15th World Congress on Computational Mechanics (WCCM-XV)
8th Asian Pacific Congress on Computational Mechanics (APCOM-VIII)
31 July–5 August 2022, Yokohama, Japan

Avalanching of variously shaped DEM particles in a rotating drum

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Key Words: DEM, avalanche, rotating drum, shape effects, non-convex particles

In the majority of particle simulation methods, round particles still dominate, while in actual granular materials, the particles are angular or even non-convex. Attempts to enforce "realistic behavior" with unrealistically high coefficients of rolling friction (e.g. [1]) do not necessarily result in a realistic dynamics for moving particles.

In this research, we compare how assemblies of "round", irregular convex and non-convex particles behave with respect to avalanching in a two-dimensional rotating drum using a polygonal discrete-element method based on [2]. Round particles are modelled as regular convex polygons with a high number of corners, but the differences to the ideal round shape are negligible. Solid friction is implemented via the "numerically exact" Differential-Algebraic-Equation formulation [3].

All things being equal, we find that aggregates of round particles are clearly distinguishable from aggregates of non-round particles – whether convex or non-convex – in a parameter space describing the whole of the aggregate, as well as in the behavior of avalanches, due to the differences in particle mobility and strength of solid friction. On the other hand, the deviations in the behavior between aggregates of irregular convex and non-convex particles are less marked. We find differences in the angle of marginal stability, as avalanching starts at a higher slope angle for non-convex particle aggregates compared to aggregates of convex particles, but both mixtures revert to the same steady-state angle after an avalanche. We see further differences between convex and non-convex particles in the distribution of the phasespace trajectories of the bulk center-of-mass, where the translational and the rotational energy as functions of the center-of-mass height form more compact cycles for convex than for non-convex particles, while for round particles the cycles are compact with little dependence on the drum rotation.

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