Public Abstract
First Name:Xin
Middle Name:
Last Name:Dou
Adviser's First Name:Yuwen
Adviser's Last Name:Zhang
Co-Adviser's First Name:
Co-Adviser's Last Name:
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Particle packing has been studied experimentally and numerically in the recent years due to its wide applications in physics and engineering. Mechanical phenomena and physical properties in granular materials, such as fluid flow, stress distribution and electrical conductivity, and modeling the structure of materials such as liquids, amorphous and ceramic materials, have been studied. Granular packing simulation is usually used to model structures of materials that involved in the industry ranging from manufacturing raw materials to develop advanced products. The impact of particle properties on their packing structures is also of the prime importance to the whole packing process and is always an essential for industry fabrication. A better understanding of packing is beneficial to optimize and improve industrial processes. Generally speaking, packing is a dynamic process that involves contact forces due to the collision, rotation and friction among particles.

In this work, granular packing of particles with three different sizes and three different size distributions (mono-sized, uniform and Gaussian) are simulated using Discrete Element Method. In addition to the contact force, four kinds of forces are considered in the simulations which include two dissipative forces: viscoelastic and frictional force, and two conservative forces: gravity and van der Waals force. The effect of van der Waals force on the packing structure of particles in micro-meter domain has been systematically investigated. The results showed that the effect of van der Waals force is not significant for the particle size and its distributions investigated in this paper. It is also found that even though our model is much simpler than the Hertz History Model, the final packing structure is very similar. Moreover, the tendencies of the force distributions and RDF results are the similar when particles have the same diameter and distribution. The effects of particle size and its distribution are more significant than the force model. In addition, under cohesive effect, packing structures of particles that have different radius and size distributions are also rigorously studied by analyzing RDF and force distribution, porosity and coordination number. The force involved includes normal and tangential contact force, viscoelastic force, friction force generated by collision between particle and particle or particle and boundary, cohesive force which is added through Johnson-Kendall-Roberts (JKR) model and gravity. It can be observed that particles with Gaussian distribution always have the highest packing density while the mono-sized particles have the medium packing density and particles with uniform size distribution normally have the lowest packing density. Besides, clear pattern of packing density cannot be found by changing particle radius. For particle packing under cohesive effect, size distributions always result in the same tendency of packing density while particle sizes do not. Coordination number is basically affected by particle sizes significantly while particle size distribution does not contribute much. Unlike the particle packing without cohesive effect that has a clear trend by changing particle size or distribution, when cohesive effect is added to the system it also gives the system some kind of uncertainty.