

THE TIMBER ROOF OF THE CENTRAL NAVE IN THE BASILICA OF SAN MICHELE IN PAVIA

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Keywords: Timber structures, timber trusses, San Michele in Pavia, history of construction, critical survey

Abstract. *A Basilica dedicated to Saint Michael was first built in the Longobardic period (6th-8th centuries), however the present building dates back to 11th-12th centuries. The church was built in Romanesque style and it is unanimously considered one of the masterpieces of the Lombard architecture of the period. During the subsequent centuries, the building underwent several changes and restoration works. Dealing with the roof of the central nave, the rebuilding of the vaults (1488-91) was the most relevant work. Traces of the pre-existent vaults are still visible in the attic; they were much higher than the present ones and thus they were incompatible with the structural organisation of the existing timber roof structure. Therefore the conception of this structural system probably dates back to that period. In 1860–75 the building underwent works of stylistic restoration and since the 1930s many preservation interventions were done in order to consolidate the decayed sandstone of the façades; however, these interventions did not affect the roof structures. In 1942 two reinforced concrete wall plates were built on the top of the longitudinal walls of the central nave and the timber trusses now lay on them. Since the early 19th century the church has been studied by many art and architecture historians, and many surveys and drawings have been done, both before and after the stylistic restoration works. However the historians' attention has focused mainly on the formal features of the building and on the construction phases of masonry structure. In many of the drawings the roof structures are not even represented; in the others, they are only sketched out schematically. Therefore, the knowledge of the timber roof structures of the church is still very poor. In this situation, the study of archival documents and the survey and in situ investigation of the timber trusses play a fundamental role in the historical knowledge of this important but neglected timber structural complex. The structural complex is composed of a sequence of seven quite different trusses supporting the upper layers of timber elements (i.e. purlins, joists and laths) and the roof tiles. The paper advances a hypothesis about the dating of each of the trusses, based on the matching of the archival data with the critical interpretation of the surveyed signs: structural type of the truss, type of joints, signs of woodworking tools (e.g. axes, saws, hand drills, chisels), assembly marks, signs of reutilization of timber elements, type of iron reinforcement elements, etc.*

1 THE BASILICA OF SAN MICHELE IN PAVIA

A Basilica dedicated to Saint Michael was first built in Pavia during the Longobardic period (probably in the 6th century). Historical documents attest that during the Frankish period many monarchs of the Italian kingdom were crowned in this church: Berengar I in 888, Hugh of Arles in 926, Berengar II together with his son Adalbert II in 950, Arduin of Ivrea in 1002, Henry II (later Holy Roman Emperor) in 1004. After the crowning of Henry II a major fire devastated the city of Pavia, and maybe on this occasion the old church of Saint Michael was destroyed or heavily damaged.

Certainly the last major coronation which took place in Pavia – i.e. the crowning of Frederick Barbarossa – took place in the present church in 1155. Indeed the present building dates back to the late 11th or early 12th century and was consecrated in 1132. The Basilica of San Michele was built in Romanesque style, and it is unanimously considered one of the masterpieces of the Lombard architecture of the period.

During the subsequent centuries, the building underwent several changes; for example the addition of some chapels in the aisles, and many baroque modifications to adapt the church to the new liturgical needs and to the aesthetic taste of the period. Dealing with the roof of the central nave, the most relevant work was the rebuilding of the vaults between 1488 and 1491.

Since the early 19th century the interest in the study of medieval architecture has gradually grown, and the church has been analysed by many art and architecture historians.

In 1860–75 the building underwent works of stylistic restoration and since the 1930s many preservation interventions were done in order to consolidate the decayed sandstone of the façades [1].



Figure 1: Aerial view of the Basilica of San Michele in Pavia (source: Bing Maps).

2 HISTORICAL DRAWINGS OF THE ROOF OF THE CENTRAL NAVE

In the last two centuries many description, surveys and drawings of the church have been done, many photograph have been taken, both before and after the stylistic restoration works. However the attention has focused mainly on the formal features of the building and secondarily on the construction phases of masonry structure.

In many of the drawings the roof structures are not even represented; in the others, they are only sketched out schematically. Therefore, the knowledge of the timber roof structures of the church is still very poor.

In the plates enclosed in the *Histoire de l'art* published posthumously in 1823 by Jean Baptiste Louis Georges Seroux d'Agincourt (1730-1814) [2], the roof of the central nave is depicted with nine trusses, but there is a large number of inconsistencies with coeval representations (e.g. number and shape of windows) and with the current state of the building. These incongruities are probably due to an attempt to reconstruct the original state of the building but denounce the freedom with which the building has been reinterpreted and it makes the representation unreliable.

