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Discrete Element Contact Stiffness of Granules with Rough Surfaces

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In this study, surface characteristics of granules are accounted for in macro-contact modeling of interactions between spherical particles. Statistical analysis of surface topography parameters is performed on scanning probe and electron measurements, from which: (1) an extended Hertzian normal contact is characterized per the characteristics of surface roughness and waviness on the contact surfaces under compression; (2) Tangential compliance (per Mindlin's theory) is assessed in association with nominal normal contact stiffness, which in turn, controls stick-slip friction phenomena during sliding; and, (3) Scale-dependent friction limits over a selected range of wavelengths is estimated using adhesive bond friction theories. As an application, surface topography parameters are determined for ceramic spheres via statistical characterization of two-dimensional surface profiles. The profiles are described as isotropic Gaussian random fields, which derive from power spectral density functions of asperity for height distribution, density, and mean radius. Finally, the macro contact model of rough surfaces is used in performing LS-DYNA® discrete element simulations of granule-to-granule contact phenomena, which are substantiated by (macroscopic) physical test data.

Keywords: Normal contact of rough surfaces, Contact stiffness, Asperity height distribution, Discrete element analysis