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Micro-macro constitutive relations for granular material in the elastic range

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ABSTRACT

Determination of the relationships between microscopic and macroscopic constitutive parameters is a key issue in the use of discrete models for real materials [1]. Results of numerical investigation on micro-macro constitutive relationships in the discrete element model of granular material will be presented. The macroscopic response has been analysed in a series of simulations of the triaxial compression test.

The numerical studies have been focused on the influence of microscopic parameters on the initial deformation characterized by the elastic constants (Young's modulus, Poisson's ratio, bulk modulus and shear modulus). Relationships between the microscopic parameters defining the interparticle contact model (the contact stiffness in the normal and tangential direction and the Coulomb friction coefficient) and macroscopic effective elastic moduli have been established.

The numerical results have been compared with analytical estimations based on the kinematic Voigt hypothesis [2]. It has been shown that that numerical results are close to theoretical predictions for particle assemblies with higher coordination numbers values. Higher coordination numbers are related to more compact specimens and for a given specimen can be associated with low values of contact stiffness and higher confining pressure. The results have also shown that the analytical formulae give good results for particle assemblies in which overall deformation is governed by the elastic deformation at the contact with no or small influence of particle rearrangement.

The results of the present study allow us to understand better micromechanical mechanisms in deformation of granular materials and can be useful in calibration of the discrete element models.

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