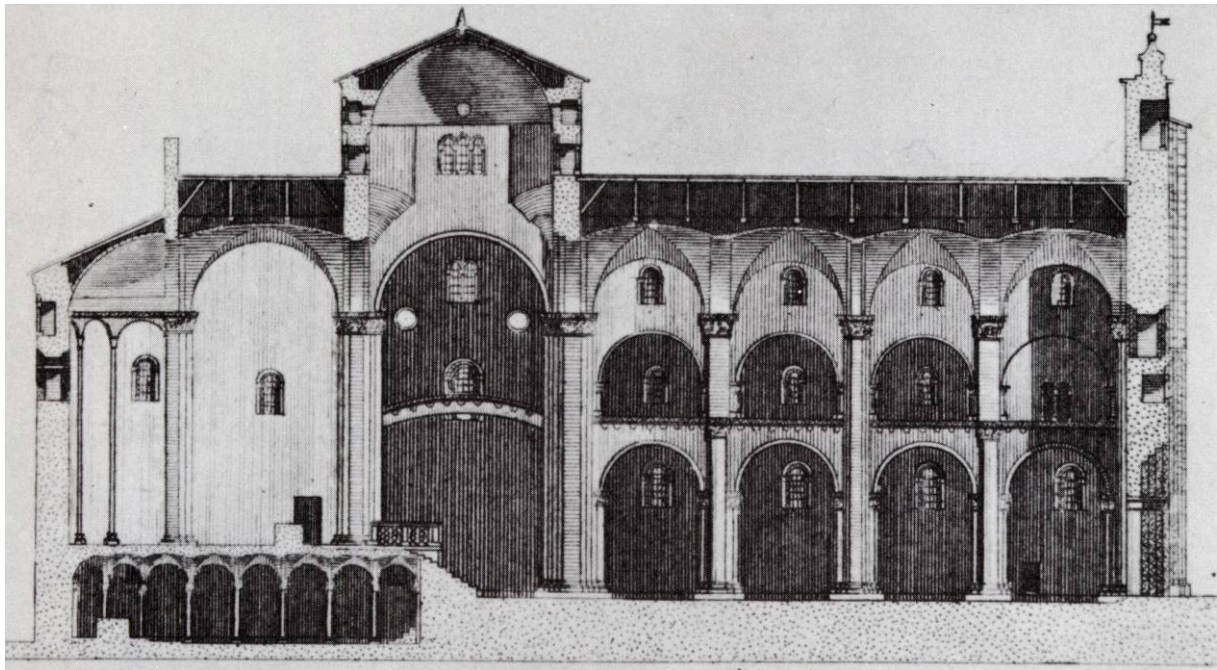


Figure 2: Longitudinal section of the Basilica by Seroux d'Agincourt published in 1823 [2].

The surveys published by Giovanni Voghera in 1828 [3] seems to be more reliable, because of fewer discrepancies in respect to other coeval documents and to current state; even the representation of the roof of the central nave seems more trustworthy (e.g. there are seven trusses as at present), however it's not possible to deduce from the longitudinal section any meaningful information about the construction type of the trusses. All the trusses are equal and schematically represented, in each of them we can see three sectioned elements: one at the bottom, the tie-beam; one at the top, the rafter; the third at half height. It's impossible to state with certainty if this member represents a straining beam or a strut, however – since the height of the element is smaller than that of the tie-beam and of the rafter – we can favour the second hypothesis.

