CALIBRATION OF DISCRETE ELEMENT MODELLING PARAMETERS FOR BULK MATERIALS HANDLING APPLICATIONS

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Abstract

The Discrete Element Method (DEM) models and simulates the flow of granular material through confining geometry. The method has the potential to significantly reduce the costs associated with the design and operation of bulk materials handling equipment. The challenge, however, is the difficulty of determining the required input parameters. Previous calibration approaches involved direct measurements and random parameter search. The aim of this research was to develop a sequential DEM calibration framework, identify appropriate calibration experiments and validate the framework on real flows in a laboratory-scale silo and chute.

A systematic and sequential DEM calibration framework was developed. The framework consists of categorising the DEM input parameters into three categories of determining the directly measured input parameters, obtaining the literature acquired input parameters, and linking physical experiments with DEM simulations to obtain the calibrated parameter values. The direct measurement parameters comprised the coefficients of restitution and the particle to wall surface coefficient of rolling friction. Literature obtained parameters were the Young's Modulus and Poisson's ratio. The calibrated parameters comprised the particle to wall surface coefficient of sliding friction calibrated from the wall fiction angle, the particle to particle friction coefficients (sliding and rolling) calibrated from two independent angles of repose, particle density calibrated from bulk density, and adhesion and cohesion energy densities. The framework was then tested using iron ore with a particle size distribution between +2mm and - 4.75 mm in LIGGGHTS DEM software.

Validation of the obtained input parameter values in the silo and chute showed very good qualitative comparisons between the measured and simulated flows. Quantitative predictions of flow rate were found to be particularly sensitive to variations in the particle to particle coefficient of sliding friction. It was concluded that due to their inherent limitations, angle of repose tests were not totally reliable to calibrate the particle to particle coefficient of sliding friction.

Sensitivity tests conducted showed that in the quasi-static flow regime, only the frictional parameters were dominant, while both the frictional and collisional parameters were dominant in the dynamic flow regime. These results are expected to lay a solid foundation for further research in systematic DEM calibration and greatly increase the effectiveness of DEM models in bulk materials handling applications.