Implementations of homogenized behaviours in structural codes: examples and on-going efforts on extending the MFront code generator

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Abstract

So-called "mean-field homogenization" (MFH) theories, often providing closed-form expressions for the effective properties of heterogeneous materials, have been continuously developed for more than 50 years. Yet, MFH is not commonly used in engineering studies at the structural scale for several reasons. On the one hand, implementation of behaviours resulting from MFH theories is complex and generally inefficient at the structural scale: explicit schemes are preferred for the sake of simplicity but have high local integration costs (at every Gauss's point) and do not provide a consistent tangent operator, leading to poor convergence rate at the structural scale.
This contribution presents an on-going effort to:

- develop efficient implicit algorithms for behaviours resulting from MFH theories
- extend the *TFEL/Material* library and the *MFront* code generator in the hope to make such behaviours easier to implement and available in many academic and commercial solvers.

The first point will be illustrated by an implicit scheme based on the static condensation of the equations resulting from the Berveiller-Zaoui scheme proposed in *Helfer et al.* This algorithm is extended in various ways, including support for behaviours with internal states, Cailletaud's beta-rule, etc. Based on the work of the members of the AnoHonA project, extensions to more general schemes will be discussed.

The second point will be illustrated by exposing some facilities introduced in MFront code generator that simplify the implementation of behaviours resulting from MFH theories.
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