Site Preparation Tooling for Operations on Mobility Platforms (STOMP) M. A. Gudino[1], E. A. Bell[2], B. H. Burdess[3], C. J. Clark[4], [1]NASA Kennedy Space Center Swamp Works, Mail Code: NE-L6, KSC, FL 32899 (marco.a.gudino@nasa.gov), [2]NASA Kennedy Space Center Swamp Works, Mail Code: NE-L6, KSC, FL 32899 (evan.a.bell@nasa.gov), [3]NASA Kennedy Space Center Swamp Works, Mail Code: NE-L6, KSC, FL 32899 (benjamin.h.burdess@nasa.gov), [4]NASA Kennedy Space Center Swamp Works, Mail Code: LAS080, KSC, FL 32899 (casey.j.clark@nasa.gov)

Introduction: Swamp Work's RASSOR 2 [1] is a Technology Readiness Level (TRL) 4 lunar rover that has proven capabilities of maneuvering through multi-terrain regolith surfaces and manipulating bulk regolith. Additionally, Swamp Work's Multipurpose End-Effector for Regolith Construction, Acquisition, and Transfer (MEERCAT) [2] is a TRL 5 regolith compaction tool that has proven regolith compaction capabilities; however, it is designed for small-scale site preparation demonstrations as an end-effector on a robotic arm. Currently there is not a high TRL technology capable of compacting large areas of lunar regolith. STOMP is a roller compactor that utilizes RASSOR 2's mobility platform to demonstrate digging, dumping, and compacting bulk regolith on the lunar surface.

Attachment of the STOMP compactor will occur by way of a modular disconnect system (MDS) interface that was developed under the FY24 Independent Research & Development (IRAD) project titled Modular Interface for CLPS Excavators (MICE) and Quick Attach Docking Interface for Lunar Electric Rover [3]. The roller will be designed to match current dimensions of the bucket drums of RASSOR 2 to maintain full mobility capabilities.

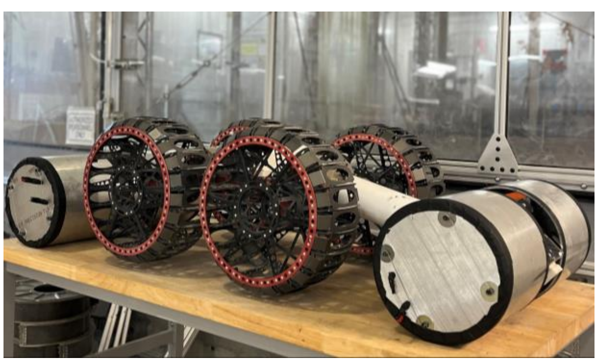


Figure 1. RASSOR 2 Mobility Platform with STOMP "Alpha" Roller Compactor

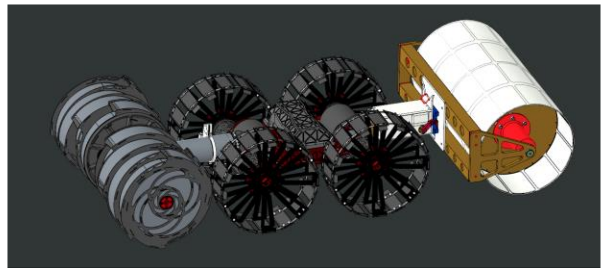
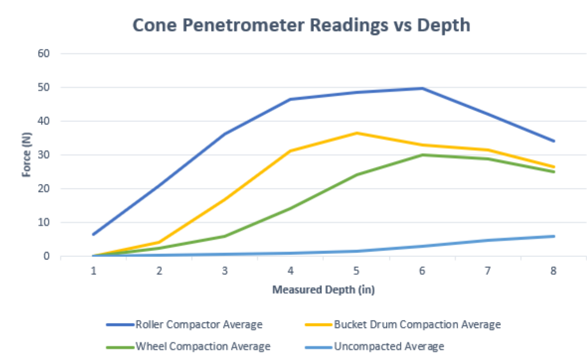


Figure 2. RASSOR 2 with STOMP Compactor (White and gold hardware). The interface connecting RASSOR 2 and the compactor is MDS, a quick attach that also passes power through.

Preliminary Testing: Preliminary testing is underway and will continue throughout March 2025. Figure 1 shows the "alpha" roller compactors that are being used to drive final design decisions and ensure feasibility of the final concept . The alpha compactor utilizes commercial off the shelf vibratory actuators at a fixed frequency of 60 Hz and force output of 50 lbs. These preliminary compaction runs have shown vibratory roller compaction is significantly more effective than compaction via driving over the surface with wheels and bucket drums without vibratory actuation.



	Uncompacted	Wheel Compaction	Bucket Drum	VbRC (5 passes)	VbRC (10 passes)
Pocket Pen Average Force (KPA)	1.505	1.505	1.577	1.742	1.716
Average Relative Density (%)	49.3%	49.3%	61.4%	85.4%	82.0%

Figure 3. Results from preliminary tests. The plot shows force readings from the cone penetrometer and the table shows calculated relative density. The results show the vibratory roller compactors cause a higher force reading and average relative density.

Testing: Testing will be conducted in the Granular Mechanics and Regolith Operations' (GMRO) BP-1 "Big Bin" from March to May 2025. To demonstrate improvement of lunar terrain, RASSOR 2 will level an area including high and low topology using the existing RASSOR 2 excavator bucket drums, grade the surface using the bucket drums, and then perform compaction of the terrain and final leveling using the STOMP compaction system. The density of the surface will be measured directly and indirectly using core samples, pocket penetrometer readings, and cone penetrometer force readings. Measurements will be recorded after initial bucket drum grading, between compaction passes, and after final compaction and grading. Compaction measurements will then be compared to that of current state of the art technologies such as MEERCAT and compaction via RASSOR 2's wheels and bucket drums. Power usage will also be reported based on current draw and battery usage. Surface roughness will be measured and reported. This test will demonstrate the RASSOR 2 platform is capable of a multitude of construction tasks, including compaction on the lunar surface, and demonstrate that the MDS interface is capable of mechanically and electrically connecting implements.

References: [1] Gill, T. R., and Mueller, R., "RASSOR - Regolith Advanced Surface Systems Operations Robot," NASA/TM-2015-20150022134, NASA Kennedy Space Center, Cocoa Beach, FL, November 17, 2015. Available: https://ntrs.nasa.gov/citations/20150022134. Available: https://ntrs.nasa.gov/citations/20150022134. [2] Bell, E., Bidot, E. J., Gelino, N. J., and Mueller, R. P., "Multifunctional End Effector for Regolith Construction, Acquisition, and Transfer (MEERCAT)," NASA/TM-2024-20240004381, presented at ASCE Earth & Space 2024, Miami, FL, April 15–18, 2024. Available: https://ntrs.nasa.gov/citations/20240004381. [3] Schuler, J. M., Nick, A. J., Calvert, T., Hirsh, R. S., and Immer, C., "Quick Attach Docking Interface for Lunar Electric Rover," NASA/KSC-2009-302, NASA Kennedy Space Center, FL, 2009. Available: https://www.lpi.usra.edu/lunar/artemis/SchulerEtAl_NASA-KSC-2009-302_LERdockinginterface.pdf.