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Remarkable historic timber roofs. Knowledge and conservation practice.
PART 1 - Construction history and survey of historic timber roofs

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ANCIENT WOODEN ROOFS IN THE AREA OF GENOA: THE STRUCTURE WITH A CURVILINEAR PROFILE OF THE PARISH CHURCH OF COGOLETO

Daniela Pittaluga, Cristina Accomasso

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Abstract

A particular roof is that of S.M.Maggiore church in Cogoleto. The 19th century church has an upper two-pitches roof and a lower roof underneath with a curvilinear profile. Both insist on the same perimeter, but they have no direct connection between them as far as it is visible. Therefore, the study focused on understanding this part of the building. This understanding of the building was obtained thanks to indirect sources (archive and bibliographic research) and direct ones: archaeological analyses (stratigraphic, mensiochronological, mineralogical-petrographic, and wall textures), thermographic and ultrasonic analyses. A particular effort had to be made in studying the details and reading the stratigraphic signs on the wood (this aspect is usually little developed). Extending the analysis to the entire building was necessary for a better understanding. This study highlights a sequence of interventions in the church over the past two centuries; previous structures were usually preserved while new elements and stratifications were added. The two structures were chronologically different: the upper one is the most recent but was designed to preserve the older one below. Another interesting fact that emerged is the particular shape of the lower structure: a wooden roof with a curvilinear profile. This form of coverage is not particularly widespread in this part of the Ligurian territory. In any case, it is unusual for the historical period in which it was built (19th century). The research, therefore, focused on the reasons for this particular choice and the study of the dynamics of the 1877-78 construction site. It also allowed us to understand better this specific structure's functioning, its technology, and its relationship with the remaining parts of the complex. The historic curved profile roofs highlighted differences in material and installation technique.

Keywords

Wooden roofs, Historical architecture, Curvilinear profile, Stratigraphic analysis, Multidisciplinarity.

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1. A CAREFUL READING FOR A CORRECT IDENTIFICATION

Today, the Parish Church of S. Maria Maggiore in Cogoleto has a rectangular plan and a pitched roof system on different levels. The south elevation is characterized by three orders of windows of different shapes, and a pronaos is present at the lateral access. The apse and the central nave have a vaulted ceiling, and the *orchestra* has a barrel masonry vault (Fig. 1). This conformation results from a late 19th century rebuilding; previously, on the same site, there was a church (already mentioned in the documents in 1554) of smaller dimensions that strongly influenced the subsequent construction choices.

