IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures I Design, Development and Verification (Launch Vehicles and Space Vehicles, including their Mechanical/Thermal/ Fluidic Systems) (1)

Author: Mr. Matthew Ziglar
Boeing Defense Space & Security, United States

Mr. Tin Luu
Boeing Defense Space & Security, United States
Mr. bennett torrance
Boeing, United States

AN EVALUATION OF COMPOSITE PRIMARY STRUCTURE FOR HABITAT MODULES

Abstract

The configuration and material system of an in-space habitable module's primary structure has a significant impact on the overall vehicle's mass, performance, outfitting, manufacturability, and cost. The use of composite structures in space applications has demonstrated the material's benefits of increased strength and stiffness enabling lower mass when compared to typical aerospace metallic material. Boeing has experience designing, manufacturing, and flying composite structures for aviation and space applications and is studying how best to incorporate composite structures into human deep space habitats while maintaining the high level of assured safety required for human spaceflight.

This paper discusses the key considerations for using composites as the pressure shell and primary structure of a habitat which include: material system selection, configuration, manufacturability, and material allowables and damage tolerance approach. The module requires multiple docking ports and hatches which are traditionally metallic. A composite design of the docking ports and hatches was developed and evaluated to reap additional mass savings and, simultaneously, avoid the complications of joining metal to composite and needing to address the coefficient of thermal expansion mismatches between the two materials.

Boeing performed an evaluation of the mass benefits of incorporating a composite material design into the habitation module's primary structure and compared it against a baseline metallic module. The same Design Reference Mission, Ground Rules and Assumptions, internal volume, vehicle diameter, loading, interfaces and boundary conditions were applied to both modules. To gain the full benefits of the composite system, the design was modified from the metallic baseline to take advantage of composite's strengths, such as a continuous layup of structure from dome to dome as opposed to the metal configuration requiring multiple segments and welded joints. The results show the composite system mass savings upwards of 30

A composite habitat has been shown, through design analysis cycles, to meet requirements and provide significant mass reductions. For missions where low mass, efficient structure is critical, such as surface habitats, transit habitats, or deep space logistics modules, composite structure have key advantages.