VERSITA

Acta Geophysica
vol. 62, no. 5, Oct. 2014, pp. 1109-1126
DOI: 10.2478/s11600-014-0228-3

FEM × DEM Modelling of Cohesive Granular Materials: Numerical Homogenisation and Multi-scale Simulations

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Abstract

The article presents a multi-scale modelling approach of cohesive granular materials, its numerical implementation and its results. At microscopic level, Discrete Element Method (DEM) is used to model dense grains packing. At the macroscopic level, the numerical solution is obtained by a Finite Element Method (FEM). In order to bridge the micro- and macroscales, the concept of Representative Elementary Volume (REV) is applied, in which the average REV stress and the consistent tangent operators are obtained in each macroscopic integration point as the results of DEM's simulation. In this way, the numerical constitutive law is determined through the detailed modelling of the microstructure, taking into account the nature of granular materials. We first elaborate the principle of the computation homogenisation (FEM × DEM), then demonstrate the features of our multiscale computation in terms of a biaxial compression test. Macroscopic strain location is observed and discussed.

Key words: multi-scale, FEM, DEM, homogenisation, cohesive granular materials.