

Baroque banded vaults with independent arches: from literature to realizations in Turin atria

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Abstract – This contribution presents a part of the work and the methodology applied to it developed for the realization of an international research project. It is aimed at the analysis and preservation of an architectural heritage characteristic of Turin's Baroque architecture: the 'a fasce' vaults, locally named as 'a fascioni' (banded vaults).

This architectural element, used by important architects, such as Guarini up to the local masters, to cover spaces of various sizes, found in the Turin area a wide application in palaces atria.

A considerable number of banded vaulted atria were identified and surveyed by the research group. Then, those whose bands are generated from independent arches have been recognized and surveyed.

The objective is the comparison of metric and geometric data between ideal models and built architecture over time, to evaluate their variations and understand the constructive methodology through three-dimensional modeling.

Keywords – Banded vaults, Architectural drawing, Treatise, Baroque palaces, 3D modeling.

I. INTRODUCTION

This contribution presents a development of the work and methodology elaborated within the international research project "Nuevas tecnologías para el análisis y conservación del patrimonio arquitectónico" coordinated by Roberta Spallone, assisted by Marco Vitali at the Department of Architecture and Design of Politecnico di Torino. The project allowed the stay in Turin, as visiting professor, of Concepción López from the Department of Graphic Expression in Architecture, Universitat Politècnica de Valencia). The group includes, in addition to the author of this work: Giulia Bertola and Francesca Ronco (Department of Architecture and Design, Politecnico di Torino). The research, favored by funding from the Ministerio de Ciencia, Innovación y Universidades of Spain, is aimed at the analysis and interpretation of an architectural heritage characteristic of Turin Baroque production: the 'a fasce' vaults, locally named as 'a fascioni'.

The research project is a continuation of a study conducted by Roberta Spallone and Marco Vitali on complex brickwork vaulted systems in Turin Baroque

buildings [1].

The 'a fascioni' – or banded – vaults are architectural elements for the covering of medium and large rooms derived from Guarini's experience. Guarini describes their characteristics in *Architettura Civile* (published posthumously in 1737) [2] and applies their shapes in some of his projects. From Guarini's example, a remarkable production has emerged that has seen the work of many important architects, but also of others whose identity is unknown. They have applied formal and constructive principles that have become customary in Turin building site, which have allowed a wide application in the civil buildings of the city.

Eleven banded vaulted Baroque atria were identified by the research group. Eight of them are accessible. One of the objectives was to catalogue and recognize the vaulted structures with independent arches, and those whose arches are generated by vertical cuts of the main reference vault (e.g. pavilion, 'a conca', 'a schifo' (shell-like), etc.).

This analytical phase preceded the comparison of the metric data obtained by TLS (Terrestrial Laser Scanning) metric survey, coordinated by Concepción López. The information obtained from the point cloud was fundamental for the comparison through sections of the various parts of the structure. The philological reconstruction of the design idea was analyzed comparing the ideal schemes of the treatises, archive drawings, and realizations in the city, through two- and three-dimensional modeling.

II. ARCHITECTURAL TREATISES AND MANUALS

The 'a fasce' vaults are introduced, as we have seen, by Guarino Guarini into *Architettura Civile*. Starting from a rigorous knowledge on vaulted systems, with studies related to geometry, stereotomy, calculation of surfaces and volumes present in his previous treatises (*Euclides adauctus*, 1671 and *Modo di misurare le fabbriche*, 1674) in the *Architettura Civile*, Treatise III, chapter XXVI 'Delle Volte, e varj modi di farle', Guarini dedicates the 'Osservazione Nona' and the 'Osservazione Decima' to banded vaults and flat banded vaults. This text is accompanied by two plates, 'Lastra XIX' and 'Lastra XX' (fig. 1), in which Guarini graphically illustrates the principles set out in the observations through a double orthographic projection

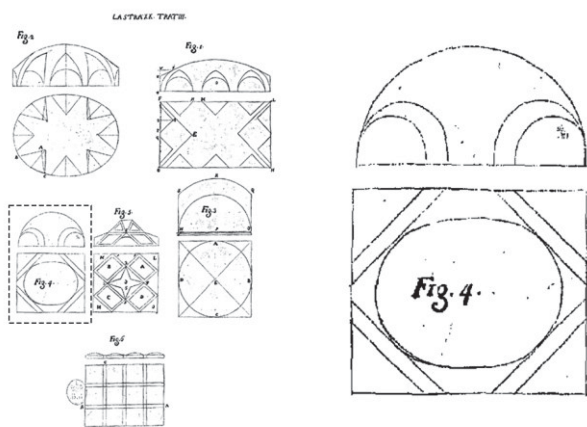


Fig. 1. Banded vault in *Architettura civile*. Guarini 1737, *Treat. III, Plate XX*.

