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IAF SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Interactive Presentations - IAF SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (IP)

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BASALT FIBRE: A SUSTAINABLE MATERIAL FOR LUNAR TRANSPORTATION APPLICATIONS

Abstract

This paper is written and submitted to the IAC because of the authors spin-out interest in transportation systems and from developing their organisation's composites capabilities – They are utilising Basalt Fibre to create their own cheaper rocket airframes for learning, teaching, outreach, and competitions. Basalt Fibre could be utilised in-situ on the moon to address the impact of methodologies discussed. This paper aims to contribute to more sustainable and responsible approaches to space transportation, ensuring that humanity's effect on space environments don't come at the cost of the environments we seek to explore and utilise. Space transportation systems play a role in humanity's multiplanetary destiny. However, current systems pose environmental and safety challenges on Earth and space environments. This paper explores sustainable approaches of new and emerging eco-designs for space transportation by analysing their impact on the Earth and space environments and assessing safety considerations. The study employs methodologies such as life cycle analysis, environmental impact assessment, and eco-design principles to evaluate current and emerging space transportation technologies. A life cycle analysis of space transportation solutions shall be conducted, incorporating cost-benefit evaluations, fatigue analysis, and component lifetimes. These assessments are essential for understanding long-term sustainability and mitigating unsafe environmental impacts. Environmental impact mitigation strategies are examined in several planetary contexts, acknowledging that solutions effective on Earth may require adaptation for extraterrestrial applications. The study highlights the necessity of integrating sustainability considerations into the design and operation of space transportation systems, ensuring that advancements don't exacerbate issues like space debris accumulation, as exemplified in popular media such as WALL-E. Eco-design principles are explored in conjunction with life cycle assessments to identify optimal materials, components, and processes that reduce ecological footprints. This paper also investigates new and emerging technologies aimed at minimising space transportation's impact while maintaining safety standards for space and ground operations. One key area of focus is the potential of in-situ resource utilisation (ISRU) as a means of reducing dependency on Earth-based resources. A comparative analysis of ISRU efforts across major, emerging, and non-spacefaring nations is presented. The paper culminates in a set of strategic recommendations for the sustainable evolution of space transportation. These recommendations weigh the feasibility and impact of various ISRU technologies and other innovative approaches, ensuring that sustainability efforts in space transportation align with both environmental preservation and safety imperatives. The research advocates for a multidisciplinary and collaborative approach to developing solutions that benefit all stakeholders.