POLYTECHNIC OF TORINO
FACULTY OF ARCHITECTURE
Degree in Architecture
Honors theses

Structural analysis of a complex vault: the Filippo Juvarra's vault in the "Sala degli Stucchi" at the Rivoli's Castle

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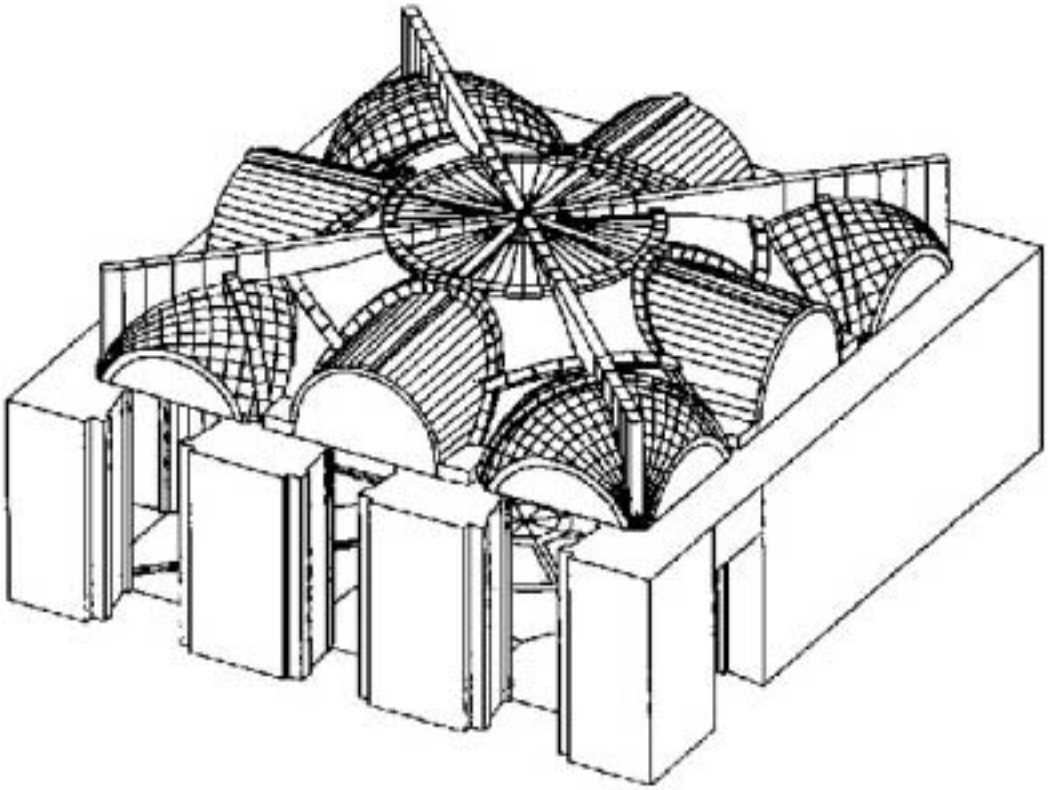
The present work's aim is to investigate the structural behaviour of a particular vault, built by Filippo Juvarra in the 1718: the Sala degli Stucchi's vault, in the Rivoli's castle.
This structure is interesting not just because it was built by a Master of architecture like Juvarra, but mostly because this vault was planned in a very new way, according to what other architects were experimenting in others Turin's yard.

The vault of Sala degli Stucchi at Rivoli's Castle (Turin)

