Development of a double curved and twisted bearing construction of glued laminated timber, including the resource-friendly production technology

CHALLENGE

The aim of the cooperation between HafenCity University and Hess Timber Limitless is the development of a new laminated timber beam system that can be used as basis segment for double-curved freeform surfaces.

Especially the development of a holistic concept for a new, integral, and consistent structural design method and fabrication technology are in the focus of the research project. Altogether a multi-functional laminated timber beam structure for wide spanning double-curved shells will be developed and realized.

From a manufacturing point of view it will be possible by developing a totally new fabrication system for double-curved and twisted laminated timber beam system to open up new applications for load-bearing long-span timber structures.

For the development of a gluing technology of wooden fins it is necessary to further improve the production equipment. More over the pressing process under consideration of the drying time of the glue with attention to the free positioning and fixation of the presses are emerging challenges that need to be engineered.

Another aim of the project is the development of a calculation concept that enables a holistic structural design including the numerical verification of the knot-system. By developing a design model of the timber beam structure, consisting of beams and knots, a numerical analysis system with free defined parameters shall be developed to optimize the variable configuration of double-curved surface timber structures.

Further more a data transfer tool to interchange geometrical and structural data between a geometry tool (Rhinoceros 3D) and a frame-structure calculation tool (R-Stab) shall be programmed with the possibility to integrate a recursive algorithmic optimization system.

Picture1: D1 Tower, Dubai, Finished 2012; www.hess-timber.com/

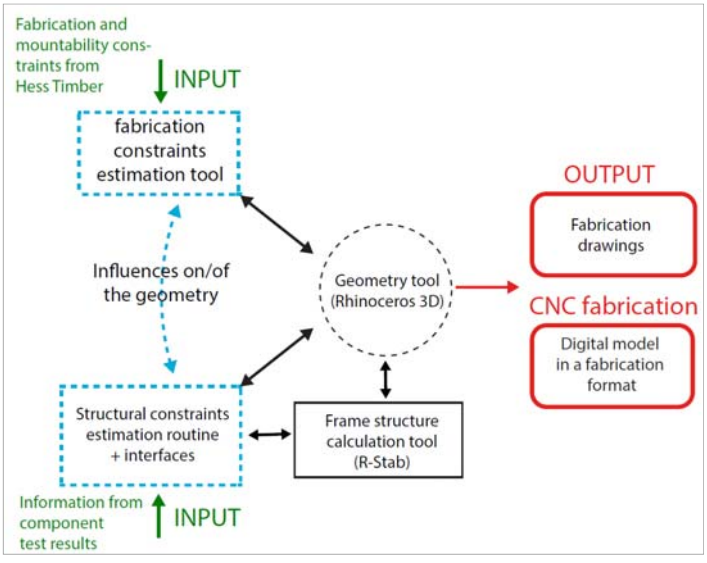
METHOD

To realize the holistic concept of fabrication and planning, as outlined above, the engineering solution concept requires the development of connections, technical tests and a parametric digital model based on variables to evaluate structural systems.

Picture2: Test setup for the new connection

First of all, knots with different configurations will be developed, accompanied with mechanical tests of transversal and longitudinal joints.

The test results about the load-bearing and deformation characteristics of the knots and beams are implemented into a structural model as mechanical constraints. Additional geometrical constraints that are used to evaluate the feasibility of a structural solution, are the maximum component dimensions given by transportation and mount ability in the digital model.



Picture3: Organization of the digital model for the implementation and optimization of timber structures for double-curved façade surfaces

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