

TOWARDS SUSTAINABLE TIMBER CONSTRUCTION THROUGH THE APPLICATION OF WOOD-WOOD CONNECTIONS

Y. Weinand^{1,2}

¹Professor and Director of the Laboratory for Timber Constructions (IBOIS), School of Architecture, Civil and Environmental Engineering (ENAC), École Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Vaud, Switzerland

²Principal Investigator, the National Centre of Competence in Research (NCCR) Digital Fabrication (DFab), Zürich, Zürich, Switzerland.

e-mail: yves.weinand@epfl.ch

SUMMARY

This paper introduces a series of sustainable timber construction using wood-wood connections, which are driven from environmental requirements. These constructions are based on geometries like origami and free-form instead of standard structural elements. In addition, to predict the structural behaviour, the simplified numerical methods for accurately modelling are used. The aim of these case studies is to better explore the value of wood-wood connections as inheritance of ancient culture and extend research on their integration into design processes. Through the design, manufacturing and assembly stage, the connections are investigated as a driver for architectural forms. The utilisation of these innovative connections with minimised metal connectors ensures the rapid, precise and simple assembly process. With in-depth study and innovation of the ancient wood-wood connections, experience in prefabricated timber structure not only offers new geometrical opportunities, but also expands the understanding of integration of ancient and modern cultures.

Keywords: *Innovative Timber Structures, Wood-Wood Connections, Integral Mechanical Attachments, Digital Fabrication, Robotic Assembly, Sustainability.*

1. INTRODUCTION

Currently, building materials are required to be sustainable, lightweight, structural, multifunctional, compelling, and receptive to parametrically-driven forms enabled by digital design. One of the answers to many of these criteria is wood. Wood is of particular interest since it grows naturally, it has a positive carbon footprint and is recyclable. Wood does not depend on a specific technology or industry. It is not newly invented, but is indeed one of the oldest building materials. In our days, timber is more and more recognised as an advanced material for future constructions on a green planet. Timber and timber-derived products are mechanically performative. Timber can be employed as a load-bearing structure, façade claddings, floor systems, ventilation systems and interior design and furniture. In addition, it is generally considered aesthetically pleasing because of its organic grain and depth of tone and colour.

In the long history of architecture, wood plays an almost continuously dominant role as a building material. Buildings that still stand today showcase intricate construction systems driven by wood-wood connections—the most famous of these being Japanese and Chinese traditional temples. The traditional, pure wood-wood connections, affected by locations, materials and also aesthetic values, from Europe and the Anglo-Saxon area differ from China and Japan, embodying various cultural characters. These traditional timber constructions, a perfect reflection of know-how in the art of timber carpentry, persist over the ages. In traditional wooden architecture, the connections are regarded as the main actors in the implementation of the planned architectural form and have an effect on determining the method used for the construction of the whole structure to the details of its frame. More importantly, the connections have an essential meaning, as they contain clues in understanding the construction principles. As the core of architecture expression in timber structures, the structural style of connections is of great significance to the overall performance of the whole building. Details