# An Extended Continuum Theory for Granular Micromechanics: Influence of Microstructural Parameters

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A micromechanical continuum model is presented for the description of dilatant granular materials with rotating grains considered as peculiar examples of a more general theory of continuums with microstructure, a multifield theory that indicates a wide range of models in which some additional fields have to be introduced to describe the influence of material microstructures on the gross mechanical behavior of continuum bodies [1]. Thus, the kinetic energy, in addition to the usual translational one, is composed of three terms due to microstructural motion; in particular, it includes the rotation of the grains and the dilatational expansion and contraction of the individual (compressible) grains and of the grains relative to each other [2].

The balance and constitutive equations of the medium are obtained by considering it as a continuum with a partially constrained affine microstructure. Moreover, the balance of granular energy is demonstrated to be a direct consequence of the balance of micro-momentum, while the dilatational and the rotational microstresses are turned out to be of different physical nature. Finally, a kinetic energy theorem implies that, locally, the power of all inertial forces is the opposite of the time–rate of change of kinetic energy plus the divergence of a flux through the boundary.

A first application for the study of seismic waves propagating through a sediment-filled basin in the case of rigid granules was made in [3,4]: one of the advantages of the model, compared to purely propagative models, is the reproduction of a nonlinear effect experimentally observed for real seismic waves: the site amplification decreases as the amplitude of the incident wave increases.

The peculiar case of a suspension of rotating rigid granules highlighted the possibility for granular materials to support shear stresses through the generation of micro-rotational gradients [5].

A last numerical example [6] was used to model vertical granular flow and was tested starting from the Goodman and Cowin model [7].

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