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20th IAA SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (D3)
Strategies & Architectures as the Framework for Future Building Blocks in Space Exploration and Development (1)

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EVALUATION OF PHYSICAL AND MECHANICAL PROPERTIES OF A CONGLOMERATE THROUGH EXPERIMENTAL TESTING FOR FURTHER USE IN MOON-BASED CONSTRUCTION

Abstract

After Apollo 11 mission, the space exploration interest kick-started around the globe. That spacial jump leads us now to Artemis, where lunar settlements are the next goal. Although the Moon is the closest celestial body to Earth, material transportation costs are excessively high. Therefore, numerous current investigations focus on in-situ resource usage to save payload space and money. With this humongous purpose ahead, emerging countries have the stellar opportunity to offer safe habitat solutions regarding constructing materials, taking advantage of local resources and human force. The diverse technical and scientific human talent coming from these countries, boost mutual learning and can lead to significant improvements for Moon habitation. Lunar settlements are a matchless opening to involve every citizen in habitat solutions design, especially encouraging women and minorities to become game-changers. The purpose of this investigation is to find an affordable and safe constructing material with in-situ aggregates that allow astronauts to stay in our satellite for extended periods. The materials analyzed were different synthetic resins mixed with lunar regolith simulant in varying mass proportions. Regolith simulant was chosen to replicate moon dust properties such as chemical composition, particle size, and others; to effectively evaluate the behavior of the regolith-resin mixture. The core aspect of evaluation was the mechanical resistance of the material, which had to adapt to our countries constructing standards and mechanical resistance to aggressive environmental factors present on the Moon such as temperature gradients, radiation, and vacuum. Mechanical endurance was measured based on the ASTM-C109 standard test method, using cubical 5cm-side test samples and a universal testing machine for the failure process. To achieve extreme temperatures, industrial ovens at 125 C and ice baths at -0.2 C were used for hot and cold stages, accordingly. For radiation exposure, the samples were placed in a gamma radiation chamber for 24 hours; and a vacuum chamber was used to prove how damaging low pressures can be for test specimens in a seven-day time frame. As a result, maximum compression resistance of 45.5 MPa was achieved, without extreme condition exposure. For the samples exposed to all extreme conditions, the compression resistance was 15.1 MPa, while 46.2 MPa was reported without a vacuum. The following steps in the investigation include evaluating 3D printing as an alternative constructing method. This paper will describe the process and concentration that allows an ideal material workability, consistency, and mechanical resistance after five days of drying.