6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11 – 15 June 2018, Glasgow, UK

HOMOGENIZATION TECHNIQUE FOR HETEROGENEOUS COMPOSITE MATERIALS USING MESHLESS METHODS

D. E.S.Rodrigues[1,2] , J.Belinha[1,2,3], F.M.A.Pires[1,2], L.M.J.S.Dinis[1,2], R.M.Natal Jorge[1,2]
[1] Institute of Science and Innovation in Mechanical and Industrial Engineering, Dr. Roberto Frias Str., 400, S/N, 4200-465 Porto – Portugal, drodrigues@inegi.up.pt, www.inegi.pt/
[2] Faculty of Engineering, University of Porto, Dr. Roberto Frias Str., S/N, 4200-465 Porto – Portugal, jorge.belinha@fe.up.pt , fpires@fe.up.pt , ldinis@fe.up.pt , rnatal@fe.up.pt www.fe.up.pt
[3] Instituto Superior de Engenharia do Porto, Rua Dr. António Bernardino de Almeida, 431, 4249-015 Porto, Portugal. www.isep.ipp.pt

KEYWORDS: *Micromechanics; Composite materials; Homogenised elastic properties; Meshless Methods; Radial Point Interpolation Method (RPIM); Natural Neighbour Radial Point Interpolation Method (NNRPIM)*

The prediction of the mechanical behaviour of fibre composite materials is complex due to their random fibre distributions across the cross-section and their anisotropic and heterogeneous nature. In the literature, several multi-scale approaches have been proposed to predict more accurately their mechanical properties using computational homogenization approaches.
This work is based on existing multi-scale numerical transition techniques suitable for simulating heterogeneous materials and makes use of two meshless methods [1] - the Radial Point Interpolation Method (RPIM) and its enhanced version: the Natural Neighbour RPIM (NNRPIM). Representative volume elements (RVEs) are modelled assuming periodic and random fibre distributions, and are analysed using the previously mentioned numerical methods. Prescribed microscopic displacements are imposed on different RVEs whose boundaries are periodic and, from the obtained stress field, the average stresses are determined. Consequentially, the effective elastic properties of a heterogeneous composite material are obtained for different fibre volume fractions and using RVEs with different characteristic sizes. In the end, the numerical solutions are compared with the solutions proposed in the literature and the FEM solution. The obtained results show that the NNRPIM achieve more accurate solutions than the RPIM and the FEM.

ACKNOWLEDGMENTS: 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 SFRH/BD/121019/2016, and by project funding MIT-EXPL/ISF/0084/2017 and 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