BLASTRO!DS MICROGRAVITY TEAM

ASTEROID REGOLITH SIMULANT DESIGN AND DEVELOPMENT

Cameron Wichman | Christopher Brown | Endi Leonardo | Jashan Grewal | Kate Williams| Nishigandha Kelkar

Abstract

This project involved the creation of three different types of asteroid simulants C-Type, M-Type and S-Type. The purpose of creating these asteroids simulants were to realistically test asteroid mining tools. Three containment units, called test bays, held the asteroid simulants composed of their respective mineral composition. The structure was designed to withstand any stresses the core drill might impose while in NASA's neutral buoyancy lab with a safety factor of three.

Containment bay without asteroid simulants (right) and containment bay after completion of testing (left).

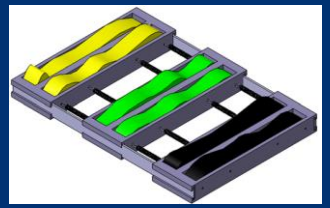
Objective

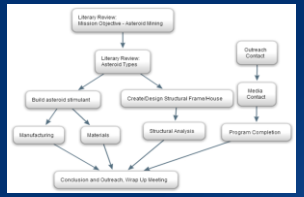
Asteroids may comprise an abundance of raw materials that could be advantageous to Earth projects and space exploration. Asteroid materials found in S- and C- type asteroids can be used for propellant of space vehicles. M-type asteroids have valuable minerals such as platinum and rhodium. The team's objective for creating asteroid simulants is to successfully help NASA test their prototype core drill. By providing NASA with a realistic asteroid simulant, they can ultimately discover problems with real asteroid mining.

Spectral Type	Similar Meteorite	Resources	Purpose
Type C	Carbonaceous Chondrite	Water, Metal, Organic Compounds	Rocket propellants and other consumables for Space missions + metal for 3D printing of hardware to use in space+making Rubber or plastic or methane for rocket fuel + CO2 for plants
Type S	LL chondrite	Platinum Group Metals	For use in earth applications
Type M	Iron Meteorite	Metals including platinum group metals	Manufacturing large hardware items in space for Colonization or larger missions and/or for sale on Earth

Project Outline

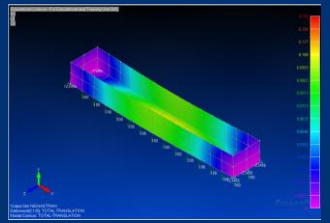
For the experimental testing stage, three types of asteroids of varying age characteristics were placed within a structural frame comprised of three bays as shown in the figure below. These sample asteroids were composed mainly of silicates such as feldspar and quartz. Using these asteroid regenerations, NASA fully tested their asteroid mining tools in a myriad of environments; thus, determining whether the tools would operate optimally and beneficially on a realistic reduced gravitational setting.





Testing

The structure in its entirety consisted of three individual 14 x 42 x 5.25 inch target bays that were bound to one another by three metallic, extension springs in consideration for acoustic disturbances. In an effort to reduce the overall weight of the structure without greatly reducing its structural integrity, the siding of each bay was comprised of 1 inch thick Douglas Fir while 6061-T651 Aluminum Plate (0.25-0.5 inch thick) was used for each base plate of the bays.



Starting Differential	Boundary Conditions
$a\frac{d^2u}{dx^2} + b = 0$	$u\|_{x=0} = 0$
	$u\frac{du}{dx^2}\|_{x=2L} = R$

Nei Nastran is a finite element analysis solver used to generate approximate solutions for both nonlinear and linear stresses, dynamics, and heat transfer characteristics of a specified structure. Implementing differential equations and the associated structural boundary conditions this software segments the model into "N" number of finite elements and the individual analysis of these elements are combined to produce the a more accurate approximation for the structure in its entirety.

Future Implication

A better understanding of asteroid various structures and composites will be achieved allowing the furthering of microgravity research involving core drilling. The data gathered will provide a conclusion on the drill efficiency to collect asteroid material as well as dangers presented by having loose debris so close to the drill operator. After collecting data on the exit patterns of the debris in a microgravity environment an appropriate capturing device can be designed to ensure maximum collection. Developing a device that collects excess debris will also decrease the potential for damage to the drilling device while it is being in use. Asteroid drilling will become very popular for gathering rare minerals and space [illegible] in the coming decades.

Deep Space Mining, designed by Bryan Versteeg.

Outreach

- South Daytona Elementary STEM Expo
- SWE's Introduce a Girl to Engineering
- Mainland High School Design Academy
- South Daytona Elementary Robotics Club
- Florida's Regional SeaPerch Competition

South Daytona elementary students playing with Boo Bubbles experiment.

Team member Endi Leonardo leading an experiment for the Introducing a Girl to Engineering campus event.

Contact Information

Dr. Sathya Gangadharan: sathya@erau.edu
Jashan Grewal: grewalj@my.erau.edu