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Graded Textile Shaping: Manufacture of Curved Cladding Panels using Multi-material Knitted Preforms

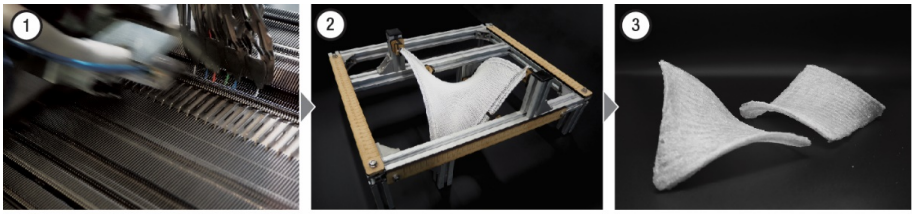
Ying Yi TAN*, Yu Han QUEK*

*Singapore University of Technology and Design
Digital Manufacturing and Design (DManD)
8 Somapah Road, Singapore 487372
yingyi_tan@mymail.sutd.edu.sg, yuhan_quek@alumni.sutd.edu.sg

Abstract

Architectural cladding panels with non-developable and non-orthogonal geometries present a challenge to fabricate. Current methods in the industry manufacture these panels out of Glass Fibre Reinforced Polymer (GFRP) composites using mould-making and wet lay-up processes [1]. However, these techniques require significant amounts of expendable material, for the creation of a hard backing mould, and manpower, to simultaneously laminate the panel upon this mould to a desired thickness.

Our research proposes an alternative resource-efficient fabrication method to manufacture GFRP panels of non-standardised geometries. We use a customised textile machine-knitted out of glass fibre and elastic yarns to serve as a flexible stay-in-place preform. Using the principles of an adjustable textile hybrid system [2], this planar textile undergoes edge-shaping by flexing carbon fibre strips, that are inserted through continuous channels integrated along its edges. We then laminate the curved surface with polyester resin to solidify the textile into a curved composite panel.



Design & Knitting of Textile Preform | Bending-Active Edge-Shaping | Resin Lamination & Post-Processing

In this work, we employ CNC-knitting technology [3] to design and manufacture a multi-material textile preform with graded elasticity to achieve intended curved geometries. We incorporate localised variations of elasticity by interlocking both glass fibre and elastic yarns in a designed configuration of stitches. To design the textile, we implement a script which reads an input curved geometry and dispatches discrete regions based on the magnitude and directionality of stretch which the textile undergoes during shaping. These regions translate to different knit configurations, which we develop into machine instructions to create the physical graded knit.

In summary, our paper seeks to achieve the following objectives:

- Development of script to map discrete regions of stitch patterns based on an input curved geometry;

- Shaping of graded glass fibre-elastic textile preforms into several non-orthogonal, doubly curved geometries upon a bending-active shaping mechanism; and

- Geometric evaluation of the prototypes with their respective digital models using 3D scanning.

References

[1] Stage One Limited, “Case Study: Chanel – Exhibition Pavilion”, 2009

[2] J. Lienhard and C. Gengnagel, “Recent developments in bending-active structures,” in *Creativity in Structural Design: Proceedings of the IASS Annual Symposium 2018*, Boston, USA, July 16-20, 2018, C. Mueller, S. Adriaenssens Ed., 2018.

[3] Shima Seiki, *Shima Seiki CNC Knitting*, 2018.