MECHANICAL PROPERTIES OF RAPID PROTOTYPING COMPOSITE: NUMERICAL MODELING AND PARAMETRIC ANALYSIS

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Abstract

Previous work by the authors [1-3] on rapid prototyping composite (gypsum/epoxy) was done with respect to the experimental characterization of mechanical properties and morphology study. This current paper deals with development of numerical homogenization models, capable to predict mechanical properties of gypsum composite as well as other similar materials with unconnected stiff inclusions (particles) and considerable amount of voids.

Large number of elements was needed to build up 3D representative unit cell (RUC) with realistic particle and void size and shape distributions. Due to numerical complexity, parallel calculations were carried out with the in-house developed FEM code. This code was verified by cross-comparison of some of results with commercial FEM package ANSYS.

The detailed digital model of gypsum/epoxy composite, containing accurate gypsum particle and void distribution was employed as RUC. The SEM micrograph of material along with example of 3D model used in calculations are shown in Fig. 1. The results of numerical modeling were compared with experimental results and predictions of simpler micro-mechanical models. Numerical modeling was also used to perform comprehensive parametric analysis with respect to mechanical properties of composite. Particle content, size and orientation of particles, and porosity (void content, distribution and geometry) were varied. The analysis of modeling results revealed an important role of void location and size distribution which may be related to percolation effects of inter-grain stress transfer.

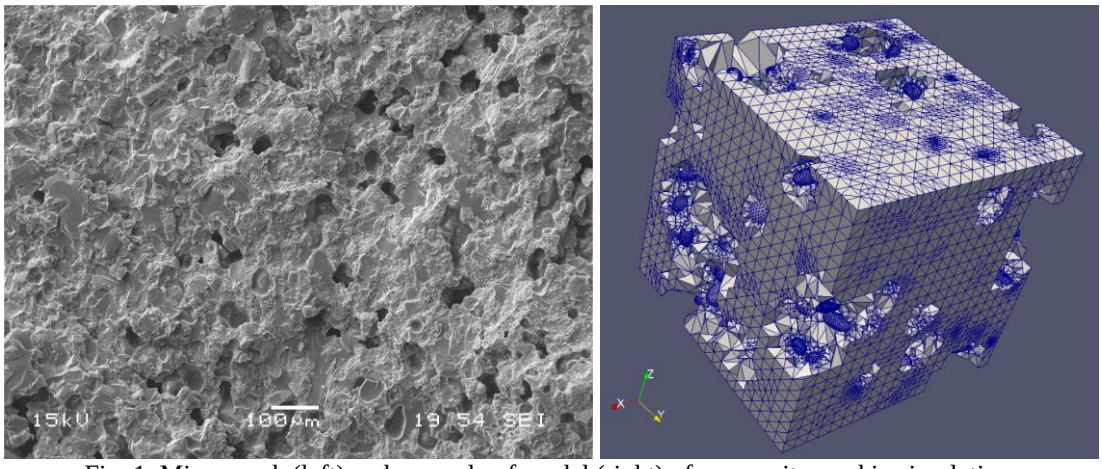

Fig. 1. Micrograph (left) and example of model (right) of composite used in simulation.

References

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