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A multiscale description of particle composites: from lattice microstructures to micropolar continua

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Abstract

We present a two–steps multiscale procedure suitable to describe the constitutive behavior of hierarchically structured particle composites. The complex material is investigated considering three nested scales, each one provided by a characteristic length. At the lowest scale (micro), a periodic lattice system describes in detail the mechanical response governed by interactions between rigid grains connected through elastic interfaces. At the intermediate scale (meso), the material is perceived as heterogeneous and characterized by deformable particles randomly distributed into a base matrix, either stiffer or softer. At the macroscopic scale, the material is represented as a micropolar continuum. The micro/meso transition is governed by an energy equivalence procedure, based on a generalized Cauchy–Born correspondence map between the discrete degrees of freedom and the continuum kinematic fields. The meso/macro equivalence exploits a statistically–based homogenization procedure, allowing us to estimate the equivalent micropolar elastic moduli. A numerical example illustrating the integrated multiscale procedure complements the paper.

Key words: Random composites, multiscale procedures, micropolar continua, lattice microstructures.

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