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Education

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Research Keywords

CFRP boom, bi-stable tubes, Self-deployable membrane truss

Research Overviews

1.Introduction

A bi-stable open section tube using CFRP (Carbon Fiber Reinforced Plastic) is regarded as deployable structures in space. The tube has two stable configurations, which are stretching configuration and coiled-up configuration, and has potential to reduce the number of parts and simplify the structures.

Therefore, it is expected that deployable structures which is more reliable and lighter than conventional ones can be achieved by adopting bi-stable tubes.

In case of use in space, we have to design the tubes, considering the degradation of extension power by long-term storage and exposure to utmost temperature and cosmic rays.

2.Theory

In general, CFRP is wound around a cylindrical mold and autoclaved. The cylindrical bi-stable structure has two shapes, a initial state and a deformed state as shown in the figure 1.

From classical lamination theory, N and M are the moments, A is the tensile stiffness matrix, B is the tensile bending coupling matrix, and D is the bending stiffness matrix as shown in the formula 1.

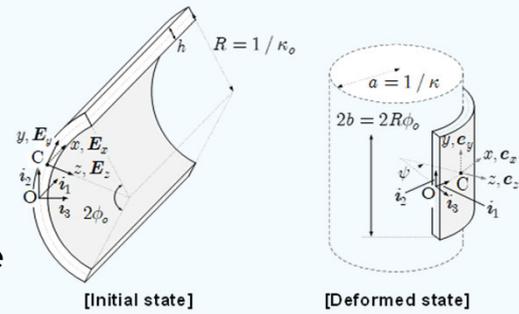


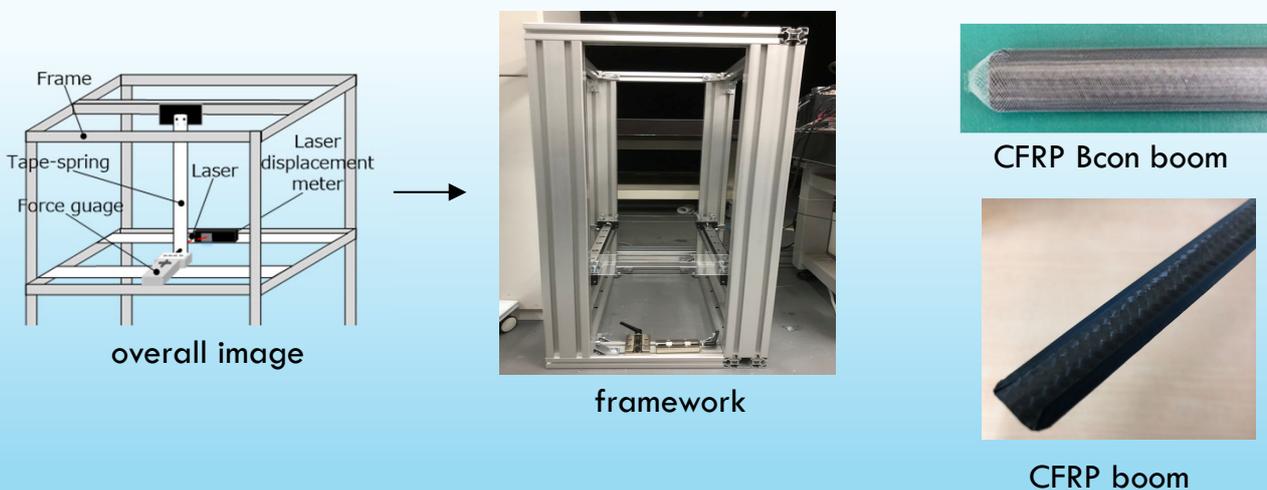
figure 1

$$\begin{bmatrix} N \\ M \end{bmatrix} = \begin{bmatrix} A & B \\ B & D \end{bmatrix} \begin{bmatrix} \varepsilon_s \\ \Delta\kappa_\eta \end{bmatrix} \dots \dots \dots \text{(formula 1)}$$

Experiment

1. Bending test

A bi-stable is fixed to a jig, and the relationship between force and deflection is obtained using a force gauge and a laser displacement meter. This experiment reveals the characteristics of CFRP.



Future plan

Carbon fiber composite materials are lightweight and rigid, can be used in a wide range of applications. Therefore, stress analysis considering all environmental conditions is possible.

Therefore, it is possible to apply high-precision technology polished in the aerospace field also in the fields of automobiles and industrial machinery.