Micro-macro, particles to continuum for landslides

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ABSTRACT The behavior of particulate and granular matter like sand, powder is of considerable interest in a wide range of research disciplines with diverse applications in nature and industry. Particle or granular materials are intrinsically disordered, often come with a wide distribution of particle sizes and materials/mixtures and can behave both solid- or fluid-like. The related mechanisms/processes in particle systems are active at multiple scales (from nanometers to meters) and understanding them is an essential challenge for both science and application, i.e., finding the reasons for natural/industrial disasters like landslides/silo-collapse.

The fundamental micro-mechanics can be modeled with particle simulations, where often the fluid between the particles is important too, as in the case of wave propagation in saturated media [1]. Large-scale applications (due to enormous particle numbers) need to be addressed by coarse-grained models or by continuum theory. To bridge the gap between the scales, so-called micro-macro transition methods are necessary, which translate particle positions, velocities and forces into density-, stress-, and strain-fields. These macroscopic quantities must be compatible with the conservation equations for mass and momentum of continuum theory. Steady state flow behavior for slow/fast, hard/soft, dry/adhesive situations are one aspect [2,3] while the transitions between this fluid-like states and the static states, e.g., at the beginning and ending of a landslide require more complete constitutive relations [4,5]. Furthermore, non-classical fields are needed to describe the evolution of the micro-structure [4] or the statistical fluctuations, e.g., of the kinetic energy [5], before one can reach the ultimate goal of solving application problems.

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