Paper ID: 88273
student

22nd IAA SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (D3)
Systems and Infrastructures to Implement Sustainable Space Development and Settlement - Systems (2A)

Author: Mr. Alessandro Siviero
Politecnico di Torino - Thales Alenia Space Italia - ISAE Supaero Toulouse, Italy

Mr. Davide Delpiano
Politecnico di Torino - Thales Alenia Space Italia - ISAE Supaero Toulouse, Italy
Mr. Dario Castagneri
Politecnico di Torino, Italy
Ms. Sannya Amoikon
ISAE-Supaero University of Toulouse, France
Mr. Lorenzo Demaria
Politecnico di Torino, Italy

STRUCTURAL DESIGN AND SAFETY CRITICAL CONDITIONS ANALYSIS ON COMPOSITE AND MODERN MATERIALS APPLIED IN CONSTRUCTION OF INFLATABLE MODULES FOR LUNAR AND MARTIAN BASES

Abstract

In recent years, there has been a renewed global enthusiasm towards the exploration and potential colonization of celestial bodies. This allowed for significant advancements in the field and new long-term commitment by space agencies worldwide. Initiatives such as NASA's Artemis program, aimed at returning humans to the Moon by 2026, and ESA's Terrae Novae 2030+ long term roadmap for human sustainable missions on the Martian surface, highlight the need for innovative solutions and designs to start shaping the future first extraterrestrial human outposts.

Within this dynamic landscape, the utilization of composite materials and modern alloys for inflatable modules gains prominence as a key area of research and development. These materials promise lightweight, durable structures capable of withstanding the rigors of lunar and Martian environments while facilitating cost-effective deployment and assembly.

The aim of the study is to investigate the utilization of composite materials and modern alloys in the construction of inflatable modules for future Lunar and Martian human bases.

In details, this paper presents the maturation of inflatable habitat programs and the recent advancements in terms of research on new materials as gateways for further methodical research on new designs, properties and functionalities of viable outposts for the near future. Taking advantage of computer simulations, challenges such as resisting stress scenarios and providing a safe environment either for storage or habitability are investigated. Structural analyses are carried out with the aim to represent the environment the inflatable modules will be in and test such critical load conditions. Hazard Analysis and Risk Assessments (HARA) considerations are also carried out in the context of functional safety. A preliminary evaluation of different alternatives and a trade-off among those is provided among the results of this research.

This study is carried out in the framework of the II Level Master's programme SEEDS (SpacE Exploration and Development Systems), a project born from the collaboration between the Politecnico di Torino (PoliTo), the Institut Supérieur de l'Aéronautique et de l'Espace (ISAE) and the University of Leicester, with the participation of Agenzia Spaziale Italiana (ASI), Centre National D'Etudes Spatiales (CNES), European Space Agency (ESA), Thales Alenia Space and Altec.