POLYTECHNIC OF TORINO
FACULTY OF ARCHITECTURE
Degree in Architecture
Honors theses

Structural analysis of the finished elements of the San Lorenzo dome
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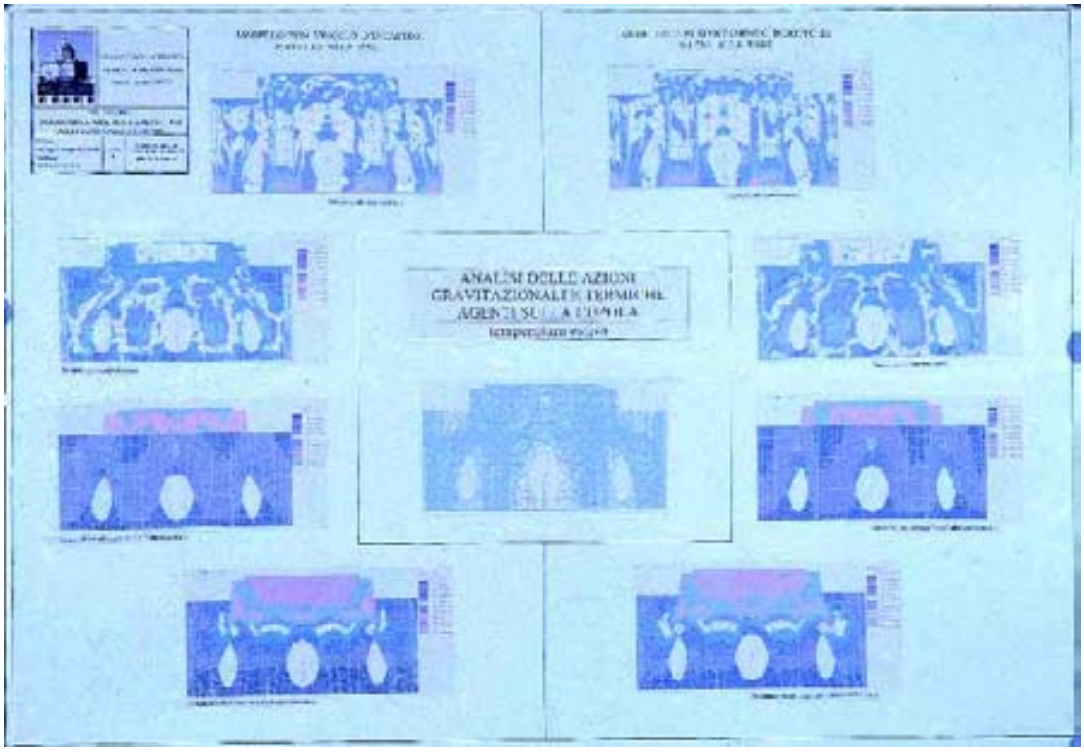
The subject of this thesis is the structural analysis of the dome of the Church of St. Lorenzo by G.Guarini, which was started from his plans in 1668 and opened for the first time in 1680.

In this work I have tried to show the relationship extant between the particular typology of the dome and its resistant structure. Basically I have tried to verify whether the choice of building the dome with a system of interwoven arches was made because of symbolic-expressive influences or because of purely static-structural matters.

