Reduced-Order Modelling and Homogenisation in Magneto-Mechanics

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ABSTRACT

The mechanical response of magnetorheological composites is highly affected by an applied magnetic field. Since a generally valid constitutive law does not exist for such heterogeneous materials, multiscale techniques like computational homogenisation are commonly used to approximate effective macroscopic properties. In our approach the macroscopic quantities at a material point of a magnetorheological elastomer are derived from the response of the underlying micro-structure, where the constitutive law is known, using first-order homogenisation [1, 2, 3].

The computational cost of this nested solution scheme known as the FE^2 method prohibits the simulation of complex macroscopic problems. To mitigate the computational bottleneck the FE models on the microscale are replaced by reduced-order models (ROMs). In projection-based ROM the governing equations are projected onto the reduced basis, which is an approximation of the solution manifold of the parametrised partial differential equations (pPDE). The reduced basis is commonly constructed by applying proper orthogonal decomposition [4, 5]. Furthermore, the reduced basis is accompanied by a hyper-reduction method [6], which efficiently computes the non-linearities for the ROM.

We will present our approach for the construction and computation of the reduced-order models on the microscale. Through various numerical examples the accuracy and time savings of the reduced models will be discussed.

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