The architect describes textually the spatial genesis of this type of vault starting from a division of the space to be vaulted through wall to wall bands, with perpendicular or oblique direction, to create fields, which can then be filled with vaults of different types.

References to this type of construction can be seen in the work of authors contemporary to Guarini, as in the case of the vault of the Sala di Diana in the Reggia di Venaria by Amedeo di Castellamonte (1661 – 1662) [3], and in later periods between the end of the 17th century and the early 18th century by Guarini's collaborators (for example Gian Francesco Baroncelli in Palazzo Barolo, 1692) or by other internationally renowned architects such as Filippo Juvarra in Palazzo Martini in Cigala (1716).

Two centuries later, Giovanni Curioni conducted a study on this type of vaults. In his *Geometria pratica* (1868) [4] he straddles the gap between a purely theoretical contribution and a practical approach. The author, starting from Guarini's teaching, develops further considerations regarding the origin of the generating surface of the bands: "on the polygon to be covered with one of these vaults already is the intrados of a vault which, depending on the figure of the said polygon, can be barrel, 'a conca', pavilion, barrel with heads of pavilion, 'a schifo', dome" [5]. The subsequent operations are carried out by cutting with vertical planes the reference surface: therefore, this do not seem to identify the construction for the independent arches. Also in the Turin area we find the work of Giovanni Chevelley. In his *Elementi di tecnica dell'architettura: materiali da costruzione e grandi strutture* (1924) [10] he collects the local building knowledge in the field of vaulted structures. Describing the banded vaults, he takes up the definition of Curioni and indicating some realizations he emphasizes their spatial qualities and variety of use, especially in the atria of civil buildings and churches of the 17th and 18th centuries.

III. BANDED VAULT IN ARCHIVAL DRAWINGS

Alongside the treatises source, we can also find the documentary source, which consists of the original Guarini drawings, or the work of his collaborators. These documents, kept in the Archivio di Stato – Sezione Corte, have been directly studied by the author of this paper. They are firstly published and analyzed in the archival regesto by Augusta Lange [6], for the 1968 conference on the figure of Guarini. Some of the drawings precisely concern the banded vaults to cover rooms in civil buildings (fig. 2) [7].

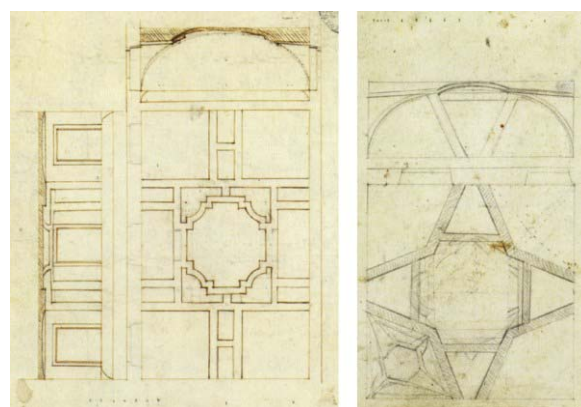


Fig. 2. G. Guarini, *Study of a banded vault*, 1680 c., Torino, ASTo, Azienda Savoia-Carignano, cat. 43, mazzo I, fasc. 6, n. 36; G. Guarini, *Study of a composed and banded vault*, 1680 c., Torino, ASTo, Azienda Savoia-Carignano, cat. 95, mazzo II, fasc. 115, n. 23.

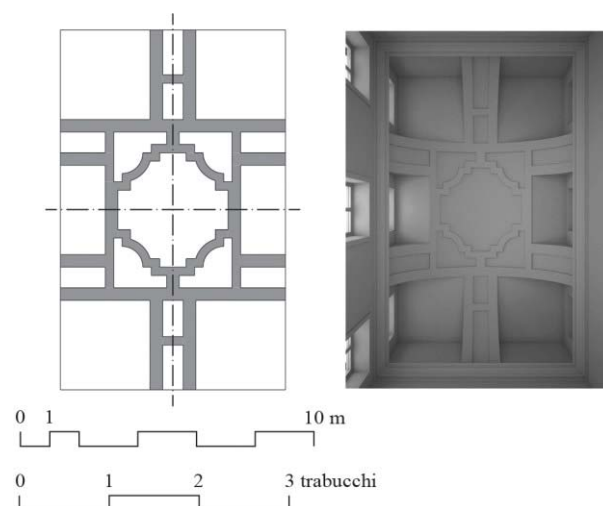


Fig. 3. Plan distribution and digital reconstruction of a Guarini's banded vault. (Drawing and modeling: F. Natta).

