A New Deployable Tensegrity Torus

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Abstract

This paper studies the design and numerical simulation of a new deployable tensegrity torus. The topology and configuration of a novel tensegrity torus are first introduced. Considering multiple symmetric properties, the tensegrity torus is composed of four groups of members: horizontal bars, stable bars, vertical strings and diagonal strings as shown in Fig.1. Group matrix is used to reduce the design variables[1]. For the sake of simplification, the topology and configuration of the torus can be parameterized into four variables. Prestress modes are obtained by singular value decomposition of the equilibrium matrix, and the prestress is determined by assigning tension in the vertical strings. Cross-sectional area and rest length of members are obtained by minimal mass design[2].

Then the novel tensegrity torus is redesigned to be deployable by replacing one horizontal bar with two pin-joint connected bars with locking devices. In folding condition, the locking devices do not work to make the horizontal bar foldable. While in deploying condition, the locking devices are working to transform the two pin-joint connected bars into one horizontal bar and the tensegrity torus is identical to the tensegrity torus proposed in the first part. The external force, member force and configuration in every step of the deploying and folding process is obtained by quasi-static analysis. In the end, a real deployable tensegrity torus model is manufactured to verify the efficiency of the proposed deployable tensegrity torus design.

Keywords: tensegrity torus; deployable; prestress; minimal mass design

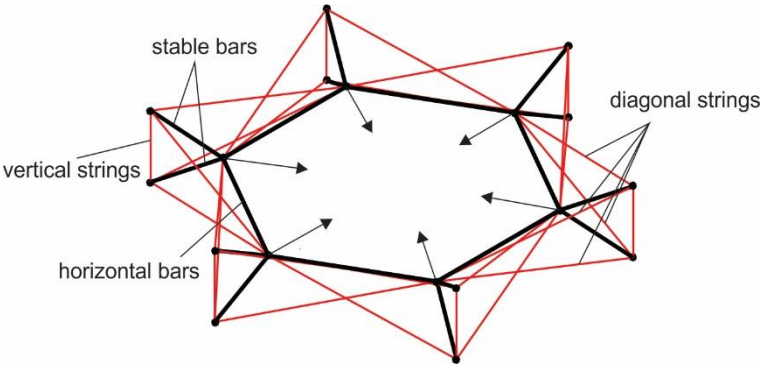

Fig.1 A novel tensegrity torus

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References:

[1] P. Zhang and J. Feng, "Initial prestress design and optimization of tensegrity systems based on symmetry and stiffness," *International Journal of Solids & Structures,* vol. s 106 – 107, pp. 68-90, 2017.
[2] R. E. Skelton and M. C. D. Oliveira, *Tensegrity Systems*: Springer, Berlin, 2011.