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Multiscale modeling and characterization of coupled damage-healing-plasticity for granular materials in concurrent computational homogenization approach

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## **ACCEPTED MANUSCRIPT**

**Highlights on "**Multiscale modeling and characterization of coupled damage-healing-plasticity for granular materials in concurrent computational homogenization approach"

- 1. Propose a novel methodology to characterize coupled damage-healing-plasticity for granular materials based on concurrent computational homogenization modeling.
- 2. Derive an incremental non-linear constitutive relation for a discrete meso-structural RVE of granular material.
- 3. Formulate a meso-mechanically informed macroscopic incremental non-linear constitutive relation for a gradient Cosserat continuum model of granular material.
- 4. Define meso-mechanically informed macroscopic anisotropic tensorial damage, healing and net damage factors and plastic strain in the thermodynamic framework
- 5. Propose scalar internal state variables, i.e. densities of thermodynamic net damage energy, plastic energy and total dissipative energy to characterize tensorial damage-healing factors and vectorial plastic strain.
- 6. The effects of damage, healing and plasticity on material failure and structural collapse are comparable.

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