

Reviving ancient timber construction: Design of a chemical-free long-span timber Shell roof

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Abstract

An important process in wine fabrication is the vinification, where the must of the grapes is transformed into wine. Traditionally, the wine is stored in barrels in a vat-room. For the conception of a vat-room for a high quality vine in the French Burgundy, a barrel-shaped roof with a span of 8m was designed. The requirements for the environment for the maturation of the stored wine, extend even to the structural level; the use of natural resources should be maximized, is to maximize whereas chemical products should be reduced as much as possible. This has led to the use of solid wood for the arched roof structure and masonry walls. Due to architectural requirements, the thickness of the masonry walls is to minimize and no tension cables spanning in the vat-room are allowed to absorb the horizontal forces resulting on the bottom points of the arc.

Since the use of glue-laminated timber is not possible due to the project requirements and curved solid wood elements are limited to a certain length, different ancient construction techniques have been explored during the design process, such as roofs in the style of Zollinger or de l'Orme. Eventually, mainly for practical reasons concerning the installation on site, the design of the structure was inspired by the construction technique in the style of Philibert de l'Orme [1]. The French architect primarily used this technique in the 16th century, where one arch is composed by multiple, shorter curved solid wood elements. Those elements are overlapping to transfer the charges from one element to the next, constituting one arch (Figure 1a). While in the ancient construction technique traditional wood joints were used for the connection of the arc elements, in this project screw connections are designed. This maximizes the net cross section, the rigidity of the joint and therefore the stiffness of the overall structure (Figure 1b).

In order to stabilize the arches without transferring perpendicular horizontal forces to the masonry walls or using tension cables, as it is the case with traditional arched roofs, the battens are used structurally. Two layers of battens are fixed diagonally, in two directions in an angle of 45°, onto the arches, following the curvature of the barrel-roof (Figure 1c). They transfer the loads to the gable walls, which take them down to the foundations. The battens are simply screwed on the arcs; thus a shell is created while avoiding chemically processed plates like OSB or Plywood. With this three-dimensional structure, consisting of discontinuous elements, the strict requirements could be respected.

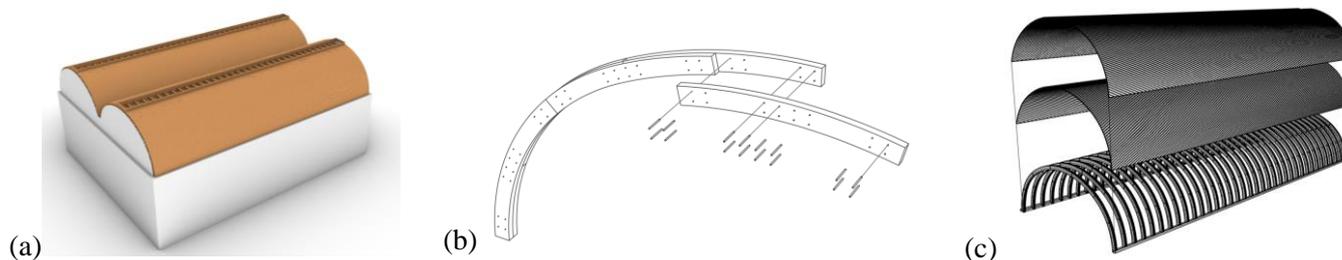


Figure 1. a) Building (vat-room); b) Layers of the roof structure: arcs – first layer of battens – second layer of battens; c) overlapping arc elements

The study shows how a traditional, nowadays rarely used construction technique can be adapted and coupled with other structural typologies to respond to project requirements and valorize the natural resource wood without any chemical additives.

Keywords: Timber spatial structure, arch structure, Philibert de l'Orme, conceptual design, structural analysis

References

[1] Philibert de l'Orme, "Nouvelles intentions pour bien bastir et à petit fraiz", *F. Morel*, 1561.