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Impact and relaxation dynamics of wet granular aggregates

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By means of extensive particle dynamics simulations, we investigate the dynamics of granular aggregates composed of spherical particles interacting via elastic, frictional and capillary forces. The capillary forces represent the action of liquid bridges between neighboring particles in the pendular state within a debonding distance. We are interested in the relaxation of the aggregates towards equilibrium either due to the addition of a given amount of liquid to an initially dry aggregate or upon impact with a rigid surface and the influence of system parameters such as liquid-vapor surface tension, debonding distance (reflecting the amount of liquid), friction coefficient, and impact velocity. We show that as the amount of liquid is increased, the relaxation process involves increasingly larger rearrangements of the contact network with non-affine displacements of the particles and a characteristic time controlled by the surface tension. In the same way, the dynamics after impact with a smooth surface implies an initial loss of capillary bonds followed by relaxation towards a larger number of bonds (consolidation) when the impact energy is high whereas for lower energies the aggregate breaks apart and the kinetic energy is partially transported by the fragments (fragmentation). We analyze the combinations of dimensionless parameters that control these regimes.

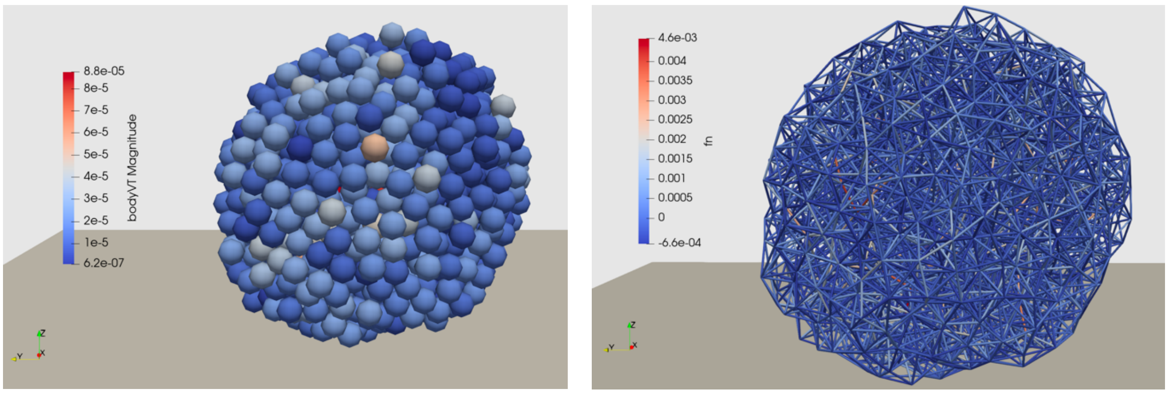

Figure 1 : The tangential velocity magnitude (on the left in m/s) and the normal force chains (on the right in N) during relaxation of an aggregate of wet particles simulated by the discrete element method.