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Patterns for Masonry Vault Design

Robin OVAL[a,b] *, Matthias RIPPMANN[a], Tom VAN MELE[a], Olivier BAVEREL[b], Philippe BLOCK[a]

*Navier MSA and Block Research Group, Stefano-Franscini-Platz 1, HIB E 45, 8093 Zurich, Switzerland, robin.oval@enpc.fr

[a] ETH Zurich, Institute of Technology in Architecture, Block Research Group, Switzerland

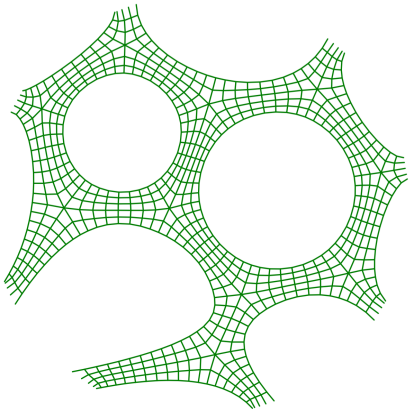
[b] École Nationale des Ponts & Chaussées, Navier MSA, Paris

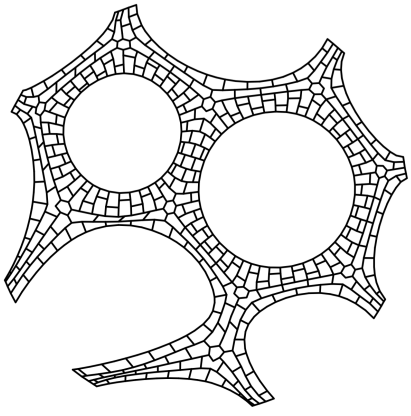
Abstract

This paper presents a methodology for a fully controlled pattern design scheme for funicular form finding, with extensions for automatic tessellation of masonry vaults. The user efficiently controls the pattern topology, singularities and density.

Unreinforced masonry vaults work primarily under compression. The double curvature and high degree of hyperstaticity in these structures allow a wide range of solutions, even for a given set of boundary conditions. Thrust Network Analysis [1] implemented in RhinoVAULT [2], permits an interactive graphical exploration of the design space, based on form and force diagrams derived from graphic statics methods.

The generation of patterns that permit an efficient exploration of possible force equilibriums is crucial to allow the designer to steer the form-finding process. This research proposes a fully controlled pattern design methodology to generate form diagrams that display a good boundary and feature alignment for a small set of singularities. The methodology takes into account the problem's boundaries as well as point and curve features like point loads and creases. Once the geometry of the vault is found, it still could be tessellated for a masonry vault. A straightforward extension of the methodology has been developed to convert the force diagram into a tessellation that guarantees a good alignment between the normal of the joints and the force network layout generated for the form-finding process.





Keywords

Structural patterns, meshing, funicular shell, thrust network, form finding, masonry vault, tessellation.

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