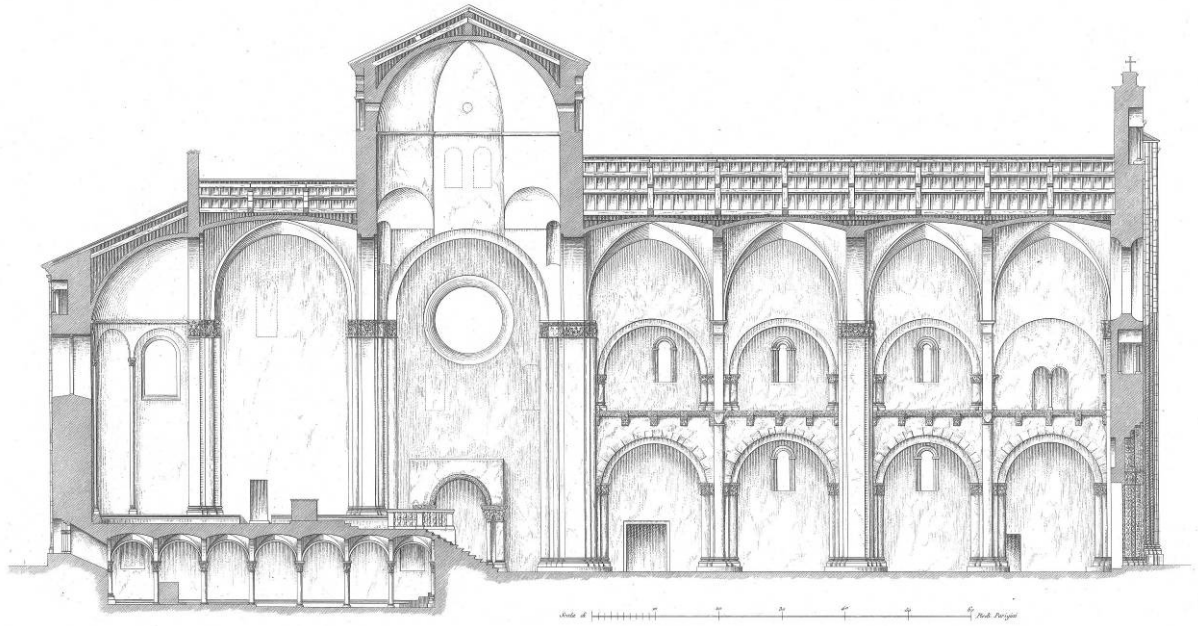


Figure 3: Longitudinal section of the Basilica published by Giovanni Voghera in 1828 [3].

At first instance a greater reliability could be attributed to the drawing by Siro Dell'Acqua – sketched out on the occasion of the restoration works directed by himself – due to the greater knowledge of the building related to his own professional activity [1]. However, this drawing is actually only an adaptation of the draft by Giovanni Voghera, of which it repeats some information (e.g. the wooden structure covering the presbitero) that the study of documents has proven to be incorrect.

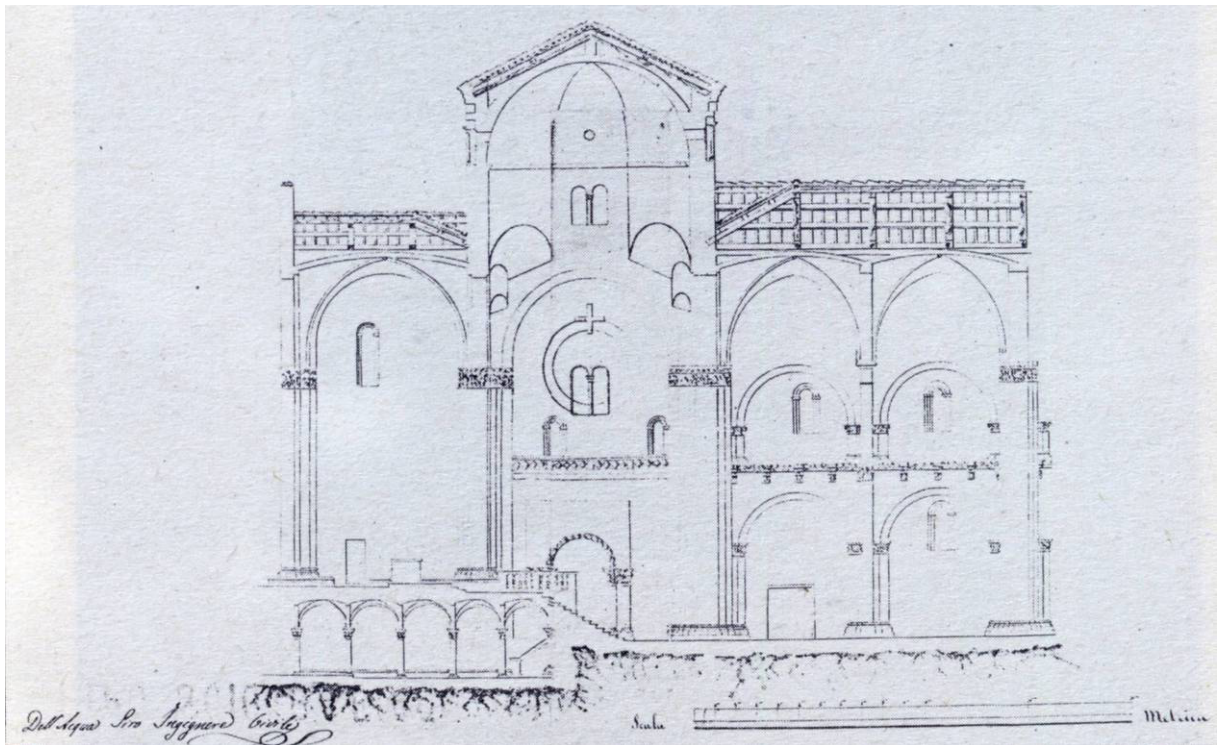


Figure 4: Longitudinal section of the Basilica sketched by Siro Dell'Acqua in [4].

The drawings drafted by Fernand De Dartein [5] have a completely different nature: they represent a reconstructive hypothesis of the ancient vaults of the central nave on the basis of traces present in the attic, therefore De Dartein expunged the existing vaults and didn't represent the structures bearing the roof covering.

Since graphic documents dealing with the roof of the Basilica are very few and often not reliable, it is fundamental to cross the information gathered from the direct investigation of the material consistency of the building with those deduced from archival documents.

