The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

Efficiency of boundary conditions on the computation of local fields in a Representative Volume Element

L. Belgrand[1,3,*], I. Ramière[1], R. Largenton[2], F. Lebon[3]

[1] CEA, DES, IRESNE, DEC, SESC, LSC ; Cadarache, F-13108 Saint-Paul-Lez-Durance
{louis.belgrand,isabelle.ramiere}@cea.fr
[2] EDF R&D, Dpt MMC ; Cadarache, F-13108 Saint-Paul-Lez-Durance
rodrigue.largenton@edf.fr
[3] Aix-Marseille Université, CNRS, Centrale Marseille, LMA ; 13453 Marseille cedex 13
{belgrand,lebon}@lma.cnrs-mrs.fr

Keywords: *Numerical homogenization, Heterogeneous materials, Local behaviour, Boundary conditions*

Within the framework of numerical homogeneization approaches, we focus on the effect of boundary conditions (BCs) on local mechanical fields computed by the Finite Element method. The influence of classical BCs (affine displacements, periodic conditions) imposed on the Representative Volume Element (RVE) has been largely studied with respect to the effective macroscopic behaviour [1]. When a periodic microstructure can be generated at the RVE scale (periodic or model materials typically), periodic conditions produce more accurate results. However, these conditions come with technical difficulties linked to the generation of the periodic mesh and additional costs in terms of computation time.
In a multiscale use of numerical homogenization [2], local fields are of great importance to detect phenomena arising at the local scale. Moreover these fields must be computed in reasonable calculation times to make these numerical coupling approaches efficient. Very few studies focus on the effects of the BCs on the local behaviour. Affine displacement conditions, which are the computationnally most efficient technique, are subject to local boundary effects, located on cut inclusions in case of matrix-inclusion composites [3]. Different ways are followed in order to improve the ratio precision over cost of such approaches : truncation or filtering [4], homogenization-based Dirichlet values, RVE without cut inclusions.

REFERENCES

[1] T. Kanit, S. Forest, I. Galliet, V. Mounoury, and D. Jeulin. Determination of the size of the representative volume element for random composites: statistical and numerical approach. *International Journal of Solids and Structures*, 40(13):3647–3679, 2003.

[2] S. Saeb, P. Steinmann, and A. Javili. Aspects of computational homogenization at finite deformations: A unifying review from Reuss' to Voigt's bound. *Applied Mechanics Reviews*, 68, 06 2016.

[3] M. Salmi, F. Auslender, M. Bornert, and M. Fogli. Apparent and effective mechanical properties of linear matrix-inclusion random composites: Improved bounds for the effective behavior. *International Journal of Solids and Structures*, 49(10):1195–1211, 2012.

[4] X. Yue and W. E. The local microscale problem in the multiscale modeling of strongly heterogeneous media: Effects of boundary conditions and cell size. *Journal of Computational Physics*, 222:556–572, 03 2007.