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# BEARING CAPACITY OF GRANULAR MATERIAL IN LOW-GRAVITY: IMPLICATIONS FOR LANDING AND MOVING ON ASTEROID SURFACES

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In October 2020, the OSIRIS-REx spacecraft performed a successful touch-and-go (TAG) sampling maneuver on the regolith-covered surface of asteroid Bennu. A preliminary review of the spacecraft's telemetry suggests that the sampling event lasted longer than expected, and that the sample collector met little resistance as it penetrated deep into the seemingly cohesionless surface material [1]. Regolith properties like grain size and shape, cohesion, internal friction and bulk strength will influence important outcomes like how much a lander sinks into a surface, how easily a rover gains traction on a surface, and how much (or how little) resistance is felt by a sampling mechanism. Designing and operating surface systems for small-body missions is particularly challenging, because engineers have to make critical assumptions regarding the materials that they expect to encounter during a mission and also predictions regarding how the regolith will respond to perturbations in micro-gravity.

Recent experimental results have indicated that granular materials behave differently in micro-gravity conditions. For example, compared to terrestrial gravity conditions, the inter-particle frictional forces are reduced [2], the force contact network may be weaker [3], and granular materials behave more like a fluid [4, 5]. These experiments support the notion that granular flow in reduced-gravity is dominated by a hydrodynamic regime rather than a frictional regime. If this is true, then the relative absence of a quasi-static state will influence the vertical bearing capacity of regolith material on asteroid surfaces.

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Here, we use the soft-sphere Discrete Element Method in Chrono [6] to perform numerical simulations and explore the importance of gravity in the reponse of a granular material to vertical loading. We study the sinkage of a plate and a sphere into a container filled with cohesionless particles under different gravity levels. We present the results in terms of existing collision theories and sinkage models. We also discuss the implication that of our findings have on the design and operation of landers and instruments for future asteroid missions.

**Comments:** Oral presentation preferred. The presenter works in Central European Time. Please take this into account when planning the presentation times. If possible, please schedule this presentation after the presentation of Drilleau et al.

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