RELIABILITY OF COMPUTATIONAL HOMOGENIZATION

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ABSTRACT

Very often computational homogenization is the only reasonable method to evaluate overall properties of heterogeneous materials and model structures made of them. However, replacement of a heterogeneous body by a homogenized one inevitable introduces a modeling error resulted from systematic data reduction. Thus, it may happen that the homogenization should not be used at least in a certain part of the domain. Therefore, estimation of homogenization (modeling) error is crucial for reliability of the results and a-posteriori modeling error estimation is considered here exclusively for materials with periodic microstructure and continuum mechanics valid at two scales for which RVE based and local approaches are used.

One of the possibilities of homogenization error assessment is based on an upper bound theorem that originated from theory of differential equations. The next method makes use of additional analyses in selected subdomains with boundary conditions determined by the homogenized solution. Residuum of the differential equation for heterogeneous body may also be used to detect subdomains with large discrepancy between the exact and homogenized solutions.

Quite different possibility of verification of homogenized solution quality offers application of two various homogenization techniques. Besides the RVE apprach we use also the local homogenization method. The key point of the later method is to replace a patch of fine finite elements by such a large element that the difference between the solutions, which would be obtained by the fine and coarse meshes is as small as possible. Having two homogenized solutions at hand we are able to get information on the homogenization error.

The methods presented above briefly will be illustrated by selected numerical examples in which solutions at both scales are computed by the reliable automatic *hp*-adptive FEM with approximation error assessment.