The role of water in case of compaction of granular matter

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The investigation of dry granular matter and their behavior under external force fields and dynamic boundary conditions increases rapidly during the last two decades. However, the typical appearance in nature are wet granular materials, conglomerates or real sediment rocks. Here, the particles are connected by bridges of liquids (water, oil, liquid sulfon) or solids (carbonates, salts). These contacts between neighbored generate an attractive interaction.
Solid bridges stabilize the structure of conglomerates or sediment native rocks so that one may expect a characteristic elastic behavior. The elastic coefficients of such materials will be determined in terms of a perturbation expansion. In order to check the validity of the obtained results, the obtained results are applied on several classes of native rocks and conglomerates. Above a critical stress, solid bridges will be irreversibly destroyed. This leads to characteristic, cascade-like settlement processes, which can be observed in numerical simulations as well as in compaction experiments considering real conglomerates.
In contrast, the particles of wet granular matter are exclusively connected by liquid bridges. Pressure or shear forces may also destroy these bridges, but a further contact leads to a renewal of the liquid bridge. In order to study these mechanisms more explicitly, numerical studies will be presented using a simplified model of wet granular matter. This model considers 10^5 spherical particles in a box with cyclic boundary conditions under the influence of external force fields. The interaction between the particles is of the friction-free hard core type. It is assumed that a bridge generates a nearly constant attraction force between the corresponding particles. Although a rigorous expression for the attractive force can be obtained by analytical investigations, the above mentioned assumption seems to be reasonable for the presented numerical simulations.
Below a critical force, wet matter behaves like a compact solid. Only some few structural rearrangements are observed and the system is fixed finally in a stationary state. On the other hand, wet granular matter is similar to a liquid above the critical threshold. Here, we observe a flow with liquid like properties, e.g. longitudinal and transverse normal diffusion of particles or hydrodynamic flow profiles. This behavior is well known as soil liquidifaction effect.
The crossover between both regimes indicates a self organized critical behavior at the critical shear force. We present various observables, e.g. longitudinal and transverse mobilities, fluctuations of the injected mechanical work, cascade intensities or the segregation of disperse particle distributions, which prove the statement above. Especially at the critical threshold, wet granular matter shows a strange behavior with alternating periods of liquid like dynamics and temporary compaction of the system.