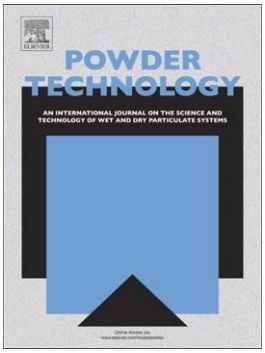

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Binary Collision Outcomes for Inelastic Soft-sphere Models with Cohesion

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Abstract

We present an in-depth study on the restitution coefficient and sticking behavior of two models commonly used in the Discrete Element Method (DEM) community for simulating fine cohesive powders. The cohesion in this study is the result of the van der Waals force and is added to commonly used contact force models. We obtain a collapse of the restitution behavior depending on four independent non-dimensional variables governing the dynamics of the system, and a quantitative model for the restitution behavior is presented. Additionally, the physical validity of the DEM models under consideration is shown to be governed by the Tabor parameter, commonly used in the surface science community. If the Tabor parameter is too large such models are not applicable, in a physical sense, and a theory for compliant contacts is needed. We show that the Tabor parameter can be cast in terms of non-dimensional quantities used by the DEM community, and depends on particle stiffness. While softer particles are often used to reduce temporal resolution requirements, we find particle restitution and sticking become sensitive to spring stiffness. This is particularly evident at stiffnesses near the physical validity limit set by the Tabor parameter. Generally, we find that particle stiffness appears to decrease the dissipation of energy in the presence of cohesion. Large differences in restitution and sticking behavior are discussed in the presence or absence of a short-ranged attractive well. Lastly, the effect of restitution on rheological regime transitions in sheared cohesive assemblies is addressed, where a transition from inertial to quasistatic stress scaling occurs. The occurence of the transition correlates excellently with the transition from restituting to sticking behavior. This study demonstrates, echoing fluidization studies by several authors, that un-

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