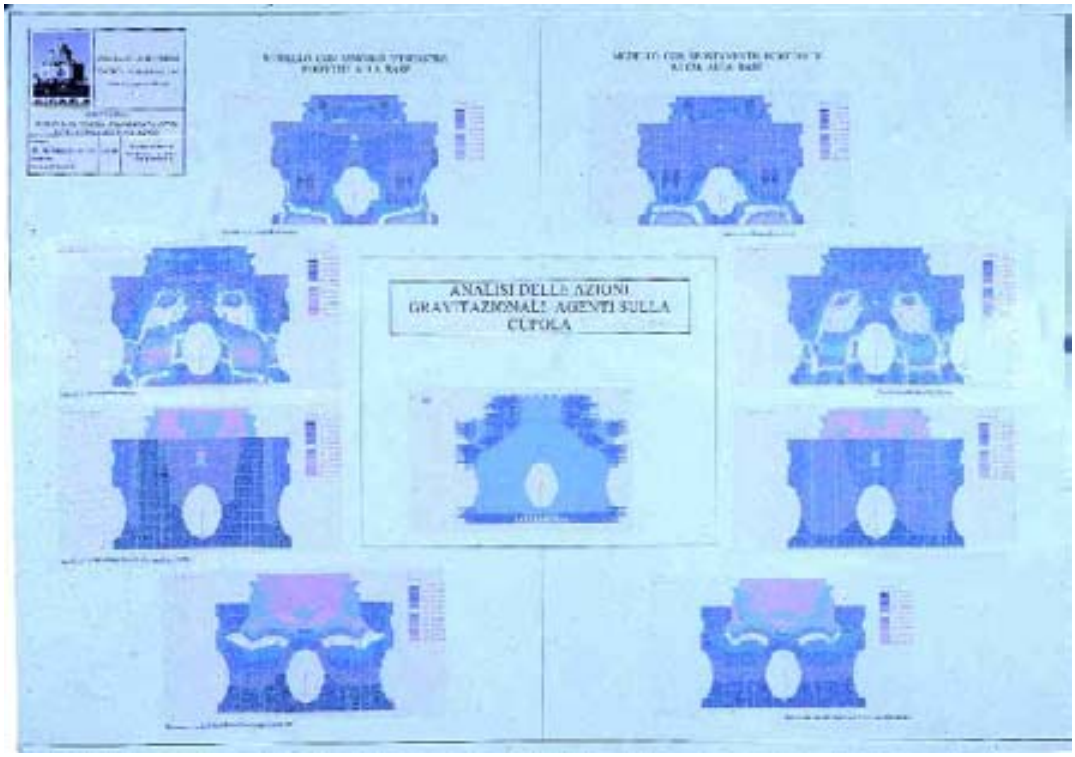
I fulfilled this aim through an attentive analysis of Guarini's cultural background, an accurate description of the Church, the study of the tangled - and often hidden - structures of the dome, some historical-structural considerations and finally the study of the results obtained with the linear analysis.



The St. Lorenzo Church presents in the inside an undulated environment, which perceptively seems to be burdened by forces which find one only forced outlet toward the top, where Guarini puts the stately dome.

The study of the treaty " Architettura Civile" has produced useful indications which allowed me to understand sources and stylistic influences, represented mostly by the works of the Islamic Civilization and by the themes peculiar to the " Ordine Gottico " .

After this introductory studies I proceeded to examine closely the structure of the dome, analysing it in its static, tensional and deformative regime, through the method of the finished elements.