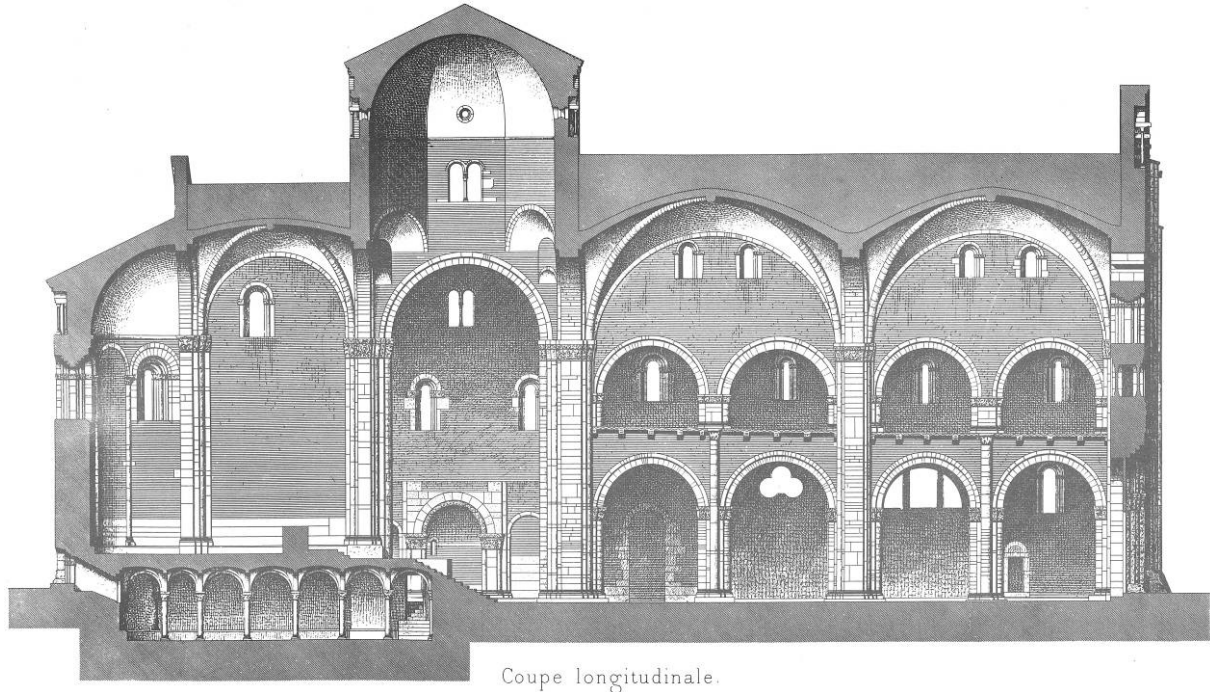


Figure 5: Longitudinal section of the Basilica drafted by Fernand De Dartein [5].

3 SURVEY OF THE STRUCTURES AND EXAMINATION OF ARCHIVAL DOCUMENTS

As written, the study of archival documents and the survey and in situ investigation of the timber trusses play a fundamental role in the historical knowledge of this important but neglected timber structural complex. First of all we must notice that in the attic of the central nave the traces of the ancient vaults (or domes as supposed by Sanpaolesi [6]) demolished in the 15th century can be seen. These traces prove that those vaults were higher than the present ones (as we can see in the already cited drawing by De Dartein), thus the present trusses are incompatible with the ancient vaults and they have surely been built after the construction of the new vaults, therefore the conception of this structural system probably dates back to that period. The previous roofing was probably lain on debris supported by the vaults, as it was in the other parts of the roof before the restoration works carried out in the 19th century.

The direct observation of the timber structure shows that the structural complex is composed of a sequence of seven quite different trusses supporting the upper layers of timber elements (i.e. purlins, joists and laths) and the roof tiles.

3.1 Existing trusses

Existing trusses of the central nave may be divided into three categories. The first category consists of the truss number 3 only (see fig. 1), which is the most different from the others:

it's a queen post truss without king post; the tie-beam is made of a single and quite irregular beam; the queen posts are joined to the tie-beam with a half dovetail tenon-mortise joint probably originally locked with a wedge (now absent); the rafters are discontinuous at the joint with the queen posts. The second category consists of trusses number 4 and 5: they are king post trusses with struts; the tie-beams are made of two beams joined with a hooked scarf joint with nibs reinforced with planks nailed to the side faces of the beam; the king posts are in direct contact with the tie-beams, to which they were previously linked with a stirrup strap. The third category consists of trusses number 1, 2, 6 and 7: they are king post trusses with struts; the tie-beams are made of two beams joined with a key locked scarf joint with nibs, reinforced with square head bolts. In the third category trusses number 1 and 2 differ from number 6 and 7 due to the different design of the joints between rafters and king post.



Figure 6: Truss number 3 (photograph by the author).

