Homogenization-Based Multiscale Modeling of Particulate Composites

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ABSTRACT

Lightweight particulate composites (LPC), incorporating fly ash cenospheres (CS) in calcium aluminate cement (CAC) based materials, offer enhanced thermal conductivity, mechanical strength, sustainability, and cost-effectiveness, fostering improved energy efficiency [1]. Multiscale modeling methods including Computational homogenization FE2, Voronoi cell finite element method (FEM), Fast fourier transform, and Interface stress models excel in accuracy and efficient multiscale modeling, but face challenges in computational demands [2], [3], [4], [5].

Homogenization serves as a key component in the multiscale techniques for heterogeneous materials [6], [7]. Herein is suggested FEM homogenization-based multiscale model tailored for heterogeneous LPC composed of CSs and concrete matrix, allowing to predict effective mechanical and thermal properties with sufficient accuracy and low computational cost. A satisfactory agreement was achieved between the results of the heterogeneous and homogeneous material models. However, validation with experimental results and comparison with analytical methods are anticipated in future research.

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