Moon Adaptive Technology for Extraterrestrial Architectural Robotics (MATEAR)

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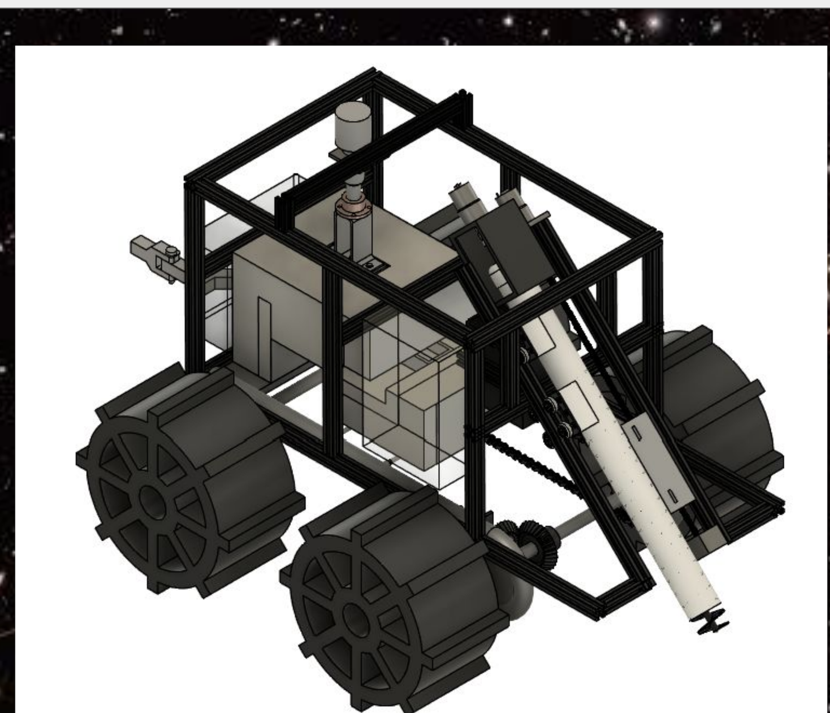
Introduction

Transporting materials to the Moon is extremely costly and occupies valuable cargo space needed for critical life-support systems. In addition, Earth-dependent supply chains are **slow**, **inefficient**, and **unreliable** for sustained lunar operations.

This is where **In-Situ Resource Utilization** (ISRU) becomes essential. The new lunar era requires fully autonomous systems with minimal dependence on Earth-supplied materials.

MATEAR addresses this challenge by enabling the autonomous production of foundational construction elements directly from lunar regolith.



System Overview

The MATEAR system consists of five sequential steps:

Regolith Collection – Acquisition of regolith from the surface

Compaction – Pressing regolith into a predefined mold

Thermal Processing – Heating the material up to 1000 °C to enable sintering

Cooling Phase – Controlled cooling to stabilize structural integrity

Brick Extraction – Removal and handling of the finished structural unit

Experimental Set Up

Two lunar regolith simulants, **LHS-1D** (Lunar Highland Simulant - 1 Dusty) and **LMS-1D** (Lunar Mare Simulant - 1 Dusty), were used to evaluate the influence of composition on structural performance. Samples were compacted into molds and thermally processed to a peak temperature of **1000 °C** under varying heating profiles.

