Structural dynamic optimization of deployable antenna truss structure

Lu Dai[1, 2], James K. Guest[2], Fuling Guan[1]

[1]College of Civil Engineering and Architecture, Zhejiang University, Hangzhou, Zhejiang 310058, China

[2] Department of Civil Engineering, Johns Hopkins University, Baltimore, MD 21218, USA

Abstract

Demand for large-caliber and ultra-large-caliber antennas is increasing with the rapid development of space science and astronautical technology. However, the caliber of antennas is severely restricted by weight and volume limitations of the transportation vehicle, such as the cowling for space use. Ultimately, this creates a design space governed by competing properties, where the antenna is desired to be as light and small in size as possible during transportation and as large in caliber as needed for effective operation when the antenna is fully deployed in orbit. Foldable and deployable supporting structures have proven to be an effective system for addressing this challenging design problem.

This work presents a new deployable truss structure for large caliber antennas. Dynamic characteristics of the deployable truss in each deploying state were investigated using the geometrical models output by a self-programmed procedure. Subsequently, structural dynamic optimization work of the deployable antenna truss structure was carried out. A deployable pantograph was studied as a case; finally, the deployable antenna truss structure was optimized to obtain the minimum weight until the dynamic constraints were satisfied at each deploying state in the entire deploying process. The optimization methodology proposed in this paper has the potential to be implemented in a wide range of deployable structures. The presented analyses illustrate that the diameter of the cube-shaped cross sections tends to the maximum, while the thickness to the minimum to maximize the stiffness under the optimal weight.