# The ‘Signature’ of Particle Geometry - DEM Modelling Perspective

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## ABSTRACT

With the recent advances in the computing resources and modelling techniques, the discrete element method (DEM) has evolved to consider realistic particle geometry for more accurate of interactions between particles and therefore the simulation fidelity of granular material behaviour has been greatly enhanced. However, when it comes to modelling of mineral particles (e.g., for geomechanics problem), a large gap still exists with many questions remain to be better answered. For example, every mineral particle is different in terms of shape and size, how can we model these different particles in DEM? If it is impractical to model all of those, how many shapes do we need to model to make the DEM simulation accurate? Is there a systematic way we can use to identify some representative shapes for DEM modelling? In general, the particle shape changes with size, then how can we effectively model it? This study attempts to answer these questions by developing a new way to find the ‘signature’ of particle geometry.

This study evidences the ‘signature’ is realized by a power-law relationship between the particle surface-area-to-volume ratio (A/V) and the particle volume (V) in a form of $V = (A/V)^{\alpha} \times \beta$. We found the power value $\alpha$ is influenced by the shape-size relationship while the $\beta$ term characterizes the representative particle shape of the granular material. This study then discusses how the particle shape can be retrieved from the power-law ‘signature’ as A and V do not explicitly provide the shape information. To this end, the M-A-V-L concept [1] is introduced which interprets the particle shape (morphology) M as a function of surface area A, volume V, and size L. This concept is instituted with a MArVeLously simple formula, $M = A/V \times L/6$, that enables to estimate the particle shape from the power function with the additional size information L. This study explains the analytical aspects of the power-law relation and M-A-V-L, and examines the idea using a set of example particles to address the DEM modeling questions stated above.

## REFERENCES

[1] Y. F. Su, S. Bhattacharya, S. J. Lee, C. H. Lee, and M. Shin “A new interpretation of three-dimensional particle geometry: M-A-V-L.” *Transportation Geotechnics*, **23**, 100328. (2020).

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