11th. World Congress on Computational Mechanics (WCCM XI)
5th. European Conference on Computational Mechanics (ECCM V)
6th. European Conference on Computational Fluid Dynamics (ECFD VI)
July 20 - 25, 2014, Barcelona, Spain

EFFECTIVE PROPERTIES OF TWO-PHASE RANDOM MEDIA MODELED BY XFEM

G. Stefanou[1,2], D. Savvas[1], M. Papadrakakis[1] and G. Deodatis[3]

[1] Institute of Structural Analysis & Antiseismic Research
School of Civil Engineering
National Technical University of Athens
Zografou Campus, 15780 Athens, Greece
[2] Institute of Structural Analysis & Dynamics of Structures
Department of Civil Engineering
Aristotle University of Thessaloniki
54124 Thessaloniki, Greece
[3] Department of Civil Engineering & Engineering Mechanics
Columbia University
New York, NY 10027, USA
stegesa@mail.ntua.gr, dimitriosavvas@yahoo.gr, mpapadra@central.ntua.gr,
deodatis@civil.columbia.edu

Key words: *Random media, effective properties, level set, XFEM, Monte Carlo simulation*

In this paper, the effective properties of random heterogeneous (two-phase) media with arbitrarily shaped inclusions are computed in the framework of the extended finite element method (XFEM) coupled with Monte Carlo simulation (MCS). The implementation of XFEM is particularly suitable for this type of problems since there is no need to generate a new finite element mesh at each MCS [1]. The inclusions are randomly distributed and oriented within the medium while their shape is implicitly modeled by the iso-zero of an analytically defined random level set function, which also serves as the enrichment function in the framework of XFEM. The analytical function used is a random "rough" circle defined by a set of independent identically distributed (i.i.d.) random variables and deterministic constants governing the roughness of the shape [2]. Homogenization is performed based on Hill's energy condition and MCS. The homogenization involves the generation of a large number of random realizations of the microstructure geometry based on a given volume fraction of the inclusions and other parameters (shape, spatial distribution and orientation). The influence of the inclusion shape on the effective properties of the random media is highlighted. It is shown that the statistical characteristics of the effective properties can be significantly affected by the shape of the inclusions especially in the case of large volume fraction and stiffness ratio.

ACKNOWLEDGEMENT

This work is implemented within the framework of the research project "MICROLINK: Linking micromechanics-based properties with the stochastic finite element method: a challenge for multiscale modeling of heterogeneous materials and structures" - Action "Supporting Postdoctoral Researchers" of the Operational Program "Education and Lifelong Learning" (Action's Beneficiary: General Secretariat for Research and Technology), and is co-financed by the European Social Fund (ESF) and the Greek State. The provided financial support is gratefully acknowledged. M. Papadrakakis acknowledges the support from the European Research Council Advanced Grant "MASTER–Mastering the computational challenges in numerical modeling and optimum design of CNT reinforced composites" (ERC-2011-ADG 20110209).

REFERENCES

[1] N. Sukumar, D.L. Chopp, N. Moës, T. Belytschko, Modeling holes and inclusions by level sets in the extended finite element method, *Computer Methods in Applied Mechanics and Engineering*, **190**, 6183–6200, 2001.

[2] G. Stefanou, A. Nouy, A. Clément, Identification of random shapes from images through polynomial chaos expansion of random level set functions, *International Journal for Numerical Methods in Engineering*, **79**, 127–155, 2009.