2018-2019 EXCEL Program

Experimental Investigation of Regolith Granular Material Properties

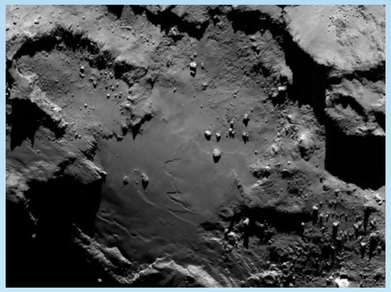
John Hatchitt, Alex Madison, Dan Remie, Mariana Mendonca, Julie Brisset

Florida Space Institute

BACKGROUND

Moons, asteroids, and comets are covered in a layer of dust called regolith. In order to understand how this regolith shapes the surfaces of these bodies and how we can interact with them, we need to measure its internal friction, compressive and shear strengths. The objective of this project is to measure these values for grains of regolith simulant, which are representative of the granular material that can be found at the surface of asteroids. Ultimately, the measured values will be used in numerical simulations in order to reproduce the size scales and conditions present at the surface of real asteroids. The project includes three main tasks:

- (1) The preparation of simulant grains and the measurement of their angles of repose depending on the grain size;
- (2) The measurement of the compression strength of large number of grains using an already existing measurement setup;
- (3) The measurement of their shear strength.



Surface of an Asteroid

Learning about the surface properties helps:

- Finding safe touchdown zones for landers.
- Understand the surface features.

OBJECTIVE

The objective of this project is to measure the soil properties value (internal friction, compression, and sheer strength) for grains of regolith simulant, which are representative of the granular material that can be found at the surface of asteroids.

MATERIALS & METHODS

Preparation of Grains

- CI Orguiel Simulatin (Covey et al. 2016)
- 3 size distributions
  - Small: 1-6mm
  - Large: .6-1.5 cm
- Grain Porosity: ~ 0.24 +/- 0.02
- Grain compressive strength ~ 75 +/- 44 N

Compression Testing

- We prepare 3 kilos of grains
- Target porosity of .46 +/- .02
- We use a force sensor in vertical compression measurement of target material resistance in compression.

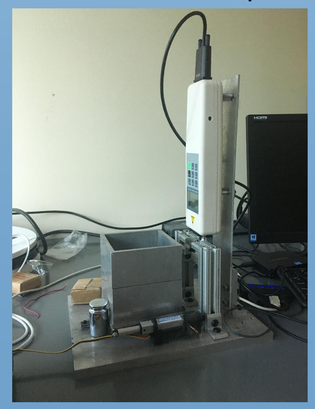
Shear Testing

- two force sensors
- two cups each with a volume of 28.125 cubic inches
- A linear actuator and a rail and carriage system
- Measurement of target resistance in sheer

Angle of Repose in regolith

Grain sorting

Compression Testing



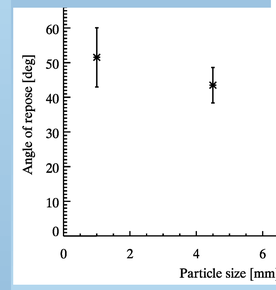
Shear Box

RESULTS

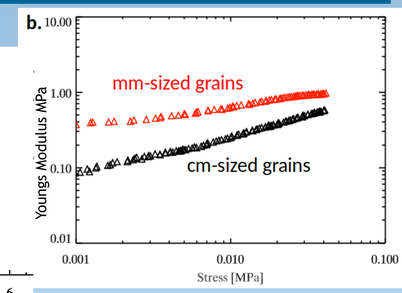
We are measuring the angle of repose for various grain sizes (see angle of repose figure) and are able to quantify the increased cohesion of smaller grains compared to larger grains.

We measure Young's modulus from our compression test and we see a higher Young's modulus for smaller grains which means they are stronger as a granular material.

We just started measuring shear, we are measuring stress strain curves which allow us to quantify the shear strength of the different granular materials.



Angel of Repose



Compression Tests

CONCLUSIONS

Cohesion of larger grains is much lower than for smaller grains. For very low gravity environments and a rotating asteroid this could lead to grain lifting from the surface of asteroids as seen on asteroid Bennu by the Osiris-Rex.

The asteroid Bennu