The examples describe different layouts starting from the tracing of the bands, perpendicular to the wall in the first case, and oblique in the other: both present independent arches [8] [9].



Fig. 4. Banded vault in baroque atria in Turin: Palazzo Martina di Cigala, Palazzo Capris di Cigliè, Palazzo Barolo. (Photos: F. Natta).

The first (fig. 3), even in a hypothetical three-dimensional view, reveals many similarities with the surveyed vaults

This structure is characterized by the doubling of the bands; starting from the transverse arches, the longitudinal band is specularly supported, leaving the central field free for the insertion of further decorations, as described in Guarini's treatise.

IV. BANDED VAULTS IN TURIN BAROQUE ATRIA

The applications of this particular type of vaulted structure find therefore after Guarini large development in the city of Turin, and take the maximum expression and variety in the atria of the Baroque palaces of the city. The already mentioned works by Castellamonte and Juvarra seem to follow a typological taste that involves many other authors. In their realizations, it is possible to identify those characters derived from Guarini's thought but also to understand the peculiarities of different creative processes.

The phase of identification and cataloging of these vaulted structures was therefore fundamental. Is it possible to firstly identify a census maps in the research directed by Cavallari Murat and published in *Forma urbana e architettura nella Torino Barocca* (1968) [11] and later in the volume by Spallone and Vitali (2017).

This kind of structure was built between the 17th and 18th centuries in the areas of the second and third Baroque extension of the city.

In the variety of the atria surveyed, three until now have been identified as belonging to this category (Table 1).

The classification identifies the maximum dimensions of the vaults and the grids layout.

Table 1. Baroque atria under analysis.

| Address | Width, Depth, Height | Grid |
|------------------------|----------------------|------|
| Via della Consolata, 3 | 7,66 x 10,37 x 6,75 | 3x5 |
| Via Santa Maria, 1 | 9,33 x 5,97 x 6,24 | 3x3 |
| Via delle Orfane, 7 | 8,62 x 10,42 x 6,78 | 3x4 |

This cataloging, certainly expandable by extending the analysis to entire buildings, has provided a first overview of the spatiality created through this structure. The most common grids, in the whole context, were 3x3, with a smaller number of 3x4 and 3x5 used for rooms with a larger floor plan.

The atria with vaulted structures generated from independent arches (fig. 4) by Filippo Juvarra (in Palazzo Martina in Cigala), Gian Giacomo Plantery (in Palazzo Capris in Cigliè), and Gian Francesco Baroncelli (in Palazzo Barolo) are characterized by a varied spatial division (fig. 5), maintaining the constant of the transversal arches as the basis for the creation of the bands and the vaults to complete the further fields created by the grids.

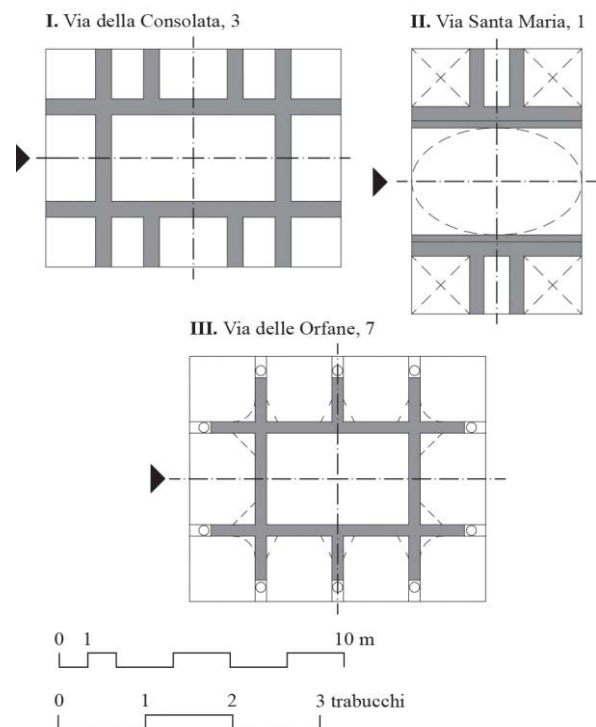


Fig. 5. Plan distribution of banded vault in baroque atria in Turin. (Drawings: F. Natta).

