Knit Tensegrity Shell Structures

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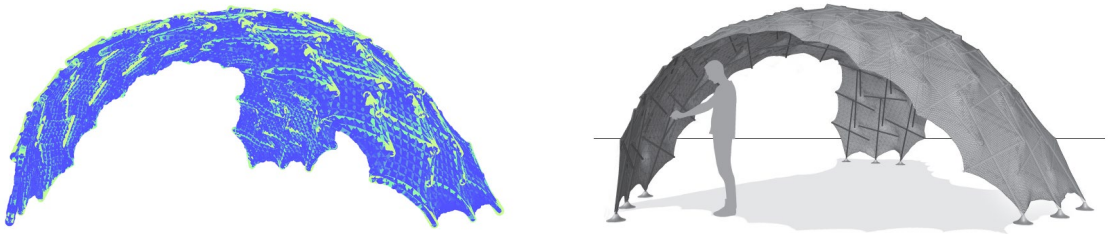
Abstract

Membrane tensegrity structures utilize principles of tensegrity to resolve tension and compression forces into an ultralightweight, free-spanning structure [1]. They consist of two main elements: a continuous textile membrane and a series of compressive struts, whose geometrical relationships must be carefully delineated to achieve a state of stable self-equilibrium. The few cases of membrane tensegrity structures that have so far existed have either closed forms or required tethering by external elements [2]. Here, we present membrane tensegrity shells, a new structural typology that is enabled by specially-tailored strut configurations. Unlike previous examples of membrane tensegrity structures, membrane tensegrity shells are self-supporting and feature wide openings that can respond to programmatic requirements.

In order to demonstrate this novel typology, we explain the development process of the Knit Tensegrity Shell that was submitted as a pavilion competition entry to IASS Form and Force 2019. First, we describe our investigation of various strut patterns embedded in the membrane, using digital form-finding tools to derive shell forms. Second, we illustrate the design of the textile membrane, in which individual customized knit loops influence the macroscale geometry. To accommodate the concentrations of stress exerted at the strut ends, the textile is graded in terms of its elasticity, which is informed by structural analysis data and materialized by 3D CNC knitting technology. These structural explorations are translated into a design-to-fabrication workflow which enables the production of full-scale knit membrane tensegrity shells.



(a) *(b)*

Figure 1. Visualization of stress distribution (*a*) and design proposal (*b*) for Knit Tensegrity Shell

References

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[2] K. Kojima, "MOOM Pavilion," *MOOM Tensegritic membrane structure*, 2011. [Online]. Available: http://c-and-a.co.jp/projects/other/moom.html. [Accessed: 29-Jan-2019].