Inclined chute flow of rod-like particles using the discrete element method

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ABSTRACT

The Discrete Element Method (DEM) has established itself as the prime numerical technique for simulating many industrial granular flows. The main advantage of the DEM is that it can be used to explore the relationship between macro- and microscopic properties in granular materials.

It is known that the shape of the particles strongly affects the dynamics of granular materials. When examining the effect of the particle shape on granularity, rod-like particles are often used. This is because rod-like particles have been widely used in chemical, pharmaceutical and other industries [1].

The shapes of rod-like particles used in the DEM are roughly classified into glued-spheres and spherocylinder. The glued-spheres model is formed by rigidly connecting spheres in a straight line. The spherocylinder model is a representation of a true cylinder with hemi spherical ends of the same radius. Although significant progress for the dynamics of rod-like particles has been achieved, these investigations have not yet been completed. The glued-spheres model makes it easy to detect the contact between particles. However, the sliding motion between two particles seems to be unrealistic when the two parallel particles are in contact with each other. This is because it is difficult for particles to move in the case of interlocking. The spherocylinder model presents a realistic representation of two parallel particles in contact with each other. However, the linear viscoelastic model is used for the contact force–overlap relation [2]. Since there are many contact patterns for spherocylinders, the relation should be defined in accordance with the contact pattern.

In this paper, an analytical method for spherocylinder model is adapted for the three-dimensional simulation of inclined chute flow. The contact patterns for spherocylinders are divided into six types. Each contact force–overlap relation is defined. The normal component of the contact force acting on the particles is given by the sum of the damping force and the elastic force. The orientation of the particles is represented using quaternion. In the experiment, an assembly of brass cylinders of uniform size was used. The validity of the theory was confirmed by a comparison of experimental and analytical results. In addition, the flow pattern of spehrocylinder particles is presented.

REFERENCES

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