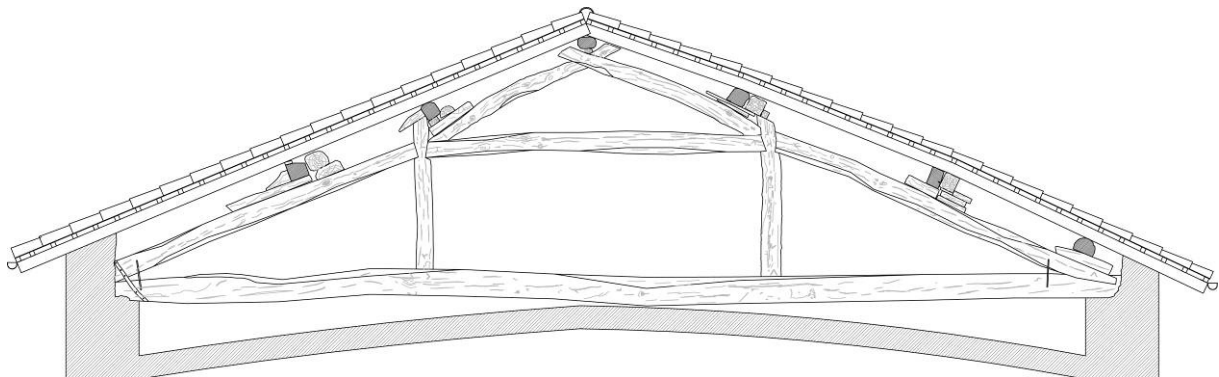


Figure 7: View of truss number 3 (survey by Giorgio Aivazopoulos, Stefania Bertagnolli, Federica Lana, Santo Occhiuzzi, Teresa Oddi and Antonella Semeraro, under the supervision of the author).

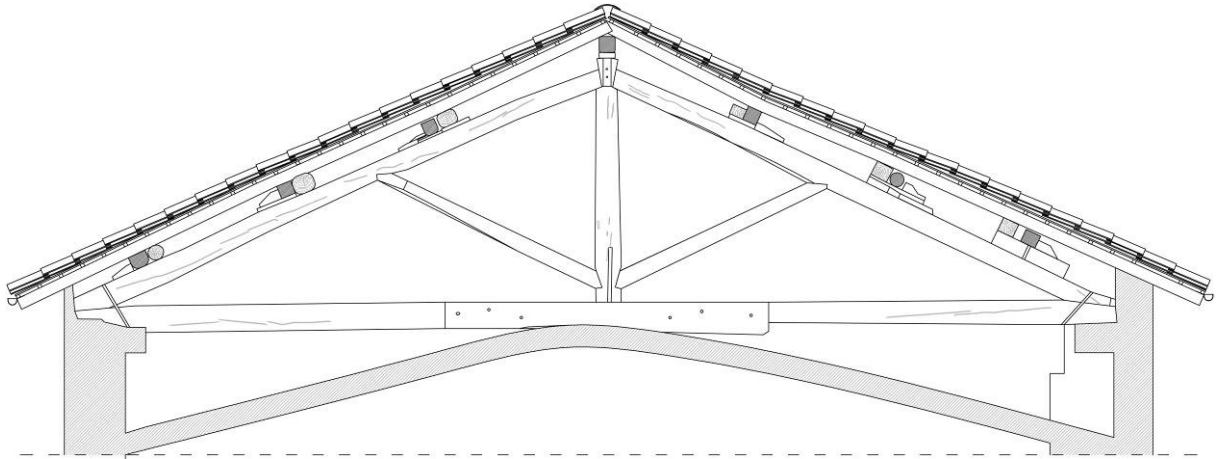


Figure 8: View of truss number 5 (survey by Leandra Farruggio, Eleonora Mitruccio, Salvatore Morgante, under the supervision of the author).

3.2 First hypothesis of relative dating

A first hypothesis of relative dating of the trusses can be based on some clues that can be found directly in the roof.

Both of the rafters of the truss number 1 show signs of a previous use: a mortise analogous to that present in truss number 3. The same type of mortise is present in a purlin placed next to the tiburium; many other purlins show signs of a precedent use, in particular some of them shows signs of a previous halved joint similar to that present in the top joint between the rafters of truss number 3. Therefore we can suppose that a higher number of trusses of the first category was previously present, and we can hypothesize that these constituted the structural system of the roof built together with the present vaults in the 15th century.



Figure 9: Truss number 1 (photograph by the author).

