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Performance Assessment of Double-Layered Timber Plate Shells using Alternative Structural Systems

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Abstract

With recent advances in digital fabrication, innovative wood-wood connections inspired by ancient timber joining techniques have recently been applied to various free-form timber plate structures [1]. This paper focuses on the recently developed double-layered and double-curved timber plate shells [2]. Design, fabrication and numerical automated tools have been successfully developed for these structures. However, three-point bending tests on prototypes composed of fifteen boxes with no curvature have pointed out challenges in the initial assembly system [3]. Namely, failure paths which can be attributed to the herringbone pattern used to segment the target surface were appearing at the stretched bottom layer. This research presents the performance assessment of double-layered timber plate shells using an alternative structural system to the initial one. Numerical investigations were performed to compare both systems in terms of displacements and forces in the joints. The proposed design, involving additional abutment areas of the boxes, was shown to enhance the interlocking connection of the plates and, therefore, the stiffness of the structural system. Tensile forces in the joints were also significantly reduced.

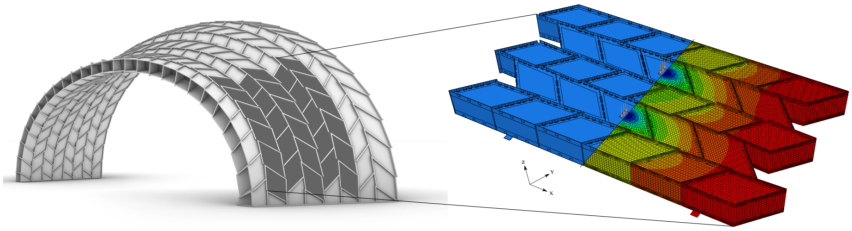

Figure 1: Double-layered and double-curved timber plate shell with the proposed modified design modelled with Rhino® (*left*) and finite element model of a small-scale prototype without curvature built with Abaqus™ (*right*).

References

[1] A. Menges, T. Schwinn and O. Krieg (eds.), *Advancing Wood Architecture A Computational Approach*, Routledge, 2016.

[2] C. Robeller, M. Kinakovic, M. Dedijer, M. Pauly and Y. Weinand, A Double-Layered Timber Plate Shell - Computational Methods for Assembly, Prefabrication, and Structural Design, in *Advances in Architectural Geometry 2016*, Zurich, Switzerland, September 9-13, 2016, S. Adriaenssens, F. Gramazio, M. Kohler, A. Menges, M. Pauly, Zurich: vdf, 2016. pp. 104-122.

[3] A. C. Nguyen and Y. Weinand, A Double-Layered Timber Plate Shell - Computational Methods for Assembly, Prefabrication, and Structural Design, in *Proceedings of the World Conference on Timber Engineering (WCTE 2018)*, Seoul, South Korea, August 20-23, 2018.