



## CNC-fabricated formwork for a UHPFRC thin folded plate arch

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### Abstract

Folded plate structures or shells are statically efficient structures. However, their construction is limited by the complexity and cost of their formwork. We used Computer Numerical Control Milling Technology to design a wooden formwork for an Ultra-High Performance Fibre Reinforced cement-based Composite (UHPFRC) folded plate arch. This paper describes the design and assembly of a formwork made from cross-laminated veneer lumber panels (LVL) with integrated wood-wood connections and the testing of the resulting thin origami-like UHPFRC arch. Currently achieved for a lab scale, CNC wood milling technology combined with integrated panel joints could enable mass-customized formwork for complex structures. UHPFRC is probably the only existing material with required strength and sustainability properties for ultra-thin structures. However, special attention should be given to the casting direction and fibres orientation in sharp edges. Based on this consideration and the result of the first lab test, some geometric adjustments and construction details are proposed and discussed in this paper.

**Keywords:** timber folded plates shell, Ultra-high performance fibre reinforced cement-based composite (UHPFRC), CNC-fabricated formwork, integral mechanical attachment, digital fabrication

### 1 Introduction

Folded plate thin shells are statically efficient and stiff structural systems to cover large spans with a minimal amount of material. However, they are complex and expensive to realize in concrete with conventional formwork techniques. The high labour cost of formwork reduces the competitiveness of using relatively cheap wood panels for casting.

Recent developments in wood panels jointing techniques and Computer Numerical Control (CNC) technology enable the construction of timber folded plate structures [1][2]. Firstly, the new integrated mechanical attachment technique for panel edgewise connection allows rapid and precise assembly of panel elements without metal fasteners. Second, digital fabrication makes it possible to customize every structural element without extra fabrication time and cost.