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Jason P. Marshall, Ryan C. Hurley, Dan Arthur, Ivan Vlahinic,
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Failures in Sand in Reduced Gravity Environments

Jason P. Marshall[a], Ryan C. Hurley[a,d], Dan Arthur[a], Ivan Vlahinic[a], Carmine Senatore[b], Karl Iagnemma[b], Brian Trease[c], José E. Andrade[a,*]

[a] *Mechanical and Civil Engineering Department, California Institute of Technology, Pasadena, CA, USA*
[b] *Department of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, MA, USA*
[c] *Department of Mechanical Engineering, University of Toledo, Toledo, OH, USA*
[d] *Present address: Lawrence Livermore National Laboratory, Livermore, CA 94550, USA.*

Abstract

The strength of granular materials, specifically sand is important for understanding physical phenomena on other celestial bodies. However, relatively few experiments have been conducted to determine the dependence of strength properties on gravity. In this work, we experimentally investigated relative values of strength (the peak friction angle, the residual friction angle, the angle of repose, and the peak dilatancy angle) in Earth, Martian, Lunar, and near-zero gravity. The various angles were captured in a classical passive Earth pressure experiment conducted on board a reduced gravity flight and analyzed using digital image correlation. The data showed essentially no dependence of the peak friction angle on gravity, a decrease in the residual friction angle between Martian and Lunar gravity, no dependence of the angle of repose on gravity, and an increase in the dilation angle between Martian and Lunar gravity. Additionally, multiple flow surfaces were seen in near-zero gravity. These results highlight the importance of understanding strength and deformation mechanisms of granular materials at different levels of gravity.

Keywords: granular material, shear bands, failure, reduced gravity

*Corresponding author: jandrade@caltech.edu