

POLYTECHNIC OF TORINO  
FACULTY OF ARCHITECTURE  
Degree in Architecture  
***Honors theses***

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**Structural analysis of the scurolo of the Holy Shroud Chapel**

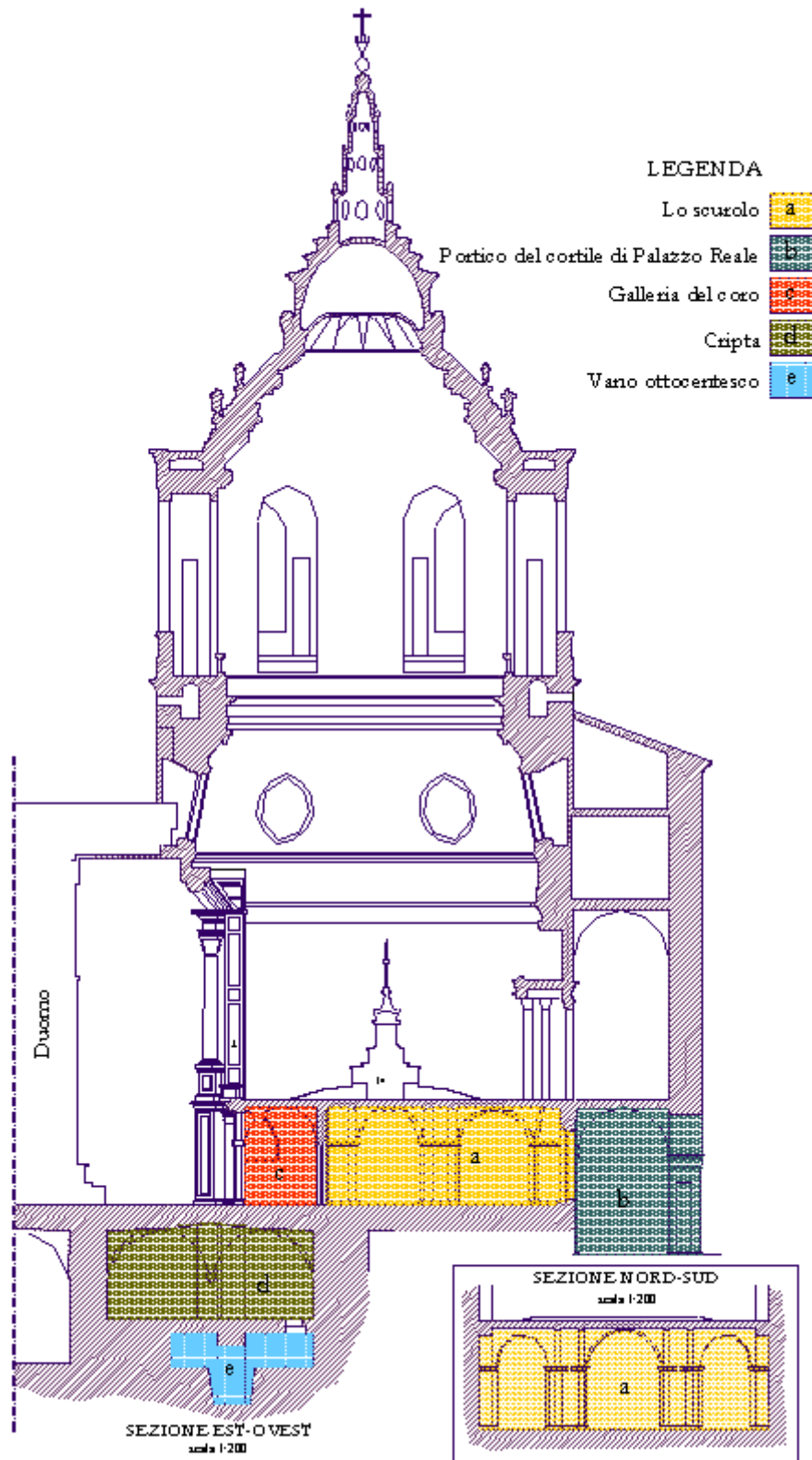
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The Chapel of the Holy Shroud in Turin is certainly one of the most important examples of baroque architecture. This monument is the starting point of the treatment, but not its real subject.

