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MESO-MECHANICALLY INFORMED DAMAGE-HEALING AND PLASTICITY OF COSSERAT CONTINUUM FOR GRANULAR MATERIALS

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Granular material is a highly heterogeneous medium, consisting of particles and voids and is modeled as discrete particle assembly and porous Cosserat continuum in micro- and macro-scales respectively. A Voronoi cell model representing a typical local meso-structure of heterogeneous granular materials and its evolution is proposed. The model including not only the reference particle laid inside the Voronoi cell but also its intermediate neighboring particles is employed to derive meso-mechanically based macroscopic constitutive relations and constitutive modular tensors of effective Cosserat continuum of granular materials.

The meso-mechanically informed macroscopic plastic work and damage factor tensor to characterize the plastic dissipation and anisotropic damage at a local material point of effective Cosserat continuum for granular materials are identified with no need specifying macroscopic phenomenological plastic and damage criteria and associated evolution laws. The formulations derived to identify the macroscopic plastic dissipation and damage factor tensor along with numerical results also reveal their meso-structural mechanisms, i.e. the relative slide yielding between two particles in contact, loss of contacts, re-orientation of contacts of the reference particle with its intermediate neighboring particles and concomitant volumetirc dilatation of the Voronoi cell. Finally the thermodynamic statement for meso-mechanically informed macroscopic Cosserat continuum of granular materials was presented. The thermodynamic interpolation of the damage-self healing process is given.

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