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

PROBABILISTIC ANALYSIS OF COMPOSITE MATERIALS WITH HYPERELASTIC MATRICES AND STOCHASTIC INTERFACE DEFECTS

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Key Words: *Probabilistic Homogenization, Hyper-elasticity, Particulate Composites, Generalized Stochastic Perturbation Technique, Monte-Carlo Simulation, Interphase, Interface Defects, Multiscale Approach.*

A major topic of this paper is determination of the effective material parameters of composites with stochastic interface defects in their hyper-elastic mode of strains. This is achieved with a common usage of experiments and probabilistic numerical homogenization. Both experimental tests and computer simulations concern the given particulate composite under uniaxial stretch. This composite consists of high density polyurethane matrix made of Laripur LPR 5020 and 5% of carbon black F60 spherical particles reinforcement. The proposed numerical approach has been prepared using hyper-elastic potential corresponding to the isotropic material, where Mooney-Rivlin, Arruda-Boyce and Neo-Hookean constitutive models have been selected. It introduces a concept of the augmented material model, which describes dependency of the effective material parameters upon the stochastic interface defects geometrical parameters. It is described by a single parameter – the semi-spherical defects volume fraction, which is the only uncertainty source in this model and distributed due to the Gaussian distribution. The interphase of constant thickness surrounding all CB particles in the given cubic Representative Volume Element is assumed to be hyper-elastic also. Computational algorithm for determination of statistical estimators of the input random variable is introduced within a framework of the Stochastic Finite Element Method released using both generalized iterative stochastic perturbation technique as well as the Monte-Carlo simulation. Deterministic part of the FEM system study has been delivered using the system ABAQUS, whereas probabilistic calculus has been performed in the computer algebra system MAPLE 2019. Probabilistic characteristics as well as probabilistic entropies due to the Shannon theory have been computed for the composite effective material parameters, effective strain energies and effective stress under uniaxial stretch.

Acknowledgement
This paper has been written in the framework of the research grant OPUS no 2021/41/B/ST8/02432 entitled "Probabilistic entropy in engineering computations" and sponsored by The National Science Center in Poland.

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