Validation of a nonsmooth discrete element method by confined compression and rod penetration

D. Wang* and M. Servin†

* Department of Physics / UMIT Research Lab
Umeå University, SE-90187 Umeå, Sweden
e-mail: da.wang@physics.umu.se,
web page: http://www.org.umu.se/umit

† * Department of Physics / UMIT Research Lab
Umeå University, SE-90187 Umeå, Sweden
e-mail: martin.servin@physics.umu.se,
web page: http://www.org.umu.se/umit

ABSTRACT

The nonsmooth discrete element method (NDEM) [1-2] is an alternative to the conventional smooth discrete element method (DEM). In the nonsmooth approach the contacts are modelled using constraints and impulses, which allows for velocity discontinuities and instantaneous force propagation throughout the system and thus making large time-step integration possible. The method may result in fast simulations, including realtime simulators with heavy machinery [3] and large-scale granular matter flow simulation for exploring the design space of balling drum outlets [4] used in mineral ore pelletization.

We present results for the validation experiements described in Ref. [5] and [6] of bulk behaviour under confined compression and rod penetration. We use the NDEM regularized with the nonlinear Hertz contact law, referred to as semismooth DEM in Ref. [1], that allows modeling of the microscopic properties particle elasticity, restitution coefficient, contact friction and rolling friction. The simulation results are compared to measurements from experiments and DEM simulation provided in [5] and [6]. The dependency on NDEM solver choice and parameters, such as size of time-step and number of iterations, are investigated.

REFERENCES

[1] Servin, M., Bodin, K., Lacoursière, C., Wang, D., *Examining the smooth and nonsmooth discrete element approach to granular matter, s*ubmitted for publication (2013). http://umit.cs.umu.se/granular/dem

[2] Radjai, F., Richefeu, V., Jun, *Contact dynamics as a nonsmooth discrete element method,* Mechanics of Materials 41 (6), 715–728 (2009).

[3] C. Lacoursière, M. Servin, A. Backman , *Fast and stable simulation of granular matter and machines*, DEM5 - The Fifth International Conference on Discrete Element Methods, London 25-26 Aug (2010). http://umit.cs.umu.se/modsimcomplmech/docs/papers/faststable2010.pdf

[4] D. Wang, M. Servin, K.-O. Mickelsson, *Outlet design optimization based on large-scale nonsmooth dem simulation*, Submitted for publication (2013). http://umit.cs.umu.se/granular/outlet

[5] Chung, Y. C., Ooi, J. Y., *Influence of Discrete Element Model Parameters on Bulk Behavior of a Granular Solid under Confined Compression*, Particulate Science and Technology, vol. 26 (1) p. 83-96 (2007)

[6] Chung, Y. C., Ooi, J. Y., *Confined Compression and Rod Penetration of a Dense Granular Medium: Discrete Element Modelling and Validation*, in Modern Trends in Geomechanics, ed. W. Wu and H-S. Yu, Springer Berlin Heidelberg, Vol. 106, p. 223-239 (2006).