

Structural optimization and rationalization of a fibre composite dome

Bas RONGEN*, Valentin KOSLOWSKI, Marta GIL PÉREZ, Jan KNIPPERS

* Institute of Building Structures and Structural Design (ITKE)
University of Stuttgart
b.rongen@itke.uni-stuttgart.de

Abstract

In the context of the Bundesgartenschau 2019 in Heilbronn from the 17th of April 2019 until the 6th of November 2019 a Pavilion will be exhibited, fabricated from core-less-wound fibre reinforced polymers. The load bearing structure of the Pavilion is a development of a continuous endeavour and collaboration of the institutes ICD/ITKE at the University of Stuttgart. An architectural visualization of the design can be seen in figure 1a, together with a prototype of a fibre composite component in figure 1b. The goal of the research is the design and engineering of lightweight and high-performance building components. A previous structure in the same fabrication methodology was exhibited in 2016 at the Victoria and Albert Museum in London.

The structural system of the pavilion is an unbraced dome structure covered by a transparent ETFE membrane. The structural characteristics of an unbraced structure is that bending moments appear in the joints. The dome structure is made of 60 components, each of these components is hollow in section and bone-like in shape. Due to the ETFE façade loads are unequally distributed over the dome.

This paper will describe how the shape of the dome is structurally optimized in order to reduce design forces in the components as a main objective (figure 2a, 2b), while at the same time rationalizing the 60 different components in manageable geometries for fabrication (figure 2c).



Figure 1. a) Fibre Composite Dome Interior Perspective; b) Component Prototype - ©ICD/ITKE University of Stuttgart

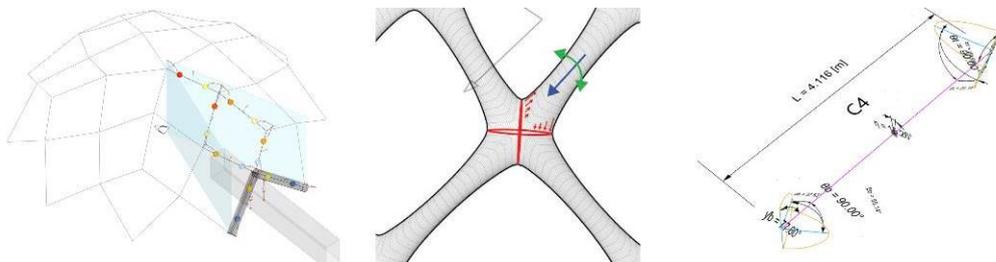


Figure 2. a) Parametric Model; b) Forces in joints; c) Rationalized component model C4