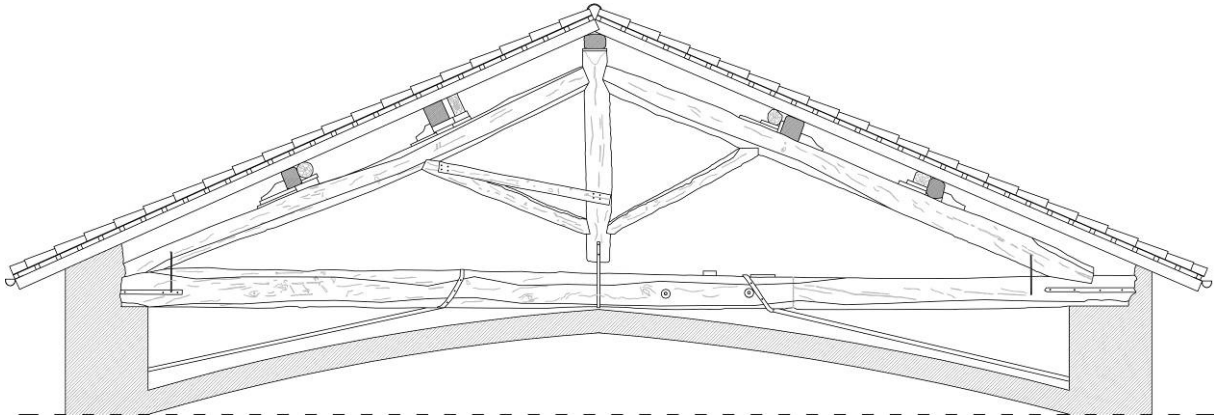


Figure 10: View of truss number 1 (survey by Giorgio Aivazopoulos, Stefania Bertagnolli, Federica Lana, Santo Occhiuzzi, Teresa Oddi and Antonella Semeraro, under the supervision of the author).

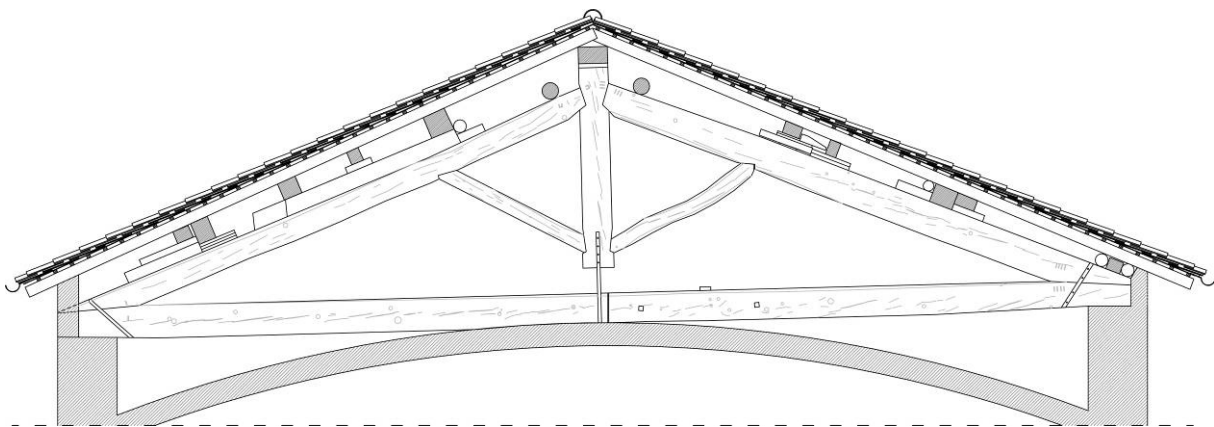


Figure 11: View of truss number 7 (survey by Francesco Ambrosini and Alessandro Cerri, under the supervision of the author).

3.3 The study of archival documents

The perusal of archival documents may cast further light on the construction phases of the roof structure.

Among the documents collected by monsignor Rodolfo Maiocchi in the *Codice diplomatico artistico di Pavia*, we can find some notary deeds about the masonry works done by Iacopo da Candia and by his son Agostino (documents n. 1436, 1442, 1459, 1461 [7]) in 1489. This documents never mentions the roof structures, however it is probable that they have been built by the same master builders soon after the emergency demolition of the pre-existing vaults (that the cited documents acknowledge to be already done); indeed in other documents Iacopo da Candia is called «magister a muro et lignaminis» (i.e. master mason and carpenter, document n. 774 [7]). Only a comparison of the only survivor truss of that period with other trusses certainly attributed to Iacopo da Candia (if there are some) could confirm whether or not this assumption is truthful.

In the parish archives of the Basilica of San Michele Maggiore we can find several folders containing documents related to the maintenance and restoration of the church carried out from the beginning of the 19th century.

The oldest document about these works dates back to August 1828 [8]. In these documents the *Fabbriceria* (vestry board) of the church asked the *Imperial Regia Delegazione Provinciale* (the public body delegate to supervise public works) the authorization to refurbish the roof structures of the central nave *in economia* (i.e. without a detailed project and quantifying

the costs ex post on the basis of the works actually executed) to accelerate the execution time; indeed while doing maintenance works the master mason Calderara found out that the conservation status of the structure was a precarious and that it needed urgent and necessary repairs.

Together with this request there is a slip of paper (without date and signature) on which we can read the cost estimation of some maintenance works to be done on the roof: plumb the trusses; disassemble and reassemble purlins, joists and roofing. These are probably the cited maintenance works.

Unfortunately there is no other coeval document that clarifies what were the repair work actually performed in 1828.

