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EINLADUNG

zum Gastvortrag

von

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am

Donnerstag, 27. September 2018, 15:00 Uhr

Technische Universität Wien, Karlsplatz 13, 1040 Wien
Hörsaal 15 (Stiege 3, 3. Stock)

Randomness in Mechanics of Materials … within and beyond the Second Law of Thermodynamics

Microstructural randomness is present in just about all solid materials. When dominant (macroscopic) length scales are large relative to microscales, one can safely work within classical, deterministic solid mechanics. However, when the separation of scales does not hold, various concepts of continuum mechanics need to be re-examined and new methods developed. In this talk, we focus on scaling from a Statistical Volume Element (SVE) to a Representative Volume Element (RVE). Starting from the Hill-Mandel homogeneity condition, without assuming any spatial periodicity, the RVE is approached in terms of two hierarchies of bounds stemming, respectively, from uniform kinematic and static boundary value problems set up on the SVE. This is illustrated in various settings: conductivity, linear or finite (thermo)elasticity, elastoplasticity, viscoelasticity, and Darcy permeability. The methodology can also be extended to the homogenization of random media by micropolar (Cosserat) rather than by classical (Cauchy) continua. This entire approach also forms a systematic basis for setting up of tensor-valued random fields with continuous realizations and stochastic finite element methods.

In the case of permeability, should the pores' sizes be nanoscale level, one may have/want to account for spontaneous violations of the Second Law of thermodynamics. According to contemporary statistical mechanics, the latter are described by a non-zero probability of negative entropy production rate on very small scales and times. The Second Law then needs to be replaced by the fluctuation theorem, implying a formulation of continuum mechanics via stochastic functionals of energy and entropy. This is illustrated by examples drawn from a Couette-type flow, acceleration wavefront propagation, and diffusion.