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STATISTICAL PROPERTIES OF THE REPRESENTATIVE VOLUME ELEMENT OF RANDOM MATERIALS

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One of the most important concepts in the micromechanics of heterogeneous materials is the Representative Volume Element (RVE). RVE is an imprecise term denoting a small (cubic) sub-volume of a material which is statistically representative of the whole. In particular, an RVE should have *effective properties*, i.e. well capture the material's average constitutive response. The size of the RVE is known to depend on the physical property being investigated (elastic properties, thermal conductivity, etc.), morphological features of the microstructure (number of phases, their volume fractions and spatial distribution), and the contrast between the properties of the phases [1]. It is usually assumed that an RVE should be large compared with the size of inhomogeneities, but good approximations of effective properties can frequently be obtained with cubes of relatively small sizes [2].

For most materials, except periodic ones, it is not straightforward to determine the size of the RVE. If a material has a random microstructure, morphological fluctuations may always cause that two samples of the material will somewhat differ in their average response, even if they are large. Therefore, the Stochastic Volume Element (SVE) is often investigated instead of the RVE [3]. The SVE is a volume element of a moderate size with respect to the size of inhomogeneities, and its average properties (*apparent properties*) vary between samples. Apparent properties are random functions, depending on the SVE size and the stochastic properties of the underlying heterogeneous material. In theory, as the size of the cube increases, the SVE approaches the RVE and apparent properties tend to effective ones.

In this work, the transition from the SVE to the RVE will be explored from the probabilistic point of view. Firstly, basic stochastic characteristics such as mean values and (co)variances of apparent mechanical properties of SVEs will be presented for several typical cases. Secondly, a more precise probabilistic definition of the RVE will be discussed, indicating an SVE of such dimensions that the probability of a given variation of its apparent properties is sufficiently small. Based on this definition and the available stochastic characteristics, approximate RVE sizes will be considered.

References

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