A Discrete Element Analysis of Cohesive Granular Bulk Solid Materials

Liz I. Del Cid*, and Graham Mustoe

* Department of Mechanical Engineering
Colorado School of Mines
1500 Illinois Street, Golden Colorado 80401
e-mail: ldelcid@mines.edu, web page: http://www.mines.edu/

ABSTRACT

In bulk handling applications, such as conveying and storage, understanding the effect cohesion has upon the flow-ability of particulate systems at the macroscopic scale is crucial in increasing the avenues of operation unit design improvements and handling scenarios of industrial operational units. This research provides a better understanding of the role cohesion has on the flow-ability of macro materials through the development, implementation and application of a macroscopic elasto-plastic adhesive (MEPA) contact model within an open source general purpose Discrete Element Method (DEM) computer code.

This paper outlines the development of a DEM contact law which can model stress history dependent strength behavior and predicted particulate flow. The research tasks in this work are focused in three major areas: 1) cohesive function applications from powders to bulk solids, 2) modeling stress history dependency of cohesive strength, and 3) flow properties test applications comparable to experimental results.

For a given bulk handling application, adequately capturing the DEM simulated behaviour of cohesive solids is crucial when evaluating is handleablility. A number of DEM cohesive contact laws are available, however, these do not demonstrate the stress history dependency behavior observed in bulk solids. A study of the available theoretical cohesive models revealed that most of these models were focused in simulating the effects of cohesion in powder systems. A major shortcoming of these available models is the iterative parametric scaling needed to represent cohesive-like behaviour. The cohesive models discussed in this paper are those that are most pertinent and most often applied commercially in bulk solids.

Simulating the handling difficulties caused by cohesion, it is apparent that modeling stress history dependency is crucial in consolidated materials with high cohesive strength potential. The investigation proposed a DEM history dependent contact model that accounts for both elastic and plastic contact deformations and adhesive attractions. The efforts generated a three branched non-linear model represented by virgin compaction loading, unloading/reloading and adhesion [1, 2].

The culmination of this research is the DEM cohesion contact model developed and implemented for granular materials in bulk solid handling applications. The model simulates the shear strength of cohesive particulate materials as defined by the Mohr-Coulomb shear failure criterion of various physical flow property test results.

REFERENCES

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