High-Performance Longitudinal Timber Joints

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Sustainable wooden joints will play an increasingly important role in the future of timber construction. This thesis examines how traditional longitudinal timber joints can be optimized for CNC manufacturing to reduce the use of metal and adhesives. Automation helps save time and costs, while the findings serve as a guideline for architects and construction planners in the Asian market.

Introduction

Sustainable wooden joints are becoming increasingly important in modern timber construction. The dependency on metal fasteners and adhesives presents both ecological and economic challenges. This thesis investigates how traditional longitudinal timber joints can be optimized for CNC manufacturing to create sustainable alternatives. A key objective is to develop a practical guide for architects and construction planners in the Asian market, where traditional timber construction remains significant. A feasibility analysis is conducted early in the process to assess critical factors such as tool requirements, manufacturing tolerances, and economic viability, allowing for optimized strategies to be developed.

Concept

This study focuses on traditional longitudinal timber joints, particularly those from Japanese construction, known for their high load-bearing capacity and interlocking design. The joints are analyzed in terms of geometry and mechanical performance and adapted for CNC joinery machines. Special emphasis is placed on processing challenges without specialized tools and achieving precise fitting. Two traditional Japanese longitudinal joints were selected and analyzed. Their geometry was modified for more efficient CNC production. A third variant was developed to combine the advantages of both adaptations into a single optimized design.

Goals

The primary objective is to develop a high-performance longitudinal joint that eliminates the need for metal and adhesives while being efficiently manufacturable on CNC machines. Additional goals include:

- Reducing material costs and environmental impact by avoiding metallic or adhesives.
- Ensuring fast and precise production through optimized geometries for CNC machining.
- Assessing manufacturing effort, tool requirements, and economic viability early on.
- Comparing the developed joint with existing alternatives in terms of production feasibility and cost-effectiveness.

Result

The study demonstrates that traditional longitudinal timber joints can be successfully optimized for CNC manufacturing without compromising structural performance. By strategically modifying the joint design, high precision and efficiency are achieved. The feasibility analysis provides insights into economic and technical challenges, supporting the viability of the proposed solutions. The findings offer a sustainable, cost-effective alternative to conventional joints, promoting resource-efficient timber construction. The developed guide assists architects and planners in integrating traditional joints into modern designs, particularly in the Asian market, where interest in traditional timber construction and CNC technology is growing.

The traditional longitudinal wood joint Kanawa-Tsugi crafted in manual joinery (Model)

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