Prediction of Mechanical Properties of Fiber Reinforced Concrete by Means of a Stochastic Multiscale Model

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ABSTRACT

With the aim of establishing a novel computational method that provides higher accuracy with less effort and computational cost than with conventional multiscale methods, a stochastic multiscale computational model for predicting mechanical properties of fiber reinforced concrete (FRC) is proposed [1]. It is based on a statistical second-order two-scale analysis method by introducing a random sample model to predict physical and mechanical properties of random composites. The key point of this model is a two-step homogenization technique, which allows solving the multiscale problem as a micro-meso-macro model.

The model is used to predict mechanical properties of FRC, which is subjected to tensile loading. The multiscale representation of FRC is shown in Fig. 1. On the mesoscale, the heterogeneity of the material is taken into account by a periodic layout of unit cells of matrix-fiber materials, consisting of short fibers and mortar. The material model on the microscale is characterized by a periodic layout of unit cells of matrix-aggregate composite materials consisting of randomly distributed fine aggregate grains and cement matrix. The main task is to determine the elastic modulus and Poisson's ratio of FRC, with glass, carbon, and polymers representing the material of fibers.

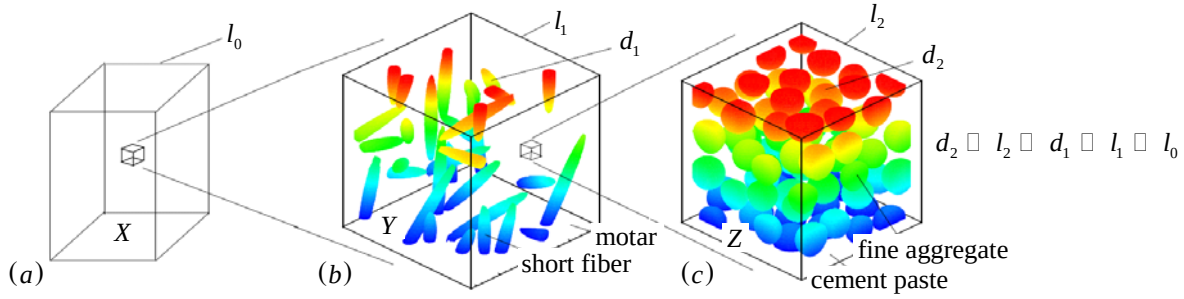

Figure 1. Multiscale represention of FRC: (*a*) macroscale FRC structure X; (*b*) mesoscale unit cell Y; (*c*) microscale unit cell Z

By comparing the obtained numerical results with empirical formulae and experimental results, the proposed stochastic multiscale model was validated. It was shown that this model is effective in predicting the elastic properties of short-fiber reinforced concrete.

REFERENCE

[1] X. Guan, X. Liu, X. Jia, Y. Yuan, J. Cui and H.A. Mang, "A stochastic multiscale model for predicting mechanical properties of fiber reinforced concrete", *Int. J. Solids Struct.* Article in press, http://dx.doi.org/10.1016/j.ijsolstr.2014.10.008.