Micromechanics Models for Viscoelastic Plain-Weave Composite Tape Springs - DTU Orbit (17/12/2018)

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The viscoelastic behavior of polymer composites decreases the deployment force and the postdeployment shape accuracy of composite deployable space structures. This paper presents a viscoelastic model for single-ply cylindrical shells (tape springs) that are deployed after being held folded for a given period of time. The model is derived from a representative unit cell of the composite material, based on the microstructure geometry. Key ingredients are the fiber volume density in the composite tows and the constitutive behavior of the fibers (assumed to be linear elastic and transversely isotropic) and of the matrix (assumed to be linear viscoelastic). Finite-element-based homogenizations at two scales are conducted to obtain the Prony series that characterize the orthotropic behavior of the composite tow, using the measured relaxation modulus of the matrix as an input. A further homogenization leads to the lamina relaxation ABD matrix. The accuracy of the proposed model is verified against the experimentally measured time-dependent compliance of single lamina in either pure tension or pure bending. Finite element simulations of single-ply tape springs based on the proposed model are compared to experimental measurements that were also obtained during this study.

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