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Thermo-mechanical coupling analysis of statistically inhomogeneous porous materials with surface radiation by second-order two-scale method

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Abstract

A novel second-order two-scale method is developed to predict thermo-mechanical coupling performance of statistically inhomogeneous porous materials. For these materials, the sophisticated microstructure information of pores, including their shapes, orientations, sizes, spatial distributions, volume fractions and so on, leads to changes of the macroscopic thermo-mechanical properties. Also, radiation effect at microscale is considered in this study which has an important influence on the macroscopic temperature fields. Firstly, the microscopic configuration for the structure with random distribution is briefly characterized by a periodic layout of unit cells. Secondly, the second-order two-scale formulations for computing the thermo-mechanical coupling problems which consider the interaction between temperature and displacement fields are given in detail. Then, the statistical prediction algorithm based on the two-scale model is brought forward. Finally, some numerical examples for porous materials with varying probability distribution models are calculated by the algorithm proposed, and compared with the data by the theoretical method and experimental results. The comparison shows that the statistical two-scale model is validated for determination of the thermo-mechanical coupling properties of porous materials and demonstrates its potential applications in actual engineering computation.

Keywords: Second-order two-scale method; Radiation effect; Statistically inhomogeneous materials; Thermo-mechanical coupling performance

1. Introduction

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