Structural optimization of coreless filament wound components connection system through orientation of anchor points in the winding frames

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Abstract

The load induction in the connections of coreless filament wound components is one of the major challenges when designing with this novel structural system. An efficient fibre layup would require the fibre bundles to be aligned with the direction of the load, taking full advantage of the anisotropic characteristics of the material. Coreless filament winding is a technique widely adopted in the development of previous research projects by the Institute for Computational Design and Construction (ICD) and the Institute of Building Structures and Structural Design (ITKE), University of Stuttgart [1]. In previous research pavilions, the direction of the fibres in proximity of the anchor points was mainly dictated by fabrication constraints (geometry of winding frame) [2].

The purpose of this research is to structurally improve the capacity of the connection system in fibrous building components. Load induction in several test specimens, representing different angles of incidence between fibres and winding frames, was investigated under tension and compression forces. Different iterations were designed and tested, resulting in a better structural performance.

Consequently, a computational tool (Figure 1), generating winding frame geometries and optimal orientation of the winding pins (which allow fibres to lay in the direction of the load), was developed and utilised to inform the fabrication setup for the prototyping and production of the components of the Bundesgartenschau 2019 Fibre Pavilion (Figure 2).

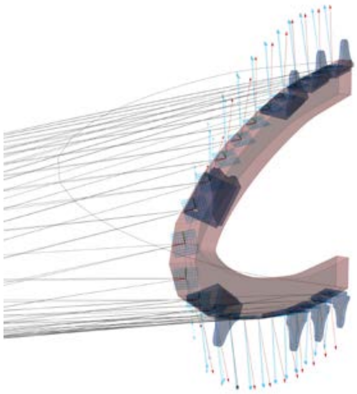

Figure 1. Pin orientation implementation in coreless filament winding frame

Figure 2. Bundesgartenschau 2019 Fibre Pavilion component

References

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