Effect of grain morphology on contact behaviour

Sadegh Nadimi* and Masahide Otsubo†

* Geotechnics and Structures (GEST), School of Engineering
Newcastle University
Newcastle upon Tyne NE1 7RU, UK
e-mail: sadegh.nadimi-shahraki@ncl.ac.uk, web page: http://www.ncl.ac.uk

† Institute of Industrial Science
The University of Tokyo
4-6-1 Komaba, Meguro-ku, Tokyo 153-8505, Japan
e-mail: otsubo@iis.u-tokyo.ac.jp, web page: http:// http://www.iis.u-tokyo.ac.jp

ABSTRACT

Real granular systems, such as soil and aggregates, comprise grains with complex irregular shapes and asperities. The importance of grain shape in force transmission has been highlighted in a number of studies and several attempts have been made to include grain shape in Discrete Element Method (DEM) simulations (*e.g.* Houlsby [1]; Ferellec & McDowell [2]). In these studies, the linear or Hertzian contact laws have been considered, although realistic grain-to-grain interaction goes beyond available theories and the geometry of contacts differs significantly from that of two ideal spheres. This study investigates the importance of grain morphology and roughness on contact behaviour.

Otsubo & O'Sullivan [3] proposed a contact law considering the grain roughness. This contact model was developed for DEM simulations using spherical particles, while the actual rough surface was not modelled. On the other hand, Nadimi & Fonseca [4] proposed a µFE model in which µCT images are employed in a combined finite-discrete element framework. The principle of this model is that the accurate contact interactions within the real granular system can be modelled using a finite element representation of the constituent grains deformation. Thus, an accurate and tractable representation of the complex geometries of real grains can be acquired and used to enhance our understanding of stress transmission between grains.

In this study, DEM simulation of irregular Leighton Buzzard (UK) and Toyoura (Japan) sands, represented by clumped spheres, under compression is compared with µFE simulation and experiment. This study highlights the important of developing and choosing appropriate contact laws in DEM simulations.

REFERENCES

[1] Houlsby, G.T., 2009. Potential particles: a method for modelling non-circular particles in DEM. Computers and Geotechnics, 36(6), pp.953-959.
[2] Ferellec, J.F. and McDowell, G.R., 2010. A method to model realistic particle shape and inertia in DEM. Granular Matter, 12(5), pp.459-467.
[3] Otsubo, M. and O'Sullivan, C., 2018. Experimental and DEM assessment of the stress-dependency of surface roughness effects on shear modulus. *Soils and foundations*, 58(3), pp.602-614.
[4] Nadimi, S. and Fonseca, J., 2017. A micro finite-element model for soil behaviour. *Géotechnique*, 68(4), pp.290-302.