MOBIUS Pavilion: A Double-Layer Grid Shell Combined with Ice Based on Bending-active Weaving Structure

Weixin Huang*, Yueqi Sun, Jingyan Zhou, Huiyin Pan

*School of Architecture, Tsinghua University
S400C, School of Architecture, Tsinghua University, Beijing, China, 100084
huangwx@tsinghua.edu.cn

Abstract

Bending-active weaving structure made of Fiber Reinforced Polymer (FRP) rods is a reliable approach to the substantiation of free-form geometry. However, due to the overall stiffness as well as joint strength, previous works usually adopted vaulted shapes to enhance the structure's stability. Thus and the available range of initial geometry was topologically constrained, and the spatial scale of the structure was also limited.

This paper presents the design and construction process of an architectural scale self-standing grid shell, the geometrical prototype of which is the Mobius strip. The free-form bending-active weaving structure encompassed over an area of 10x10m with its highest point of 4 meters including a relatively long-span cantilevered part. Coherent to the features of Mobius strip, the loop-like structure twisted all along the way with high curvature, which challenged both the design and assembly session. For the first time a double-layer weaving pattern was adopted by our team to utilize the synergy of two layers of bending rods and thus to improve the structure's performance. The structure also combined well with ice, the indigenous element, by spraying water on the surface of the rods to form ice shell and rime. The completed grid shell was 3D scanned to measure the structural deformation, and to verify the structural simulation algorithm. Through this project, our team ameliorated the generic algorithm of form-finding and structural simulation and optimized the assembly procedure, expanded the application range and scale of the weaving structure system.

Keywords: bending-active, grid shell, weaving structure, double-layer, free-from construction, Mobius strip

References

[1] Weixin HUANG, Chenglin WU, Jiankun Huang, A Weaving Structure for Design & Construction of Organic Geometry, Proceedings of the IASS Annual Symposium 2017, Hamburg, Germany, 25-28th September, 2017

[2] W. X. HUANG, D. YAN and P. LUO and X. L. LI, Digital Desian and Construction of a Weaving Structure, The 8th International Conference on Fibre-Reinforced Polymer (FRP) Composites in Civil Engineering (CICE 2016), Hong Kong, 2016.12

[3] Julian Lienhard, Holger Alpermann, Christoph Gengnagel and Jan Knippers, Active Bending, A Review on Structures where Bending is used as a Self-Formation Process, International Journal of Space Structures, Volume 28 · Number 3 & 4 · 2013, pp188-196