

Incremental-secant mean-field-homogenization method for elasto-visco-plastic materials systems

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Abstract

With the increasing use of engineered and/or heterogeneous materials, there is a need to develop multi-scale methods in order to predict with accuracy structural behaviors. One computationally efficient multi-scale method is the mean-field homogenization (MFH) one, which considers as homogenized strain and stress fields the volume average of their respective counterparts in the different composite material phases.

Although originally developed for elastic materials, MFH methods have been extended to non-linear behaviors by considering a linear comparison composite (LCC). To define this LCC, the authors have developed an incremental-secant mean-field homogenization formulation, for which the residual stress and strain states reached in the phases upon a fictitious elastic unloading are considered as starting point to apply the secant method [1, 2]. The mean stress fields in the phases are then computed using isotropic secant tensors, which are naturally used to define the LCC. The incremental-secant formulation has several advantages: it can handle non-radial loading conditions, it avoids the isotropisation step required by other incremental methods, and it can handle softening behaviors in an accurate way.

In this work, we present an extension of the incremental-secant mean-field homogenization to elasto-visco-plastic composite materials. The formulation can account for both first and second statistical moment estimates during the evaluation of the visco-plastic flow. The method predictions are compared to finite element (FE), to Fast-Fourier-Transform (FFT), and to experimental results, to demonstrate the accuracy of the method.

Keywords: Multi-scale, Visco-plasticity, Composite materials; Second statistical moments

References

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