Aerospace Engineering Thesis Defense

Validating Granular Scaling Laws for Wheels/Screw Geometries

School for Engineering of Matter, Transport and Energy

Teresa McBryan
Advisor: Hamidreza Marvi

Abstract

Building and optimizing a design for deformable media can be extremely costly; however granular scaling laws enable the ability to predict system velocity and mobility power consumption by testing a smaller scaled system in the same environment. The validity of the granular scaling laws for arbitrarily shaped wheels and screws were evaluated in materials like silica sand and BP-1, a lunar simulant, using different wheel geometries 3D printed in ABS such as non-grousered wheels, straight grousered wheels, bihelically grousered wheels, and screws Using the granular scaling laws and the empirical data from initial experiments, power and velocity were predicted for a larger scaled version then experimentally validated on a dynamic mobility platform. Consistency in testing methodology is particularly important when working with granular media due to the high variability in material properties depending on initial environment conditions. Through experiments these scaling laws have been validated; however through vigorous testing, use cases and limitations have also been found. As slip begins to increase, the scaling laws lose accuracy in effective predictability. The cause of this increase in slip is likely due to a lack of full engagement of the wheel/screw geometry with the granular media influenced primarily due to factors such as mass.

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