A second set of documents is dated June 1835 [8]. This documents too deals with a request (carried out by the *Fabbriceria* to the *Imperial Regia Delegazione Provinciale*) for approval of urgent repair works. However in this case the *Fabbriceria* attach to the letter a detailed appraisal of the work to be carried out done by the engineer Carlo Giuseppe Franchi member of the *Fabbriceria*. The request for approval of the works states that they had already been assigned to the Antonio Calderara – the same master mason who carried out the repairs in 1828 – on the basis of a tender.

The appraisal of the works describe them in detail: two trusses had to be rebuilt partly using timber from the disassembly of the two pre-existing trusses and partly new timber.

One of the trusses had to be built using the tie-beams of the pre-existing trusses as rafters; both of the new tie-beams had to be built assembling two beams and reinforcing the joint with iron bolts with nuts; the joints between tie-beams and rafters had to be reinforced with metal strapping and the king posts linked to the tie-beams with stirrup straps. This description matches perfectly to trusses number 1 and 2.

In the parish archives there are no other documents about repair works to the roof up to the 1860s. The fact that the works of 1835 have been done as urgent and necessary repairs just like the ones of 1828 and by the same master mason leads to conjecture that trusses number 6 and 7 (very similar to trusses number 1 and 2) could have been built during 1828, but further clues should be sought to confirm this hypothesis.

In the period 1860-1875 a great restoration campaign carried out under the artistic supervision of Giovanni Battista Vergani (1860-64) and Carlo Dell'Acqua (1865-75) and under the technical direction of Siro Dell'Acqua [1]. The restoration included also many works on the roofs.

The roofs of the side aisles, of the transept and of the presbytery were dismantled removing the rubbles – weighing on the vaults – that supported the roofing and new timber structures were built: simple purlins in the aisles (in 1864 the northern aisle, in 1865 the southern one); scissor trusses with iron tie beams in the transept (in 1863 the southern part, in 1864 the northern part) [8].

In this period some minor work have been done also to the roof of the central nave.

In September 1863 two mullioned windows of the tiburium – that were occluded as a result of the raising of the roof in 15th century – were re-opened requiring a change in the slopes of the roof: a new hip was built in adherence to the tiburium by master mason Giuseppe Belloni on the basis of the project engineer Siro Dell'Acqua, thus it was necessary to modify the structure of the last span of the roof adding two diagonal rafters [8].

In the document containing the statement of the work done by the blacksmith Angelo De Paoli for the church in 1864 [8], we can find that he made some metal rods for the *cavariata maggiore* (greater truss); the description of the pieces he made is not clear, nor what he meant by the expression *cavariata maggiore*, however the survey of truss number 1 show the presence of two tie rods linking the tie beam to the walls, with the function of reducing the thrust of the vault. Since in 1864 the adjacent vault of the northern aisle was rebuilt and in 1865 the

correspondent vault in the southern aisle was heavily repaired because they was severely damaged, it is likely that the metal rods made by Angelo De Paoli in 1864 are the one still present in truss number 1.

It might surprise that in the period of greater activity dedicated to the restoration of the basilica (1860-75), so little attention has been devoted to the roof of the nave; however, there are two reasons (one technical and the other cultural) that justify this fact. The first reason is that – as we already seen – a broad campaign of repairs had been made a few decades before; the second is that restorers aspired to a more radical intervention which would have involved the replacement of all existing trusses.

In 1873 Siro Dell'Acqua wrote a project report in which he proposed the demolition of the existing vaults of the central nave and the construction of new vaults that were supposed to restore the form of the original ones [8]; in this report Siro Dell'Acqua states that this was his idea since 1866 when he published a paper about the history and restoration of the Basilica [9]. Siro Dell'Acqua's project involved the demolition of the trusses and their substitution with scissor trusses, thus he never planned a systematic work of refurbishment of the roof, but he only designed local interventions waiting to get approval and funding – which he never obtained – needed to implement his idea.

