
Data-driven finite element computations for materials with an open-cell microstructure

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Abstract

In the data-driven finite element analysis the constitutive material modeling is eluded and instead data are directly employed as an input for computational analysis. This model-free description allows to implement arbitrary behaviors. It can be especially beneficial when you want to easily change the microstructural material design avoiding to start a new fitting process every time you make a change.

Our contribution focuses on the question of how we can use the data-driven finite element analysis for cellular materials. Since experimental data acquisition can be tedious, we suggest using numerical computations of representative volumes. In that way, the micromechanical behavior of the material can be employed to deduce homogenized data points.

Specifically we consider lattice-like materials and foam made of polyurethane. Dependent on the manufacturing process and the composition of the constituents, the material properties such as relative density, strut thickness, cell distribution, and general structure of the material vary. To map these different microstructures, we use regular or/and stochastic representative volume elements (RVEs) to generate the data basis. A generator produces the RVEs with the desired properties which are then subjected to some test loads to deduce homogenized data points. For illustration, the database is used in a finite element simulation of a compression experiment.

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