Static properties of a new class of planar tensegrity truss

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Abstract

Tensegrity structure is a prestressed self-equilibrated system consisting of compressed struts and tensioned cables. It has some distinguished characteristics, such as light-weight, controllable shape, novel form and so on. Towards different applications, various forms of tensegrity structures have been proposed. The planar tensegrity truss proposed by Jager and Skelton [1] is belonged to class-1 tensegrity and is prone to be used as controllable structural systems. A novel class-2 planar tensegrity truss consisting of repetitive units was found in an example for a topology optimization of tensegrity systems [2]. This novel class-2 planar tensegrity truss was able to resist a given design load in according to a load code for design of building structures and meanwhile meet the deflection limitation given by a design code of steel structures [2]. It seems that the class-2 planar tensegrity truss has a potential application in building roof structures.

To fully exploit the possible application of the newfound planar tensegrity truss in building roof structures, this paper extends the prototype system found in the previous study [2] to a class of planar tensegrity trusses by generalizing the combination scheme of the basic units and modifying the shape of the basic units, and investigates the static properties of the planar tensegrity trusses analytically and numerically.

In this paper, the state of pre-stress of the truss is analytically determined from the equilibrium conditions. The static properties of the structure are analytically formulated by using the principle of virtual work first, and then a parametric analysis of geometrical parameters on the static properties of the structure is carried out based on ANSYS. By changing the length and height of the basic units, the uniform planar tensegrity truss is extended to a fish-bellied truss. Parametric analysis is also carried out for the fish-bellied truss. An example of extending the planar tensegrity truss into a three-dimensional latticed tensegrity truss is also taken into consideration.

References

[1] B. de Jager and R. E. Skelton, "Stiffness of planar tensegrity truss topologies," *International Journal of Solids and Structures,* vol. 43, pp. 1308-1330, 2006.

[2] X. Xu, Y. Wang and Y. Luo, "Topology Optimization of Tensegrity Structures Considering Buckling Constraints," *Journal of Structural Engineering,* vol. 10, p. 04018173, 2018.