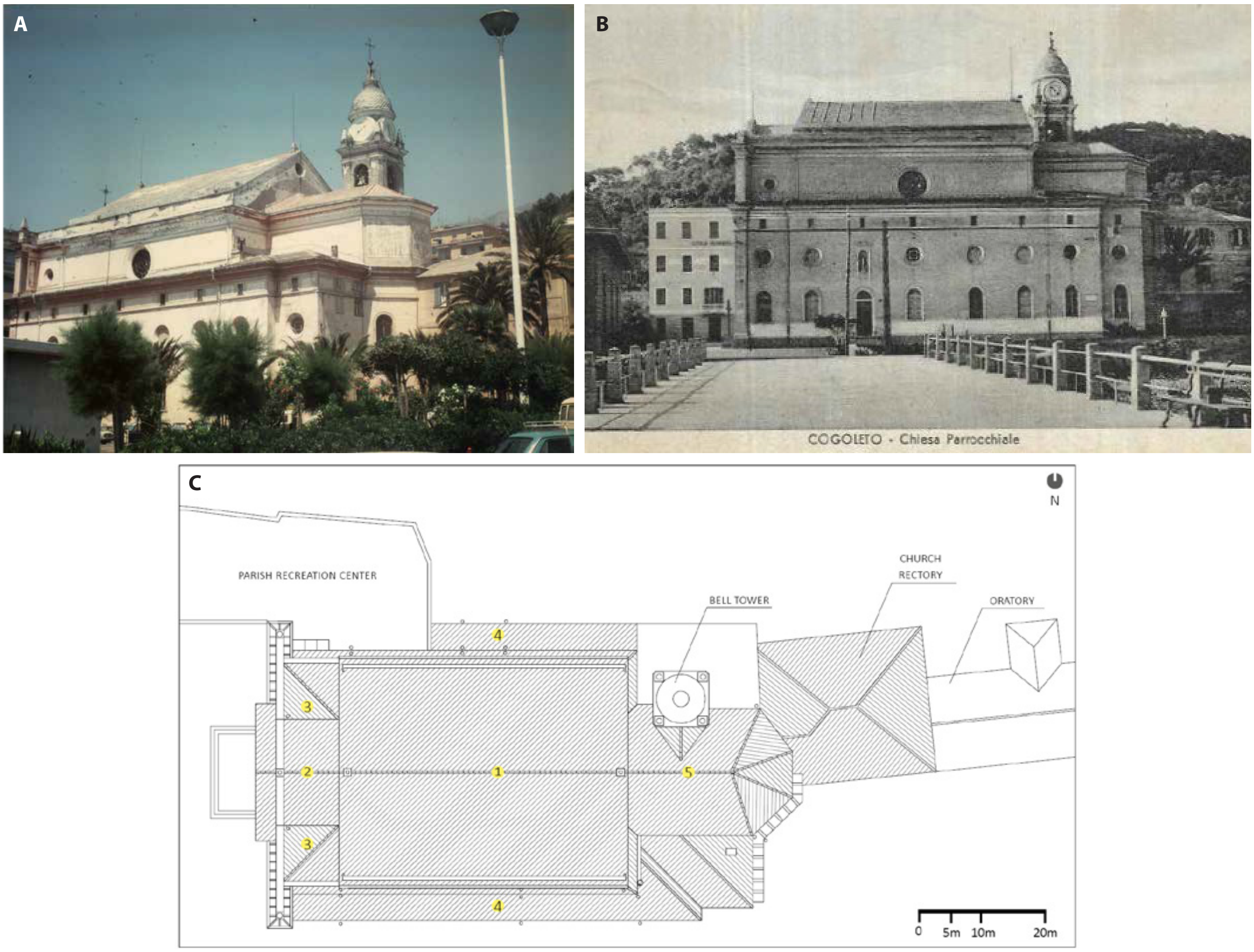

Fig. 1. *A-The Church at the end of the 1970s. (Image source: ASABAP Liguria, S. Maria Maggiore Cogoleto). B-The Church at the end of the 1930s (Image source: F. Biamonti archive). C-Roofing plan 2019 (Image source: Accomasso 2019).*