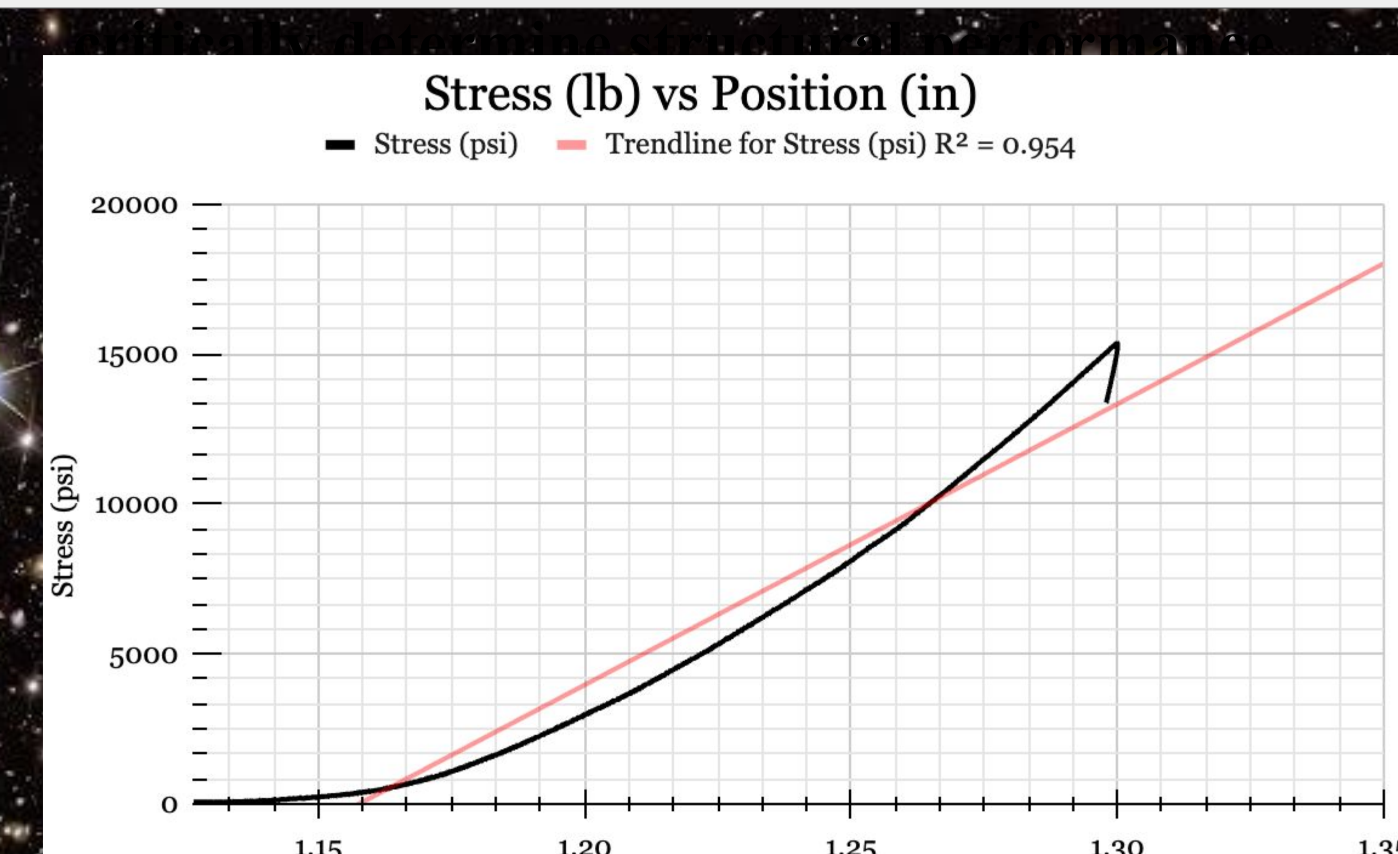
Uniaxial compression tests were conducted using a Baldwin universal testing machine to evaluate the mechanical performance of the sintered regolith samples.

Results

Mechanical Performance **LHS-1D consistently outperformed LMS-1D** across all thermal conditions. Peak maximum stress was reached in Trial 5 (~15,373 psi), followed by Trial 2 (~10,344 psi); Tria 2 also led in compressive strength (~2,502 psi), indicating optimal consolidation.

LHS-1D samples showed higher strain prior to failure, while LMS-1D exhibited lower strain and minimal displacement.

Optimized heating profiles with sufficient dwell times produced stronger, more consolidated materials, confirming that both **thermal profile and regolith composition**



Future Work

- Increase the number of samples with the same dwell profiles to get the average experimental values.
- Increase the number of samples of stimulants such as **LSP-1D** (Lunar South Pole) and Martian variants.
- Do more mechanical tests of the bricks such as tensile strength per brick and per "wall" of bricks.
- Do outgassing tests to measure how much volatile contents gets ionized by the sintering.