Abstract

Hatch Integration Testing of a NASA TransHab Derivative Woven Inflatable Module

By:
John Edgecombe Gerard D. Valle

Current options for Lunar habitat architecture include inflatable habitats and airlocks. Inflatable structures can have mass and volume advantages over conventional structures. However, inflatable structures are also perceived to carry additional risk because they are at a lower Technical Readiness Level (TRL) than more conventional metallic structures. The use of inflatable structures for habitation will require large penetrations in the inflatable structure to accommodate hatches and/or windows The Hatch Integration Test is designed to study the structural integrity of an expandable structure with an integrated hatch, and to verify mathematical models of the structure.

The TransHab project developed an experimental inflatable module at Johnson Space Center in the 1990's. The TransHab design was originally envisioned for use in Mars Transits but was also studied as a potential habitat for the International Space Station (ISS).

Figure 1: TransHab Inflatable Module

Testing of the TransHab design demonstrated a high level of predictability and repeatability and good correlation with analytical predictions of stresses and deflections. Based on JSC's experience with the design and analysis of woven inflatable structures, the Hatch Integration Test article was designed and fabricated using a woven design.

The Hatch Integration Test Article consists of a load bearing restraint layer, a gas barrier, a structural metallic core, and a metallic hatch and frame approximately 50" x 50". The test article restraint layer is fabricated from one inch wide Kevlar webbing that is woven in a basket weave pattern. Underneath the structural restraint layer is the bladder, which for this test, was required to maintain pressure for testing only and was not representative of a flight design. The bladder and structural restraint layer attach to the structural core of the module at steel bulkheads at each end. The two bulkheads are separated by a 10 foot center tube which provides the structural support for the module when in a non-inflated state as well as resists a portion of the axial load when pressurized. The members of the structural restraint layer are attached to the bulkheads and hatch frame using a series of clevises.. Strain gages are located on the clevises to measure change restraint layer strap loading under proof pressures. The test article is 88 inches in diameter and 10 feet in length.

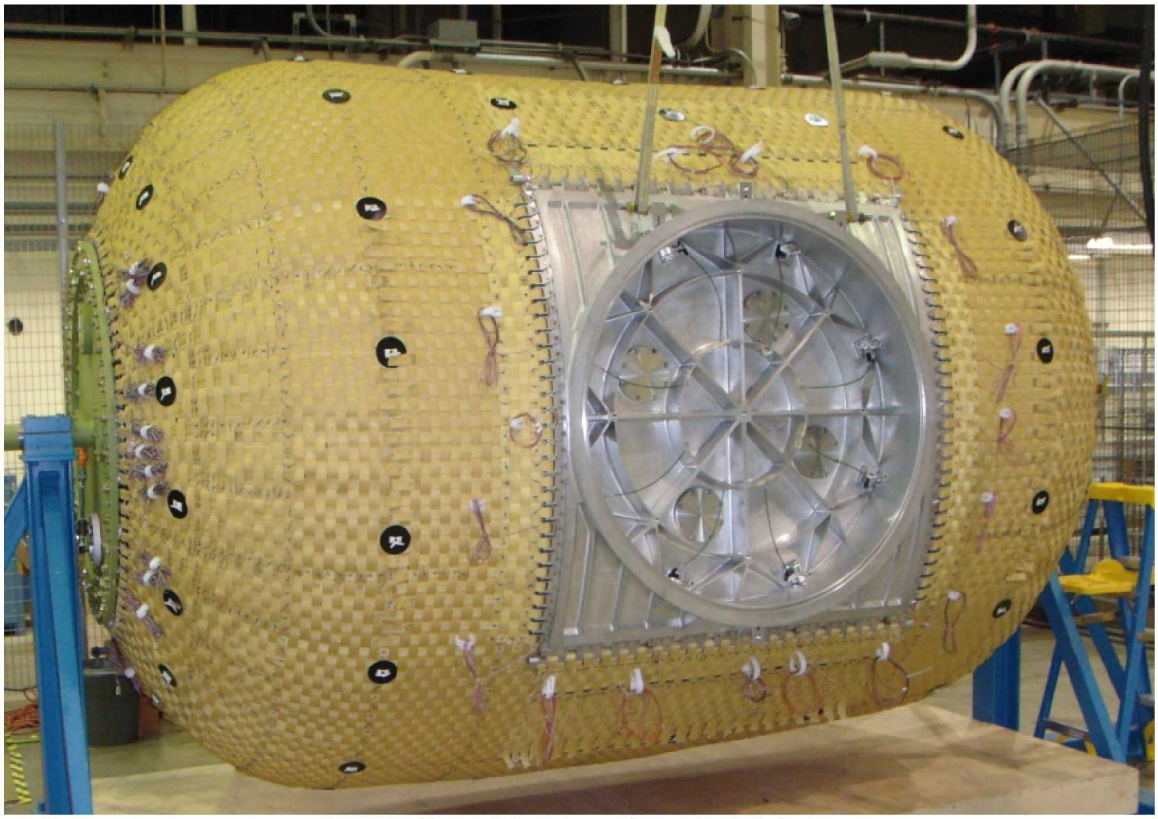

Figure 2: Hatch Integration Test Article

The objectives of the Hatch Integration Test are to (1) verify the structural integrity of the assembled and pressurized structure under proof pressures, and (2) measure

strap loading at the interfaces between the restraint layer and hatch frame for correlation with analytical predictions.

The Hatch Integration Test article will be inflated to 11.25 psig, 1.25 times the design pressure of 9 psi. This paper will discuss space inflatable structures, analytical techniques, testing results, and applicability to the Lunar architecture.