The thesis is focused on the “scurolo”, the room located under Guarini’s temple; although it is not well-known, it plays a primary role in the structural life of the chapel. Its vaults supports the chapel’s floor, and its side walls hold up the weight of the cupola. Moreover, considering the last events, the role of the scurolo has become also more important than before.

During the night between 11th and 12th of April, 1997, a terrible fire had almost devastated the chapel. It happened only few days before the re-opening of the chapel, after a long restoration. During that period the floor of the chapel was weighed by a big scaffold and props were mounted in the scurolo in order to support its vaults. But the fire vanished each effort taken and involved again structural problems for the chapel.



Section of the Holy Shroud Chapel, Turin

The subject of the thesis pertains to the new period of restoration: it is a structural analysis of the scurolo vaults by means of the Finite Elements Method.

The scurolo is the semicircular room located below Guarini's temple; its plan has a perimeter similar to that of the chapel and is interrupted by the chorus wall of the Dome in a way that gives the room the shape of a deambulatory.

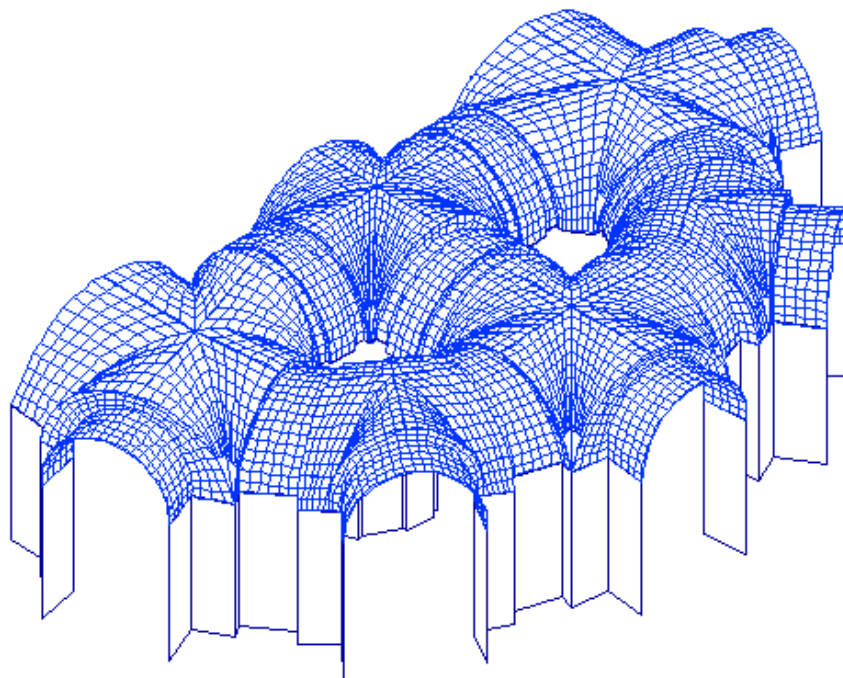
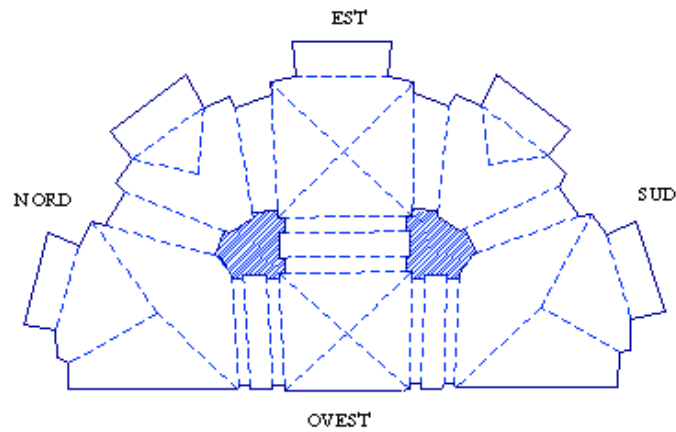
The scurolo has two massive pillars located at about one third of the room span. On pillars and side walls rest the vaults that sustain the Chapel.

