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

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DESIGN OF TAPE SPRING HINGES FOR SOLAR ARRAY CONSIDERING DEPLOYMENT PERFORMANCES

Abstract

This paper reports the development of tape spring hinges for a solar array considering various deployment performances. A tape spring hinge is widely used as deployment device due to its advantages such as self-deployable, self-locking, lightweight, and simple. However, a tape spring hinge shows strongly nonlinear behavior, and therefore, it is difficult to investigate its moment- rotation profile by theoretical solution. To overcome this problem, the nonlinear behavior of a tape spring hinge is calculated through finite element analysis. Response surfaces comprising the moment–rotation profile and design parameters of a tape spring hinge are generated by a Box–Behnken experimental design. To use the moment–rotation relationship for the design of a tape spring hinge, it is approximated by proposed interpolated functions. Furthermore, the deployment equation is derived to consider deployment performances such as low latch-up load, high deployment stiffness, and high torque margin within the framework of Kane's dynamic equation and the accuracy of this equation is verified through multibody simulation results. A design example of the tape spring hinges is performed, and through it, the tape spring hinges are designed successfully satisfying all deployment performances.