Bending active structures with a variable cross-section boundary

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Abstract

Bending-active textile hybrid structures are designed by form-finding an equilibrium between a textile in tension and a boundary system in flexure [1]. Typically, the boundary system provides support for the textile, leaving minimal structural capacity in reserve. A previous method to make the boundary system bundled multiple Glass Fiber Reinforced Polymer (GFRP) rods closely together to create a stronger laminate beam boundary [2]. Such a design for the bending-active system allowed the curvature along the boundary to vary dramatically by changing the number of bundled rods. We explore a new method for designing the boundary system, where rather than bundling rods closely together, we separate them using bracket plates to create a spatial beam. The rod spacing within the beam cross-section changes to vary the section modulus in order to achieve the desired boundary curvature. The brackets lock the rods into place as the beam is curved during assembly, leading to a precise system that can be more easily assembled and disassembled. We integrate our new method for boundary design and results from mechanical tests of GFRP rods with computational tools to realistically model the boundary shape and behavior. The computational model includes the variable cross-section, allowing us to accurately simulate the final design and identify potential construction issues ahead of time.

References

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[2] S. Ahlquist and J. Lienhard, "Extending Geometric and Structural Capacities for Textile Hybrid Structures with CNC Knitting," in *IASS 2016 Tokyo Symposium: Spatial Structures in the 21st Century, Tokyo, Japan, September 26-30, 2016,* K. Kawaguchi, M. Ohsaki, and T. Takeuchi, Eds. pp. 1-10.