National Aeronautics and Space Administration

# Assessment of Terrain Trafficability using the M2020 Abrading Bit

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**Program:** Topical

## Project Objective:

The objectives of this Spontaneous R&TD are:

1. To assess the feasibility of using the M2020 abrading bit to take terrain strength measurements in Jezero crater.
2. To develop a statistical model of *traversability* as related to terrain strength and vehicle design
3. To develop a procedure by which measurements made in flight can be used to create a first-of-its-kind Mars analogue for mobility, sampling, and ISRU research

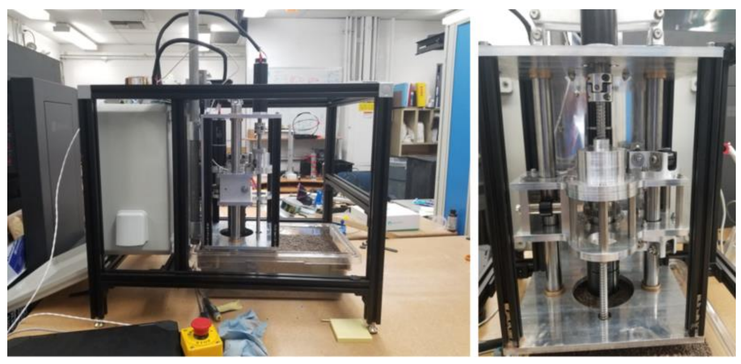
## FY18/19 Results:

Results obtained in Y1 suggest that the abrading bit is capable of making the measurements desired. Preliminary analysis shows a correlation between applied normal load and requires shear stress to fail materials. The methodology has been shown to be able to distinguish between the five simulants used, which indicates a quantitative capability has been achieved.

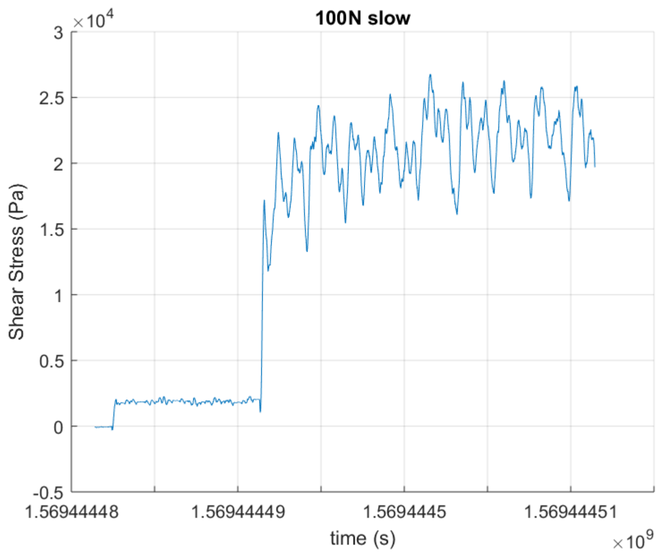
In FY20, the team will continue to refine the manner with which geotechnical parameters are obtained. Of particular interest are the effect of spindle speed on the obtained results and the effect of current estimation on repeatability.

In FY20 the team will accompany the RoboSimian robot to Death Valley for extensive field trials and an attempt to quantify the relationship between material strength and observed rover performance.

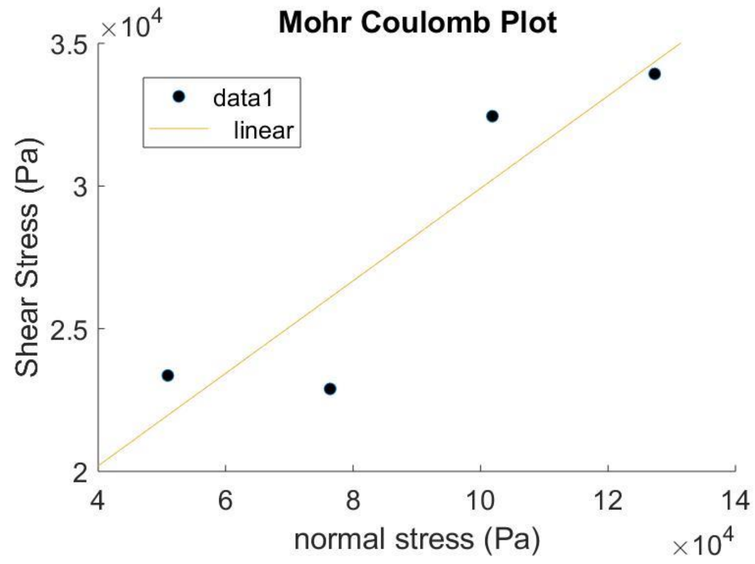
## FY18/19 Results:



Testbed built in Y1. Currently ondergoing evaluation of five Mars terrain simulants in Bldg.107




Shear stress measurement on MMS Intermediate




Example Mohr-Coulomb plot for loose, unconsolidated material

## Benefits to NASA and JPL (or significance of results):

**Background**

Spirit, Opportunity, and Curiosity have all been placed at risk of immobilization on sandy terrains (Spirit's entrapment, Opportunity at Purgatory, and Curiosity at Hidden Valley). On loose sandy terrains, rover performance is limited not by wheel torque by by the strength of the terrain and its ability to support locomotion. An instrument to measure the strength and spatial variation of Mars' regolith has never flown; as primarily an engineering instrument, such a device would consume mass and volume otherwise available for science payloads. This has precipitated the use of anecdotal evidence and posteriori curve-fitting as the state of the art, which lacks predictive capability.

**Benefits of proposed solution**

The results of this study, if transferred into flight, hold promise in three areas: 1) *in situ* measurements of terrain strength can lead to greater operational understanding of traversability risk, 2) ascertaining the strength of loose material in Jezero Crater may be used to inform the design of the fetch rover, and 3) JPL may be able to produce the first systematically developed Mars analogue for mobility, sampling, and ISRU applications.

**Future work**

In Y2 of this task, we will quantify the accuracy and repeatability of measurements using the abrading bit. We will perform tests on five material types and reference them against results obtained using standard geotechnical equipment. We will take the four-wheeled RoboSimian robot out to Death Valley for field trials and relate terrain strength measurements to vehicle performance. Finally, the statistical model developed in Y1 will be refined and used to determine is a statistical quantification of traversability is possible using this method.

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**Poster No.**