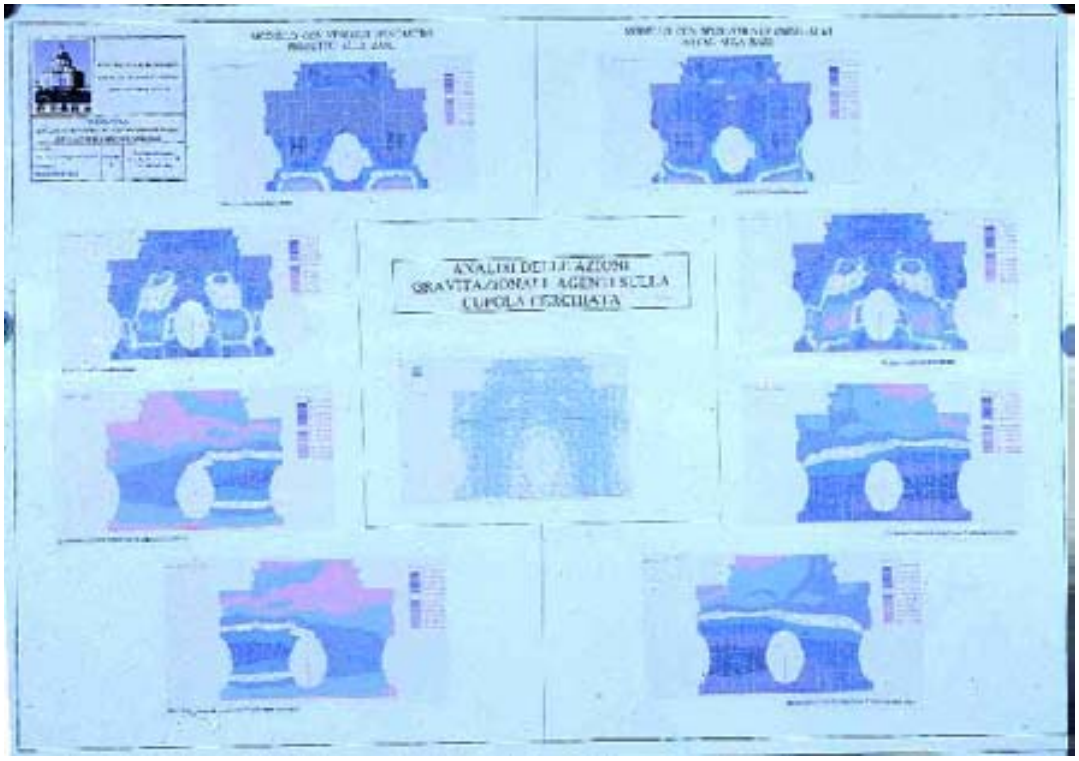
The last part is based on the construction of the numerical model of the dome and represents the main element of novelty of this thesis. In fact the construction of the model is characterized by an attentive and authentic reconstruction of the dome, based on the exact geometry of the fabrication, which has been possible thanks to the aid of the survey made by Prof. Arch. Franco Rosso.

After generating the general geometry of the dome, what followed was the phase of discretization of the model (constituted by one fourth of the dome) using TETRA10 and BEAM3D elements. Finally I have defined the conditions at the contour.

Beside the analysis effected considering the gravitational agency, in a second phase of the study the thermic agency has been introduced as well, expressed in temperatures applied to the surfaces, both in the hypothesis of summer season and winter.

Finally I proceeded with the phase of automatic analysis. This phase was accomplished through the following types of analysis: gravitational agency working on the model with joint restraint perfect at the base and with induced shifts; on the hooped dome with joint restraint perfect at the base and with induced shifts.

Generally in all the effected studies the weight of the lantern has shown to provoke a pressing effect on the underlying dome, causing a vertical lowering that reaches its maximum value at the top. The numerical analysis has fully confirmed the intuition that determined the interventions of consolidation of the dome: the deformed presents a bending toward the outside that reaches its maximum at about half of the windows, not much below the level in which the metallic hooping is inserted.



Each single arch generally presents a situation of press-flexion at the impost hewn stone, with tension of traction at the intrados and of compression at the extrados. Vice versa, at the reins the situation is the other way around, with solicitations of traction toward the outside and of compression toward the inside.

Concluding, the dome has confirmed to be a highly stable structure: the intuition of Guarini of conceiving an elliptic profile is fully successful; all this has been achieved through a system of nervations which have the task of resisting and which are very reinforced in the areas where safety is more precarious. The absence of lesions and disarrangements is the experimental evidence of the success of the static intuitions achieved by making materials and skeleton work at their best.

Finally we can assert that the innovation brought by Guarini lies mainly in the effort of bringing the technics closer to the science: he is one of the first to understand that we

must give more importance to the science than to the practises of building. This explains the privilege given by Guarini to the geometric form of the structures.

As I have already said, Guarini chose to commit the static responsability to an ellipsoid, materialized in the intersecting nervations, which ideally circumscribes the dome and fulfills the requisites of stability at best. The choice of the elliptic shape for the St. Lorenzo's dome was made primarily both for the capability of this shape to capture and reflect the light and for the likeness to the traditional profiles of the emispheric domes; such a profile on the one hand satisfies the static necessity to define, for the built part, a dome with a bending radius as high as possible, on the other it satisfies the need, prominent in Guarini, to privilege his theories about the theological meaning of the light.