Paper ID: 17435
oral

MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures II - Development and Verification (Deployable and Dimensionally Stable Structures) (2)

Author: Dr. Guangqiang Fang
Aerospace System Engineering Shanghai, China, house19@163.com

Dr. Bai Jiangbo
School of Transportation Science and Engineering, Beihang University, China, bai_jiangbo@163.com
Mr. Chao Xie
Aerospace System Engineering Shanghai, China, xchnuaa@126.com
Prof. Fujun Peng
Shanghai Key Laboratory of Spacecraft Mechanism, China, pfj_tj@yahoo.com

NUMERICAL SIMULATION OF FOLDING AND DEPLOYING PROCESS OF LENTICULAR COLLAPSIBLE COMPOSITE BOOMS

Abstract

Ultra-lightweight deployable structures are flexible assemblies which can attain different configurations depending on the service requirements. These structures are widely used in space missions such as solar sails, antennae and other instruments due to the high package efficiency. Aerospace System Engineering Shanghai (ASES) is developing deployment concepts based on lenticular collapsible booms (LCB) that are manufactured by bonding two identical ultra-thin-walled carbon-fiber composite segments at the edge. These booms can be flattened and coiled around a roller for stowage in a very tight transportation volume. After being launched into orbit, the booms can be deployed and recover to its original shape by using elastic deformation energy obtained from folding process. One of the main challenges for LCB is how to quantify and predict the large deformation behaviors in folding and deploying process. To overcome the challenge, finite element analysis (FEA) for long LCB is carried out. This paper presents some very useful results and ideas for the design of LCB. With the consideration of the large deformation and complex contact problem, an explicit analysis FEA model of composite LCB and deployment mechanism is established by using commercial code ABAQUS. In the FEA model, the folding and deploying process contains three analysis steps, namely flattening process, coiling process and deploying process. The composite LCB can be pulled flat, coiled and deployed with the movement of the roller and constraint shafts. From the FEA results, the stress-strain distribution, stored strain energy of LCB in the three processes and coiling torque versus rolling angle is obtained. In addition, the danger points of composite LCB in all deformation processes and the maximum coiling torque can be determined which is a significant reference for structure design of LCB.