

Download the full conference paper

Structural Design, Analysis, and Testing of an Expandable Lunar Habitat

Jon Hinkle¹, Richard Timmers², Anshu Dixit³, John K.H. Lin⁴
ILC Dover, Frederica, DE, 19946

Judith Watson⁵
NASA Langley Research Center, Hampton, VA, 23681

ILC Dover, under contract by NASA Langley Research Center, and in cooperation with NASA Johnson Space Center is designing and manufacturing an expandable lunar habitat. This cylindrical habitat, or Engineering Development Unit (EDU), is a hybrid system with two hard end caps and a deployable softgoods section in the center. The softgood section packs into the endcaps and the unit roughly doubles in length upon deployment. The EDU is designed to demonstrate packing and deployment of an expandable habitat under expected loading conditions. Using a unique fabric lobe system, the structure is intended to be lighter in weight with a higher volume than a similar metal configuration. The restraint layer uses a webbing net construction with a coated fabric to carry the pressure loads up to 9 psi. Finite Element Analysis of the fabric lobe and webbing structure was performed to ensure that the structure will meet the desired safety limits. Analysis was also used to establish manufacturing tolerances during the fabrication process. Testing of the webbing seams and lobe under pressure further validated the design decisions. The next step in the evolution of the EDU is system testing, interior outfitting, and field operations.

Nomenclature

σ = stress
 r = radius
 ρ = pressure
 h = hoop direction

I. Introduction

ILC Dover (ILC), under contract by NASA Langley Research Center (LaRC), and in cooperation with NASA Johnson Space Center (JSC), has been working to advance the technology of expandable habitats through the design and construction of an expandable habitat test bed. The concept of an expandable or inflatable habitat has been discussed for years, and has found its way into numerous popular science fiction works. ILC, in conjunction with NASA, hopes to make this a reality by using expandable, softgoods technology. Softgoods are flexible, lightweight materials that can be stowed in smaller volume than they occupy upon operation. ILC has applied softgoods in space flight for extra-vehicular space suits and impact attenuation bags to land rovers on Mars¹. The idea of an expandable habitat gained momentum during the design and development of the ISS Transhab, which was deployed in vacuum at JSC in 1998^{2,3}. ILC Dover worked to advance the technology of inflatable structures during the development of an intelligent material demonstration unit in 2006⁴. ILC also collaborated with NASA and NSF to deploy a double wall, inflatable structure in the extreme environment of Antarctica in 2007⁵. The

¹ Design Engineer, Space Products, M.S. 32, AIAA member.

² Senior Analysis Engineer, Research & Development, M.S. 33, AIAA member.

³ R & D Engineer, Research & Development, M.S. 33, AIAA member.

⁴ Design Engineering Manager, Engineered Products, M.S. 22, AIAA Senior Member.

⁵ Project Lead, Structure, Materials, and Mechanisms, M.S. 190, AIAA Member.

Download the full conference paper