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Author: Prof. Kanjuro MAKIHARA
Tohoku University, Japan, kanjuro.makihara.e3@tohoku.ac.jp

Mr. Takuma GOTO
Tohoku University, Japan, takuma.goto.s8@dc.tohoku.ac.jp
Dr. Nariyuki KAWABATA
Japan, n_kawa@anan-nct.ac.jp
Dr. Keisuke Otsuka
Tohoku University, Japan, keisuke.otsuka.d6@tohoku.ac.jp

EXPERIMENTAL INVESTIGATIONS: DYNAMIC ANALYSIS OF 150-MEMBER SPHERICAL TENSEGRITY TO IDENTIFY ITS CHARACTERISTICS FOR SPACE APPLICATION

Abstract

The experimental investigation on dynamic analysis of a 150-member spherical tensegrity is presented in this paper. Compared with conventional structures such as a truss and a cylindrical module, there are three main features that can render tensegrity structures more suitable for space structures. Firstly, the tensegrity structure has lightweight and high specific strength. The tensegrity structure can achieve self-equilibrium with struts and cables. Since cables are generally lighter than struts, tensegrity structures are much lighter than truss structures in which all elements are composed of struts, which is the great advantage that the structure can guarantee the strength with lightweight. Secondly, the tensegrity structures can be folded by loosening the cables, and conversely deployed by tensioning the cables. By utilizing the tensile members, tensegrity structures can change the volume more easily than folded-deployment structures composed of rigid struts. Thirdly, the tensegrity structures are stable structures. When the tensegrity structures are deformed, they self-modify their shapes in the direction of their own stability through the tensile shift. In summary, these three features are the important advantages in harsh environments and limited resources of space development. Regarding the spherical tensegrity, there is a problem that has not achieved so far. The problem is insufficient experimental data for spherical tensegrities. The fabrication and fixation on the excitation base have not been discussed. This paper has two objectives. The first objective is to show the fabrication of a 150-member spherical tensegrity, which is composed of 30 struts and 60 nodes. Four cables are connected to each node of the spherical tensegrity. Each cable functions as one side of the equilateral pentagon or triangle. The struts have 30 elements, and the cables have 60 equilateral triangle elements and 60 equilateral pentagon elements. The spherical tensegrity consists of 150 elements. The second objective is to carry out frequency analysis of the spherical tensegrity. Excitation experiments identify the natural frequencies and the mode shapes of the spherical tensegrity. This paper discusses the fixation on the excitation for the 150-member spherical tensegrity on the excitation base. The experimental results are compared with the resonance frequencies obtained from the simulations. The experimental analysis of the spherical tensegrity greatly contributes to the practical use in outer space.