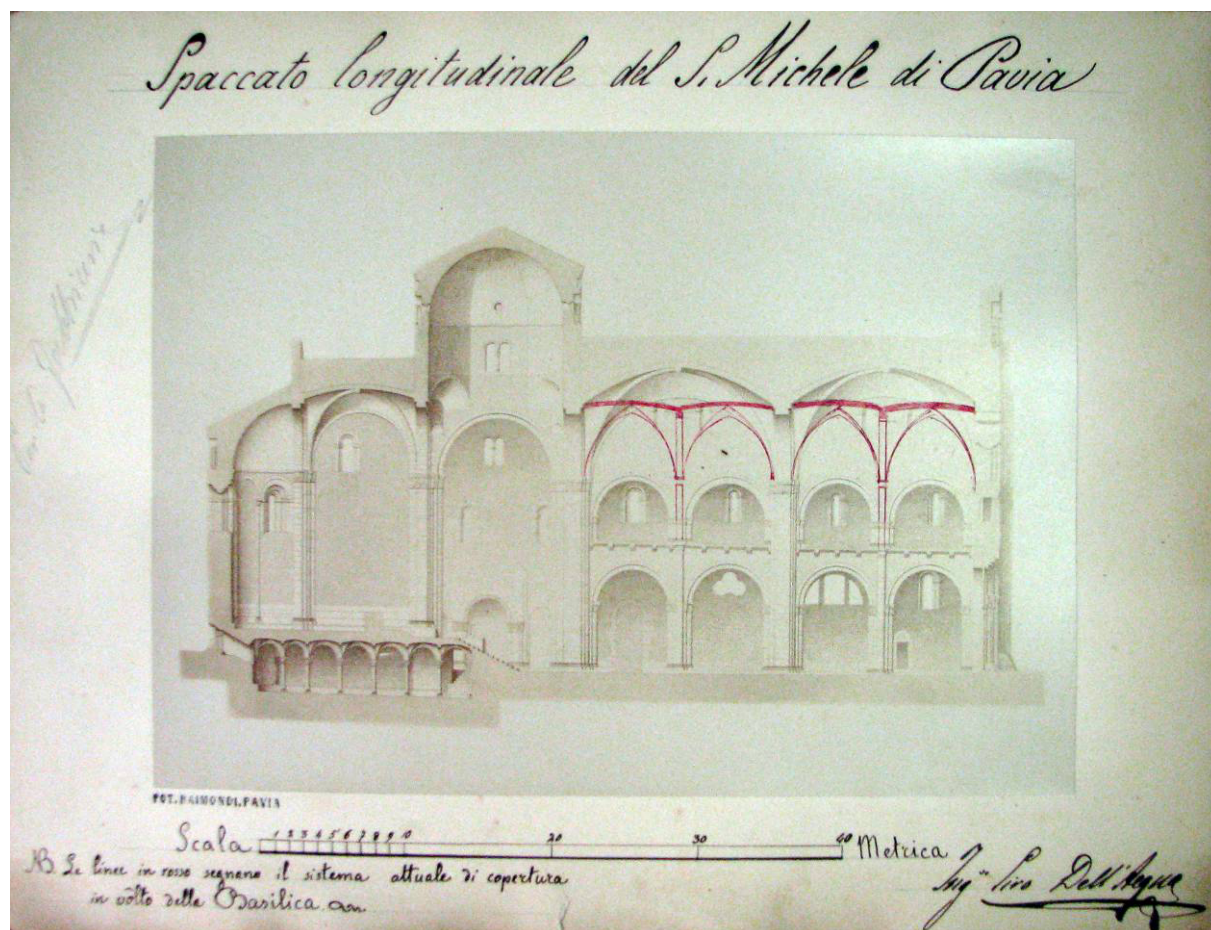


Figure 12: Plan by Siro Dell'Acqua for the demolition of existing vaults (in red) and building of new vaults [8].

Since then, no other important work has involved the wooden structures of the roof, nevertheless, in 1942 two reinforced concrete wall plates were built on the top of the longitudinal walls of the central nave – without removing the trusses – and the timber trusses now lay on them.

4 CONCLUSIONS

The study of the timber structure of the roof of the central nave in the Basilica of San Michele in Pavia presented in this paper has been carried out with an integrated method of direct survey and analysis of archival documents.

The importance of this research is strictly connected to the indispensability of knowledge for conservation. In this field knowledge plays a double role [10]:

- People preserve only those things to which they attribute a value, and – talking of a hidden-from-view roof structure – they can attribute a value only to things whose history they know and understand. Indeed knowledge could foster the recognition of a structure as a cultural heritage, and therefore could generate in the population and in the technicians the moral requirements of conservation.
- Knowledge is also the fundamental prerequisite for the design of preservation works: knowledge of the material consistency of the structure (geometry of the whole and of the details, timber species, etc.), but also knowledge of the structural conception of the structure that can be achieved only through the historical research.

As seen in the previous paragraph the matching of information inferred from direct survey and archival documents has provided many clues that allow to try an absolute dating of the trusses. Truss number 3 has been probably built in 1489, trusses number 6 and 7 in 1828, trusses number 1 and 2 in 1835; the current state of knowledge doesn't allow us to make reliable dating hypotheses for trusses number 4 and 5, however we can suppose that they have been built at least a few decades before 1828, otherwise in that year the condition of the roof would not have been so critical.

However knowledge never comes to an end, and additional researches may cast further light on the history of the studied structure. Future developments of the research may be based on additional archival research and on the realization of weakly destructive or non-destructive testing (e.g. dendrochronology, carbon-14 tests) that could also allow the dating of trusses number 4 and 5.

5 ACKNOWLEDGEMENTS

The author wants to thank: don Giulio Lunati – pastor of the Church of San Michele – and the Diocesan Commission for Sacred Art and Cultural Heritage for the permission to access the attic of the church and to consult the parish archives; the archivist William Posla for the help in the archival research; the students of the course *Recupero e conservazione degli edifici* of the University of Pavia for the survey of the trusses.

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