For the recognition of this type of structure, the point clouds generated by the TLS survey were therefore analyzed. Through a phase of identification of the characteristic sections by using the point cloud, we tried to compare this information to evaluate their conformation and geometric construction. The comparison is made between the sections that followed the same direction (in these cases only longitudinal or transversal, as there are no examples with diagonal arches). If the variances identified could be considered within a geometrically valid level (but not metrically defined and evaluated case by case), we proceed with the classification of this part of the vaulted structure of the atria.

I. Via della Consolata, 3

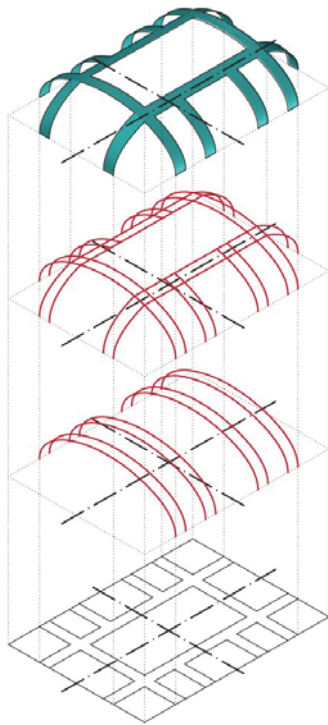


Fig. 6. Graphic analysis and digital modeling of independent arches in the baroque atria in examination. (Modeling: F: Natta).

The example of the vaulted atria of Via della Consolata is displayed to explain the classification method and the following identification of the constructive geometries (fig. 6). In this case, the cross-sections lay the basis for the construction of the independent arches. After this step, the subsequent longitudinal arches are positioned using the transversal arches as a support base. This second level of arches, due to the conformation of the space, in its central field is straight to cover the whole space in length. Solutions of this type result to be very common in these vaults (i.e. in the atrium in Via della Orfane).

The opportunities related to this type of structure allow the construction in the free fields of independent vaults, as suggested by Guarini's as we will see in the selected case study.

V. INTERPRETATION AND MODELING OF A BANDED VAULT: PALAZZO CAPRIS DI CIGLIÈ

The two-dimensional drawings allow making an initial analysis of the architectural consistencies which, reported in the three-dimensional model, are linked to the formal conception derived from architectural literature and archival documentation.

The case study now selected is Palazzo Capris di Cigliè (1730) by Gian Giacomo Plantery.

Data obtained from TLS survey (figs. 7-8) are used for restoring the symmetries in the drawing of the plan and searching the elementary geometries in the sections.

The method of analysis, developed in previous researches [12], is based on Guarini's general indications for the composition of this type of vaulted system: delineated the bands starting from the plan – identified in this case also three-dimensionally –, we pass to the filling of the empty spaces with small vaults.

The phases of geometric decomposition of the vaulted structure are shown through the representation in isometric axonometry (fig. 9).

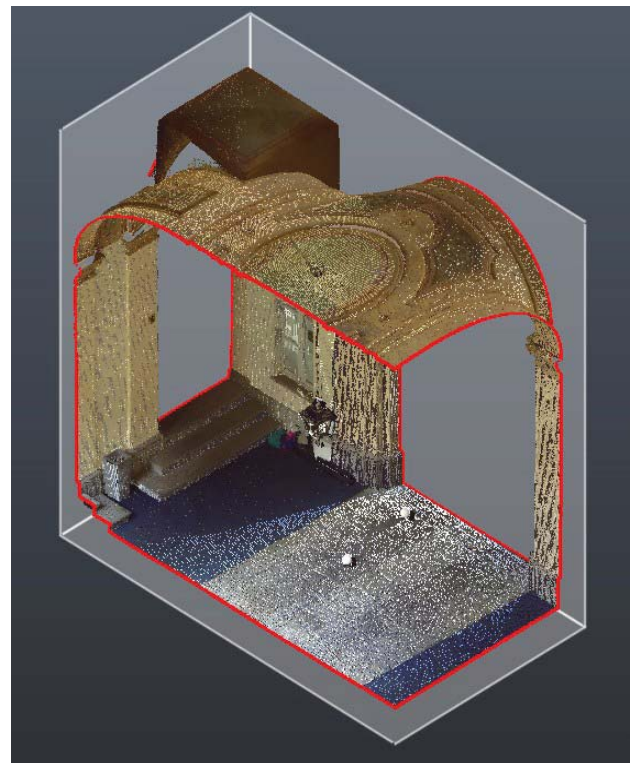


Fig. 7. Point cloud of atrium portion in Palazzo Capris di Cigliè. (Processing: F: Natta).