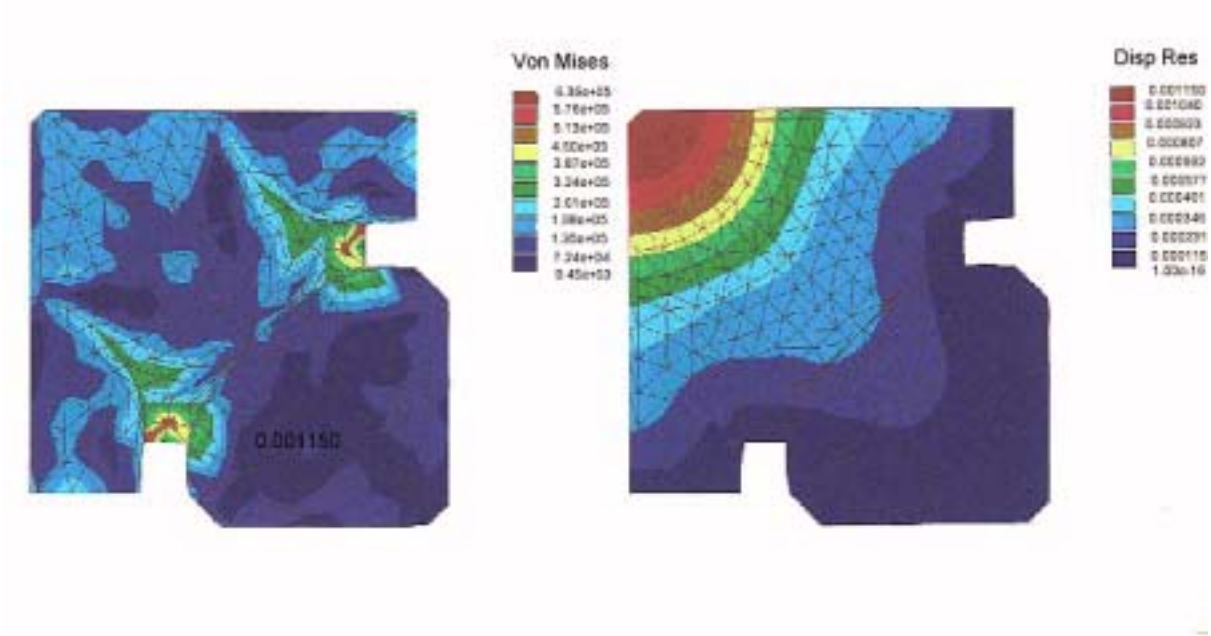
The Sala degli Stucchi's vault was planned at the same time as another architect, Jean Jacques Plantery, was attending in Turin the Palazzo Saluzzo Paesana's yard: in fact, the vault of Palazzo Saluzzo Paesana's atrium is quite similar to the vault of the Sala degli Stucchi at the Rivoli's castle.
These vaults have both the central part, which is a section of a sphere or of a barrel, cutted deep by other vaults, along diagonals and median lines: these other vaults can be spherical or portions of barrel vault.
A peculiarity of this kind of structures is that the higher point of the vault is not so much higher than the lower point's height.
This means, for instance, that the atrium or the room that has this kind of vault can be very good enlighted.
Another peculiarity is that both the central part of the vault and the cutting vaults have a structural task; you can see that by investigating the bricks structure: at the beginning, you can think there is an arches' framework that supports all the vault because you see thick arches at the different vaults' intersection.
Mostly it's not true but the cutting vaults have really a framework-task and they are not just a filling between arches.
The static-behaviour of this kind of structures is surprising, specially if you consider the knowledge of men that built them up compared with the very good results.



Assonometric view of the brick vault

Looking to understanding the static behaviour of these vaults and knowing how high are stress value in the brickwall, the structure was divided into a finite number of elements.

The vault was described by 600 elements with 340 nodes, using the Cosmos/m program.
The same features of the real brick structure were assigned to elements: the same elasticity modulus, the same mass density, the same thickness.
To nodes were applied the most important loads the structure is subject to: the brick structure load and the filling load.
After inputting this information, the Cosmos/m program can go on automatically to calculate displacements and stresses for each element and loads at nodes.
So it was possible to know stress in the brick structure and to see the deformation.
These results are quite interesting, otherwise there is always a gap between reality and virtuality. But knowing the bricks behaviour is really hard, because brick in an anisotrope material; so, it is very important to have the chance to analyse the whole walling structure and not just to investigate separately the brick behaviour and the mortar behaviour.



Stresses and displacements calculated
by the COSMOS/M finite elements programme

The electronic analysis results allowed to the design the pressure curves of the intersection arches and to know wich are the most stressed areas.

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