The model has been implemented on the basis of two surveys, one of architect Abrardi and the other of the candidate.

The thesis is divided in two parts, the first one concerns the history of the monument: the architecture of the seventeenth century chapel depends strictly to the Renaissance Dome. In fact It was built on the head apse of the church, to replace a part of the chorus. The construction of the Chapel was completed after a tortuous process that, through various projects, got its solution with Guarini's genius.

The second part of the thesis treats of the structural behaviour of the Scurolo. First of all a study of the structure has been performed: definition of mechanical properties of constitutive materials, type of construction. Therefore mechanical properties of brick wall and structural behaviour of double curved vaults have been reported.

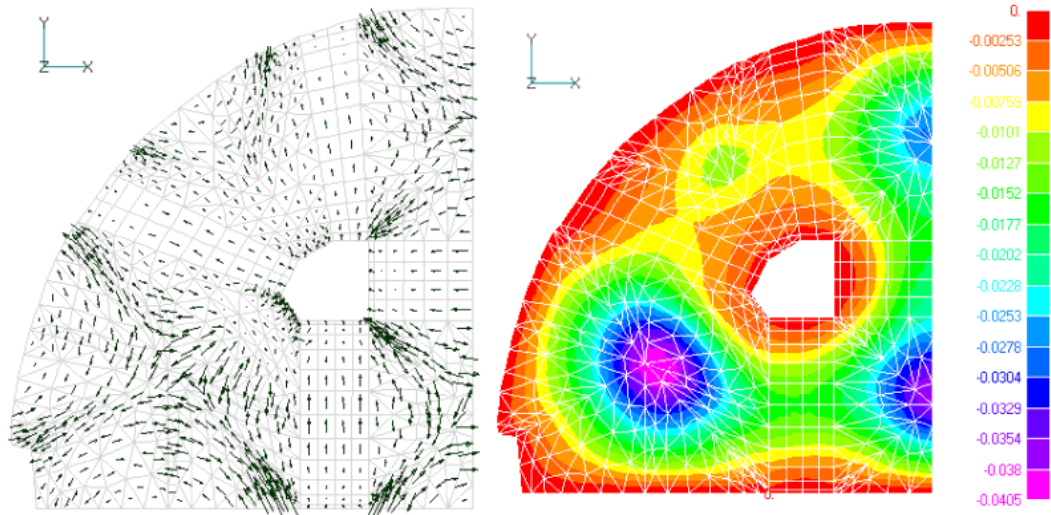
The thesis describes the theoretical basis of structural analysis, the mathematical problem and the methods to solve it with a particular attention for the Finite Elements Method. The simulation of the structure started by implementing the geometrical model by means of a C.A.D. software, then the geometry has been used to build the FEM model with MSC/NASTRAN. The vaults of the Scurolo have been represented by a model composed of 1955 nodes and 867 elements and completed with the boundary conditions.



The Scurolo plan and assonometric view of the CAD model, South-East side

Goal of the thesis is to analyse different aspects of structural behaviour of the scurolo vaults. Therefore several cases of loads have been simulated: permanent loads, loads due to the new restoration works and to the presence of visitors after the re-opening of the monument. A particular case, representing the presence of a sinking in the pillars while the chapel is under repair, has been studied.

The results have been postprocessed and analysed by means of diagrams of displacement, stress and deformation obtained with the software.



Stresses and displacements calculated by the NASTRAN finite elements programme

Even if we have to remember the differences between the real structure of the scurolo and its implemented FEM model, from a qualitative point of view, the results of the study permit us to improve our knowledge about the static behaviour and deformation process of the structure itself.

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