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

Author: Dr. XiaoFei Ma
Xi'an Institute of Space Radio Technology, China, maxf041600@sina.com

Dr. Qingzheng Song
China, saluzi009@163.com
Dr. xin zhang
China, zhangxin@sina.com
Dr. yongbin wu
China, 13895741241@126.com
Dr. houfei fang
China, 18916010833@163.com

DESIGN AND EXPERIMENT FOR A HIGH PRECISION REFLECTOR

Abstract

Large deployable mesh reflectors for space applications have continuously been developed in the past several decades.Offset feed has gradually been introduced to the mesh reflector design to minimize feed blockage of the RF beam. To increase the stiffness as well as the precision, an elliptical ring truss has been considered for an offset feed reflector that employs a circular axisymmetric parabolic surface. So the scheme of mesh geometry design for large offset deployable reflector needs to be further investigated. This paper presents a new approach to design the cable web for elliptical ring truss reflectors based on the pseudo-geodesic method. This design approach meets the requirements of high precision and uniform distribution of tension forces. First of all, the geometry of an offset reflector is defined by intersecting a parabola with a circular cylinder. The axes of these two geometries are parallel with a given distance which is defined by the offset. The intersection curve is an ellipse. It is important that the cable web can be directly connected to the hard points of the ring truss. The stiffness and precision of the reflector can thus be significantly increased. Also, the circumference of the ellipse is smaller than the circle from traditional approach. Traditional approach used an inclined circular cylinder to intersect the parabola to get a circular ring truss which is much bigger than the elliptical one. Then, a new process has been developed to determine the cable web for the offset feed parabolic surface. The design procedure contains four major steps: (1) selecting a suitable reference sphere and dividing the sphere with pseudo-geodesic; (2) adjusting the pseudo-geodesic based on the facet sizes and ring curvatures; (3) mapping the points from the reference sphere to an ellipsoid; (4) projecting the nodal coordinates from step (3) onto the desired parabolic surface and generating the connections between points. An offset parabolic reflector has been finally used as an example to further discuss and compare different design approaches. Considering static equilibrium of tension members and external mounting forces, an optimization method was introduced to systematically determine an initial profile and tension forces for the reflector. According to design and analysis, a prototype was made to test. By photogrammetry, the surface precision is less than 0.5mm (RMS). The tension level is better than analysis result. The thermal deformation is less than 0.05mm (RMS) for 40 temperature change.