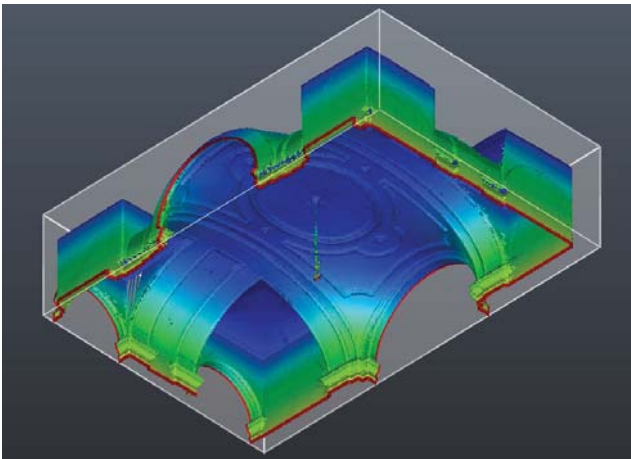


Fig. 8. Point cloud of vault in the atrium of Palazzo Capris di Cigliè. (Processing: F. Natta).

Through the sections of the point cloud are generated the most geometrically accurate curves (fig. 9b) (looking for a polycentric arc with the lowest possible number of centers). These curves, belonging to independent arches, allow generating the first order of the vaulted structure (fig. 9c).

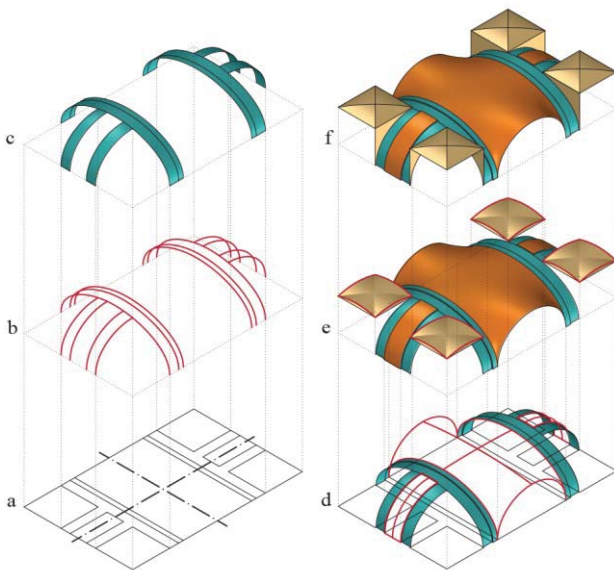


Fig. 9. Graphic analysis and digital modeling of the vault in Palazzo Capris di Cigliè. (Modeling: F. Natta).

In this case, the central area presents the interruption of the longitudinal arches leaving space to a single vaulted structure. This vault superimposed on the arched system, is sailed-shaped, as evidenced also by the decoration. Along the major axis, the portion of the vault between the two arches follows the same geometry of these arches, recreating the idea of giant arches already seen in Guarini's drawings (fig. 9d).

The last fields to complete this vaulted structure are

the angular ones. This vault is independent from the main structure. Cross vaults are set starting from the intersection of the arches and they develop with very low height (fig. 9e).

One of the most relevant features of this case is certainly the width of the discontinued bands, with specifications similar to those of the Guarini design (figs. 2-3) and leading to further evaluation of the creation of these bands and the internal areas created.

VI. CONCLUSION

Within the methodological frame-work developed for an extensive survey of banded vaulted systems, this contribution outlines the formal and geometric comparison between documentary, geometric, metric, and interpretative content on the banded vaulted systems in Turin atria.

The case study highlighted the possible comparison of between design ideas remained on paper – as far as we know at the moment – with the built heritage. They represent motives of inspiration in an architectural context like Turin that produced a large number of buildings and on which every architect was trying to give his imprint for the new look of the city.

The developments achieved will provide new ideas for research on the topic, which this contribution will be a functional component for the analysis and comparison of the vaulted systems.

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