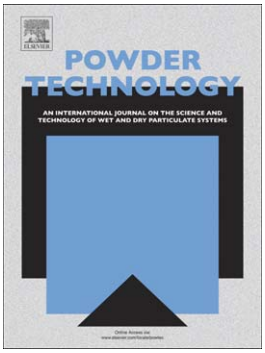

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DEM study of mechanical characteristics of multi-spherical and superquadric particles at micro and macro scales

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Abstract

Multi-spheres and Superquadrics are popular approaches for addressing particle shape effect in the Discrete Element Method (DEM). This study focuses on the mechanical characteristics of cubical particles, modelled by the two methods (using EDEM and LIGGGHTS), through conducting a series of numerical case studies at both single particle and bulk levels. In the first part of the study, several testing scenarios, which clarify the impact, interlocking, sliding and tilting characteristics of the particle, are discussed and the respective simulations are carried out. The results emphasize the importance of surface bumpiness and edge sharpness in the single-particle behaviour and are used for informing the bulk response.

Further, role of the two shape descriptors on bulk response is evaluated in angle of repose, Jenike shear and silo flow simulations. The results of these tests are assessed both at the micro, directly through DEM outputs, and at the meso- and macro- scales, using a coarse graining technique. It is seen that the properties of edge and surface in superquadric and multi-sphere particles considerably influence the heap profile in the angle of repose test. However, in a Jenike direct shear, the shape complexity only significantly affects the shear strength, porosity and mode of motion when the packing is dense. Additionally, in silo discharge, the effect of shape features is even less on the flow pattern and mass flow rate but is found to have a significant influence on the stress distribution.

Keywords: Superquadric, Multi-sphere, Multi-scale, Coarse-graining, Jenike shear tester, Silo

1. Introduction

The growth in computational power has increased the popularity of the Discrete Element Method (DEM) [1]. This powerful numerical tool is now more accessible to both industry and academia for modelling complicated particulate systems. In DEM, the granular material is treated as a system of distinct interacting particles. Accordingly, the velocity, position and contact properties of each particle are tracked individually.

An efficient particle shape representation is a key challenge in DEM. Most DEM codes use spherical particles to

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