Space Stations & Challenges (12)
Space Stations & Challenges - Session 1 (1)

Author: Ms. K.P.S.S. PRANATHI
India

Mr. Rajender Rampally
India

MATERIAL ALTERNATIVES FOR TENSEGRITY STRUCTURE OF LUNAR HABITATION

Abstract

The establishment of sustainable habitats on the Moon presents a set of unique challenges due to its extreme environmental conditions which include intense levels of radiation, reduced gravity, significant temperature fluctuations, and the absence of atmosphere. Given such harsh conditions, developing habitual structures not only requires rigorous engineering but also innovative approaches to material selection and structural design to ensure safety, durability, and cost-effectiveness. This paper delves into these complexities, examining a range of material combinations and structural frameworks tailored clearly to the demands of lunar habitation.

The study focuses primarily on materials that could be used for a tensegrity structure supporting the outer shell of lunar habitats. Tensegrity structures are characterized by their use of cables and rods in a tension-compression system, offering a remarkable balance of strength and weight which is a critical factor when constructing in low-gravity and resource-limited environments.

To evaluate the structural integrity and performance of proposed materials and configurations, this study adopts ANSYS software, a flexible tool for finite element analysis. Using ANSYS, we conducted simulations to assess the viability of various material combinations for the tensegrity structure, including lunar glass fibers, and a new metal alloy. Each material is assessed based on its mechanical properties, durability, and ability to withstand lunar conditions,and its potential as a primary support component.

In addition to selecting structural materials, this paper also studies modular assembly methods, which could enable efficient and flexible construction on the Moon. This modular approach is especially suited to the lunar environment, where transporting prefabricated components from Earth can be challenging due to weight and cost restrictions. We focus on inflatable modules as the primary habitat form, exploring ways to enhance their structural resilience. By adapting the tensegrity structure support while keeping the same outer shell material, we aim to optimize these inflatables for maximum stability without compromising with weight or flexibility.

Through a detailed analysis of these designs, this paper determines configurations that maximize both interior space and radiation protection while prioritizing the structural strength and durability of habitation. The insights gained from this research contribute to our understanding of suitable material and structural combinations for lunar habitats, offering a foundation for future missions. These findings eventually lay the groundwork for long-term extra-terrestrial habitation plans, moving us closer to a future where humans can live sustainably on the Moon.