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Digital Fabrication of a Timber Bridge

Laetitia KONING*, Stijn JOOSTEN[a]

*Department of Civil Engineer at the Technical University of Delft, Stevinweg 1
and Arup, Naritaweg 118, Amsterdam, the Netherlands
laetitia.koning@arup.com

[a] Arup, stijn.joosten@arup.com

Abstract

Research on digitally fabricated timber structures has been focused on design for an architectural rather than a load-bearing purpose. To fulfill a load-bearing and civil engineering purpose, the design needs to address outdoor conditions, a large number of load cases, strict safety requirements, and a strong focus on connection design with sufficient strength and stiffness.

This is examined through a case study: the design of a timber frame bridge that is fabricated using CNC-milling techniques, with a strong focus on the design, structural calculation, optimisation and detailing of the connections and their integration in the global design.

This research shows that the innovative combination of a reciprocal grid structure and interlocking joints is particularly suitable for a complete digital fabrication and assembly workflow. However, the strong relation between the various structural elements due to the statical indeterminacy of the structure and the embedment of the connections into the beams leads to a strong relation between design parameters and therefore a complex design process. To deal with this complexity, a completely parametric design and calculation workflow is developed in which consecutively the global design of the bridge, the connection design and the integration of both is addressed. Thanks to design tools like evolutionary solvers and machine learning algorithms it is possible to deal with the complex integration of a parametrically informed design on both global and connection level.

This research takes a step towards application of digital fabrication for load-bearing and civil engineering purposes, by showing an approach for the design of a digitally fabricated timber bridge, integrating the global and connection design, and confirming the structural capacity through lab testing.