of asphalt at different scales are presented.