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The contact density to characterize the mechanics of cohesive granular materials: application to snow microstructure modeling.

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Microstructural properties are essential to characterize the mechanics of loose and cohesive granular materials such as snow. In particular, mechanical properties and physical processes of porous media are often related to the volume fraction ν. Low-density microstructures typically allow for considerable structural diversity at a given volume fraction, leading to uncertainties in modeling approaches using ν-based parametrizations only.

We have conducted discrete element simulations of cohesive granular materials with initial configurations which are drawn from Baxter's sticky hard sphere (SHS) model. This method allows to control independently the initial volume fraction ν and the average coordination number Z.

We show that variations in elasticity and strength of the samples can be fully explained by the initial contact density $C = \nu Z$ over a wide range of volume fractions and coordination numbers. Hence, accounting for the contact density C allows to resolve the discrepancies in particle based modeling between samples with similar volume fractions but different microstructures.

As an application, we applied our method to the microstructure of real snow samples which have been imaged by micro-computed tomography and reconstructed using the SHS model. Our new approach opens a promising route to evaluate snow physical and mechanical properties from field measurements, for instance using the Snow Micro Penetrometer (SMP), by linking the penetration resistance to the contact density.