Filter-based computational homogenization

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ABSTRACT

In this work, a new homogenization method is proposed to model heterogeneous media when scales are not separated, i.e. when the wavelength of the prescribed strain is not larger than the Representative Volume Element characteristic size. The theory, introduced in [1], extends the classical homogenization framework by using low-pass filters operators instead of averaging operators, and Green's nonlocal functions instead of localization operators. The constitutive law at the mesoscopic scale naturally appears to be nonlocal in a form of a convolution product. However, in contrast with the Eringen's model [2], the kernel function is here non-translationally invariant and is fully micromechanically-based. In contrast with other nonlocal theories, a continuum of models can be constructed, from the microscopic scale up the the fully homogenized model, by modifying the filter wavelength. A complete numerical framework using finite elements is presented to numerically apply the method to complex microstructures. Appropriate choices of filters avoid numerical drawbacks related to Gaussian filters [3]. The methodology is illustrated through examples of structures composed of heterogeneous materials, where the inclusions or voids are of comparable size with that of the structure dimensions. We show that in such cases, local fields are much better represented than using first order or extended schemes of the classical theory.

REFERENCES

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