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Microstructure Evolution During Powder Compaction

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ABSTRACT

The process of powder compaction consists of the synthesis of loose powders into a solid material. The applications of compaction of granular systems extend to pharmaceuticals, detergents, food, ceramic and metallurgical processes. It is indispensable to have a thorough understanding of the behavior of confined granular systems during compaction because the performance of the final desired product is related to the microstructural features that develop during the compaction process. To have a more realistic description of the compaction, it is also important to include the packing process of granular systems. However, there are different particle packing algorithms that account for the particle filling process. The Discrete Element Method (DEM) had been used to obtain a dynamic solution to this problem but requires high computational power. As an alternative to the computationally expensive DEM approach, a static based algorithm has recently been developed for the modelling and simulation of the particle packing process. The algorithm allows for the modelling of the packing process by placing spheres inside different shapes and sizes of containers. In this study, we present a new version of the nanoHUB Powder Compaction tool. It currently simulates the microstructure evolution of monodisperse, compressible granular systems up to high relative densities. The tool also models the plastic and elastic deformation of single particles described by different contact mechanics models. The new features use a general particle packing algorithm and thus allow the user to choose a particle size distribution in a specified range for the mean, standard deviation and number of particles to fill the die. The information is passed to the solver that in turn simulates the compaction in Purdue's high-performance computer cluster.

KEYWORDS

Powder compaction, Granular Systems, Simulation, Plastic deformation, Elastic deformation, Particle Size Distribution, Hertz Theory.