A multi-scale technique using a radial interpolator meshless method for the analysis of composite materials

D.E.S. Rodrigues*, J.Belinha*,†, L.M.J.S.Dinis† and R.M.Natal Jorge†

* Institute of Mechanical Engineering and Industrial Management
Rua Dr.Roberto Frias, S/N, 4200-465-Porto
e-mail: drodrigues@inegi.up.pt, web page: http://www.inegi.pt

† Faculty of Engineering of the University of Porto
Rua Dr.Roberto Frias, S/N, 4200-465-Porto
e-mail: jbelinha@fe.up.pt , ldinis@fe.up.pt , rnatal@fe.up.pt - Web page: http://www.fe.up.pt

ABSTRACT

There is a wide range of heterogeneous materials whose macro-scale behaviour cannot be interpreted or predicted without considering the complex processes that occur in lower dimensional scales. Thus, several multi-scale techniques based on computational homogenization have been proposed in order to accurately predict the homogeneous mechanical properties of these materials, such as composite materials. Based on existing multi-scale numerical transition techniques suitable for simulating heterogeneous materials, this work provides a numerical tool which combines a multi-scale approach with new numerical techniques using advanced discretization methods - meshless methods [1]. In order to discretize the problem domain, meshless methods only require an unstructured nodal distribution. The numerical integration of the Galerkin weak form is performed using a background integration mesh and the nodal connectivity is enforced by the overlap of influence-domains defined in each integration point. In this work, a representative volume element (RVE) is modelled using a two-dimensional plane strain formulation. Periodic boundary conditions are imposed on the RVE and a computational homogenization process is implemented in order to determine the effective elastic properties of a composite material. In the end, a comparison study is performed between the results obtained using meshless methods and the finite element method.

Acknowledges: The authors truly acknowledge the funding provided by Ministério da Ciência, Tecnologia e Ensino Superior – Fundação para a Ciência e a Tecnologia (Portugal), under grants: SFRH/BPD/111020/2015, and by project funding UID/EMS/50022/2013 (funding provided by the inter-institutional projects from LAETA). Additionally, the authors gratefully acknowledge the funding of Project NORTE-01-0145-FEDER-000022 – SciTech – Science and Technology for Competitive and Sustainable Industries, co-financed by Programa Operacional Regional do Norte (NORTE2020), through Fundo Europeu de Desenvolvimento Regional (FEDER).

REFERENCES

[1] Belinha, J. (2014). Meshless Methods in Biomechanics - Bone Tissue Remodelling Analysis. (J. M. R. S. Tavares & R. M. Natal Jorge, Eds.) (Vol.16 ed., p. 320). Lecture Notes in Computational Vision and Biomechanics, Springer Netherlands. ISBN: 978-3-319-06400-0