HIGH STRAIN TEST METHOD FOR THIN COMPOSITE LAMINATES

Gregory E. Sanford*, Emil V. Ardelean†, Thomas W. Murphey‡, and Mikhail M. Grigoriev‡

*LoadPath
933 San Mateo Blvd. NE, Ste 500-326
Albuquerque, NM 87108, USA
e-mail: gsanford@loadpath.com, web page: www.loadpath.com

†Shafer Corporation
2309 Renard Place SE, Suite 300
Albuquerque, NM 87106, USA
e-mail: eardelean@schaferalb.com, web page: www.shafer.com

‡Air Force Research Laboratory Space Vehicles Directorate
3550 Aberdeen SE
Kirtland AFB, NM 87117, USA
e-mail: afrl.rvsv@kirtland.af.mil, web page: www.kirtland.af.mil/afrl_vs/

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Summary: This test and verification research effort focuses on evaluating thin composite laminates used in deployable space structures. A new test method has been developed to quantify the stiffness, strain, and curvature of composite coupon laminates subjected to a pure bending moment.

1 INTRODUCTION

Thin composite laminates are commonly used in deployable space structures. In application, the laminates are elastically folded to allow a structure to be compactly stowed during launch and subsequently deployed to an operational state once in orbit. This basic technology enables operational systems containing structures such as solar arrays, reflectors, antennas, and booms to be efficiently packaged and launched within the payload envelope of conventional launch vehicle fairings. A simple example of thin composite laminates used in a material deformation-based deployable structure is shown in Figure 1.

Figure 1: Thin composite laminate stowed and partially deployed
While the use of composite laminates in deployable structures has become widely acceptable, they are subjected to strain levels and deformations outside of traditional applications. As such, their behavior is poorly understood, making deployable structure design and analysis extremely difficult. Currently, standardized ASTM test methods are used to determine composite material strengths and linear-elastic stiffnesses under traditional loading applications such as axial and transverse tension, compression and shear. To facilitate a better understanding of thin composite laminates, this research team is investigating the development of an improved test method that better simulates high-strain bending applicable to deployable structures.

2 TESTING OVERVIEW

Previously, tests were performed on IM7-8552 uni-directional, [0], laminates of 1, 2, and 3 ply thicknesses. These tests and results, as given by Sanford et al. [1], detail the problems associated with a test that does not directly measure the bending moment or curvature. To alleviate these issues, an improved test fixture has been designed that will allow a pure moment to be imparted into the composite test coupon. As shown in Figure 1, the test fixture is used to clamp a coupon between two rotating carts that are driven downward and simultaneously rotated by a cross member. Axial load and displacement will be measured to calculate the applied moment and curvature.

![Figure 1: Progressive views of the improved, pure-moment test fixture](image)

The test fixture is currently being fabricated, and is expected to be completed in December 2010. Initial, baseline tests will be performed on hardened spring-steel samples as a means of validating the test design and assessing parasitic frictional and alignment effects. A matrix of common thin composite laminates used in deployable structures has been populated for testing in January and February 2011.

3 SUMMARY AND CONCLUSION

Upon completion of the test matrix, valuable data will be available to aid in future design and analysis of deployable composite structures. The results of these findings and a comprehensive evaluation of the improved test fixture will be presented in the final conference proceedings.

REFERENCES