Cosmic Commanders
Lunar Activities Base (L.A.B.)

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ABSTRACT

- This project is to create a habitat designed to serve as a home base for astronauts for at least 15 years on the Moon's surface.
- This is extremely challenging due to the habitat needing to withstand the harsh environment of the Moon, where extreme temperature fluctuations, lunar regolith abrasion, and constant bombardment from solar radiation are the norm.
- The habitat is designed to withstand not only these conditions, but the extreme forces experienced during liftoff.

Project Background

- Establishing a human presence on the Moon again
- Creating habitats that will house astronauts for durations on the scale of years is essential to this focus.
- Design a suitable lunar habitat to aid in the expanded human presence on the Moon.

Objectives

To design a lunar habitat for a duration of a NASA lunar mission.

The habitat must meet or exceed:

- To be habitable for 30 days or less
- Mass is compatible with chosen rocket
- Usable surface area of ~50-80 m^2
- Thermal range -130 to +120 °C
- Radiation protection of 10 $\frac{g}{cm^2}$
- Assembly time of < 30 days
- Power interface range of 5-20 kWe

RESULTS & DISCUSSION

- The hull and structural components are made of Constellium Airware® 2195-T84 high strength aluminum alloy that is CNC machined, and friction stir welded together.

Radiation Protection (Areal Density):

$$\text{Aluminum density} * \text{thickness} + \text{HDPE density} * \text{thickness}$$

$$\left(2.63\frac{\text{g}}{\text{cm}^3}\right)(0.5\text{ cm}) + (0.97\frac{\text{g}}{\text{cm}^3})(9.225\text{ cm}) = 10.26\frac{\text{g}}{\text{cm}^2}$$

Net Stresses, Axial and Hoop:

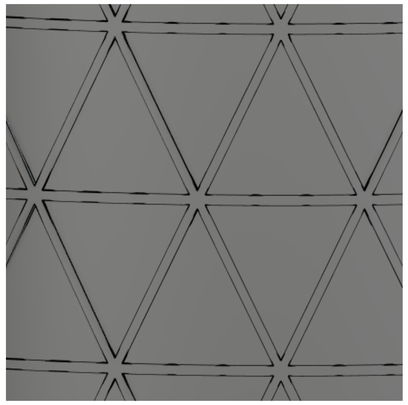
$$\sigma_x = -34.34\text{ MPa} + 45.51\text{ MPa} = 11.17\text{ MPa}$$

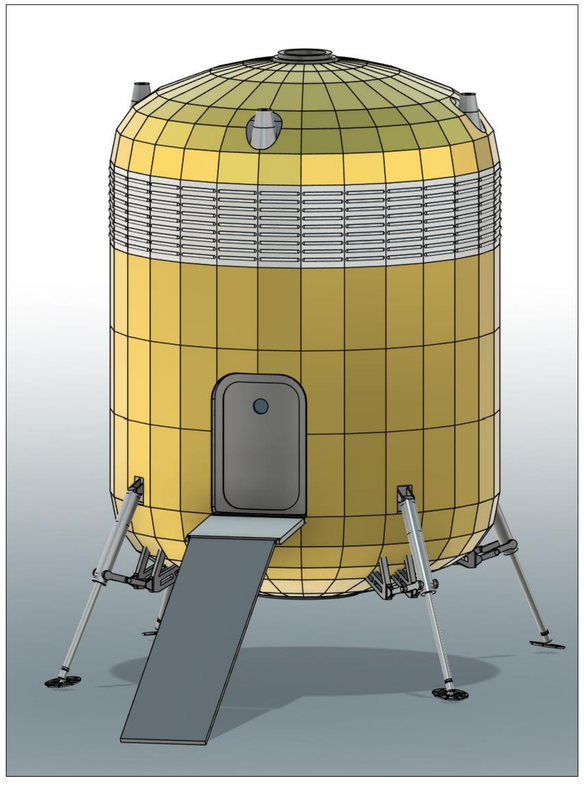
$$\sigma_y = 91.02\text{ Mpa}$$

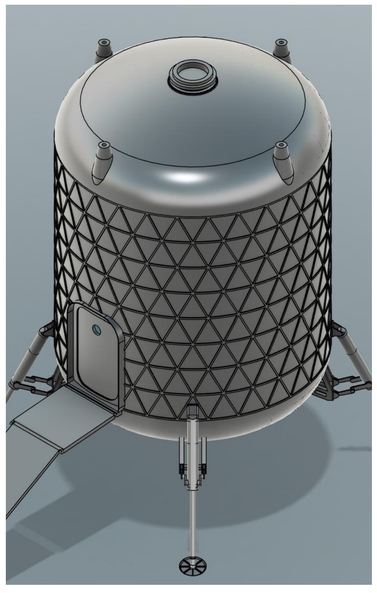
Failure Analysis:

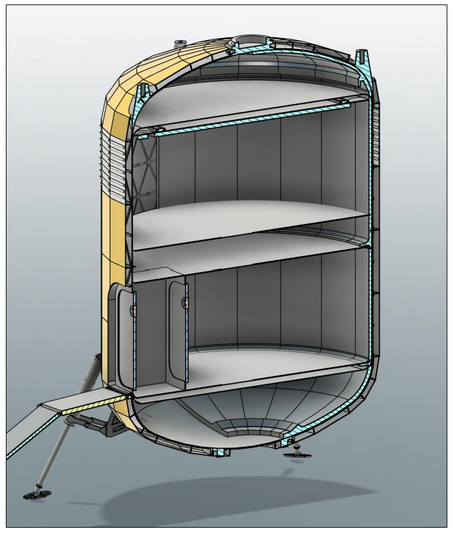
$$(\sigma' = 85.98\text{ MPa}) \ll (S_y \approx 530\text{ MPa})$$

Isogrid Pattern









Whipple Shield Components:

Kevlar and Aluminum Sheet Metal

Thermal Protection:

Multi-Layer Insulation (MLI)

FUTURE WORK

- Regolith integration would aid with radiation protection and thermal regulation.
- Sending advance technology to the moon would lead to less materials needed on initial habitats, leading to the use of mass can be used for other areas.

CONCLUSION

- The Lunar Activities Base successfully allows astronauts to live on the moon for extended amounts of time.
- The LAB is able to take the rigors of space through its robust, yet minimalist design for a lightweight and modular construction.
- Although improvements could be made regarding size and material optimization, the LAB stands are a step forward for non-earth habitation.

Acknowledgements

- Special thanks to Dr. Kazi Md Masum Billah and Robert Nuckols
- Thanks to NASA and TSGC for sponsoring this design project

References