

Digital formworks in innovative Catalan tile vaulting

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Abstract

The complex and sophisticated funicular tile vaults, presented here, are part of a rehabilitation project of a residential property situated in Ault (France), led by architect Christian Pottgiesser. The goal of this research is to explore the advances in funicular tile vaulting through form finding methods on the one hand and the experiments in compressed earth tiles constructions, using innovative virtual formworks on the other hand.

As a solution to preserve the site's heritage, the irregular perimeter walls of the existing building confine the funicular vaults. So, in order to be able to control a set of boundary conditions, the structural design tools, based on Thrust Network Analysis (TNA), such as Rhinoceros plugin, "RhinoVault" [1], were used in the process of form finding. The goal of this iterative approach is to get an overall compression only vault surface, which can then be constructed with the traditional methods such as brick masonry. Looking for the resource efficiency and a local and low-priced material, we have chosen an ecological modular tile, composed of the raw earth, excavated from the construction site and pressed on place [2].

In addition, in order to approach the traditional construction methods, in which the heavy formworks are replaced by the intelligently positioned guideworks, a "virtual formwork" will be explored. This "virtual tool" is based on the new applications in construction, offered by reality-augmented technology [3]. It is supposed to improve the construction process by minimizing the need to the cumbersome formworks and by virtually assisting the traditional masons.

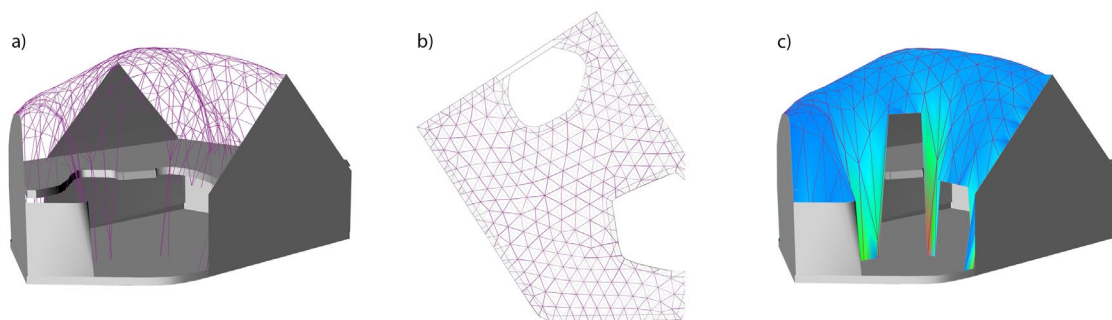


Figure 1. Some representations of form-finding process, a) vault guiding curves, b) vault boundaries, c) vault surfaces

To illustrate this methodology, validate the plausibility of the construction approach and assess the robustness of the design procedure, some prototyping stages, as well as some laboratory tests on extracting soil have been organized.

Keywords: Catalan vaults, press soil tile, digital formworks, compression only optimization, form-finding, structural analysis, augmented reality, cyber mason, construction soil excavation, local material.

References

- [1] M.Rippmann, L.Lanchauer, P.Block, "Interactive vault design", *International journal of Space structures*, vol27, No4, 2012
- [2] M.H.Ramage, J.A.Ochsendore, P.Rich, "Sustainable shells: New african vaults built with soil-cement tiles", *Proceedings of the international association for shell and spatial structures (IASS)symposium*, Valencia, 2009
- [3] G.Jahn, C.Newnham, N.van den Berg, M.Iraheta and J.son Wells, "Holographic construction", *conference paper*, December 2019