

# Particle shape influence on avalanching, packing and shearing response of granular materials

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## ABSTRACT

Particle-scale characteristics govern the behaviour of particulate materials at the macro-scale. An important factor that influences the interaction of individual grains is the particle shape, which generates interlocking affecting the rheology and contact networks in the granular systems [1]. Discrete Element Modelling (DEM) simulations are conducted in this work to determine the influence of particle shape on the mechanical response of granular assemblies at the micro- and macro-scales. The shape factor is addressed by including particles with complex geometries (by means of multi-spheres) and by using spheres together with a rolling resistance model. The main advantage of the latter approach is to have a faster algorithm for contact detection and force calculation. The influence of both approaches has been studied on macro response by means of avalanching, packing and shear strength characteristics.

The considered rolling resistance model is a simple one, which generates an opposing torque by considering the contact normal force, direction of rotational velocity (for single particle) and radius of the sphere. The magnitude of applied torque can be further tuned with a unitless parameter known as rolling friction coefficient [2]. Cylinders, as multi-spheres, are modelled in EDEM software using equal-radius overlapping sub-spheres. The particles consist of 2, 3, 4 and 30 sub-spheres, which leads to variation of the surface bumpiness.

Comparing the obtained results, the ability of the artificial shape representation method (i.e. rolling resistance) to mimic the characteristics of complex shape particles is examined. It is shown that for the angle of repose test, incorporation of the artificial torque for spheres can approximate the avalanching characteristics of the simulated cylindrical particles. Additionally, it is shown that the incorporation of the rolling resistance contributes to formation of looser packings (similar to increase of particle surface bumpiness for cylinders). However, it is seen that this specific rolling resistance model fails to provide comparable packing and shear strength characteristics to that of cylindrical particles.

## REFERENCES

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