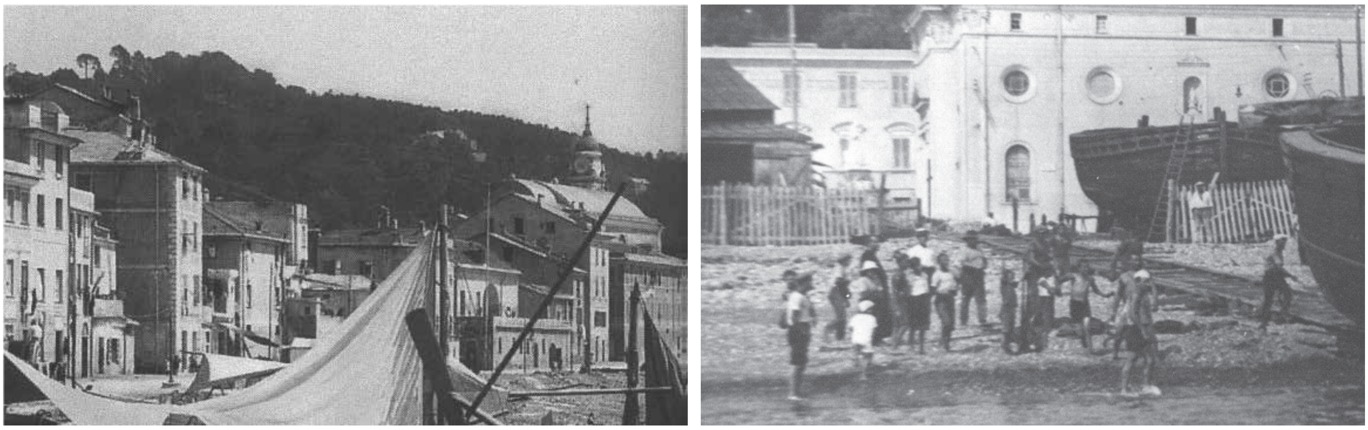

Fig. 2. *Cogoleto 1898. The Church with a curved roof (Image source: R. Cattani archive).*

The historical reconstruction of all the events was possible thanks to a careful examination of the published sources, numerous unpublished documents found in various archives (see acknowledgments), the use of material sources, and their comparison. The consultation of all these documents made it possible to collect detailed pieces of information also on the choices of materials, the tools used, and the workers participating in the work. In order to avoid hasty and superficial deductions, it was essential to compare the various indirect sources [1], distinguish their purpose (informative, scientific, etc.), their reliability, and then proceed to their comparison with the direct sources. Direct sources were used to identify the chronology of the construction of the church walls: stratigraphic analysis, mensiochronological analysis of the bricks and lithotypes [2, 3], and mineralogical analysis of the mortars. Thermographic analysis of the walls allowed the identification of openings that are now hidden. The wooden structure of the roof was well studied with archaeological analyses and instrumental investigations (in particular thermographic analyses, sonic and thermo-hygrometric surveys were carried out to understand the state of conservation).

In this article, in particular, we will focus on the complex stratification that characterized the roofs of the church.

2. THE INTERVENTIONS ON THE ROOFS

One of the most recent substantial transformations that have taken place in these roofs is the one made by Eng. Bianchi in the early 1900. This intervention was necessary because, at the time, there were evident and consistent infiltrations, especially in the portion exposed to the north wind. Therefore, it was decided to keep the wooden structure of the curved profile roof (1877-78) (Fig. 2), removing only the covering mantle (traces of this intervention are still visible on the old structure), and overlay a simple two-pitch covering on it. The overall height of the church has therefore increased, but only in this central part of the complex. It is still possible to see the different textures of the perimeter walls on which this new roof was set in the church attic. However, the most particular roof structure of this complex that aroused our interest is the late 19th century one: the curved profile roof that currently appears to be still preserved and protected by Bianchi's intervention.

3. THE DYNAMICS OF THE BUILDING SITE OF THE 19TH CENTURY RECONSTRUCTION OF THE CHURCH

The dynamics of the 1877-78 building site for the construction of the curved profile roof are of particular interest. The shape of this structure recalls the already known "inverted keel vaults", which is unusual for the time and the territorial context [4]. It was possible to reconstruct a detailed progression of the processing phases by consulting correspondence, estimates, and receipts from suppliers. It was also possible to hypothesize some reasons for this particular choice. In fact, the decision seems to be due not only to a need/desire not to interrupt the religious functions during the construction site (we recall in this regard that the enlargement/rebuilding of the church takes place on the same site as the previous one, dating back to the 16th century) but also to the possibility to contain the costs by recovering as much material from the old church as possible. The material dismantled from the old church was immediately reused in the new one. A fairly accurate estimate of the reused materials from the ancient church was made from archival documents. This information also allowed us to formulate some credible hypotheses on the conformation of the old demolished church. 1877 was the year of preparation of the construction site: initially, the bell tower was inspected to reinforce and conserve it, the costs and possible savings were evaluated, the contract was signed with the designated builder, the disassembly of the organ was organized, and some construction details were decided, such as the position of internal niches. In June, the population (the population of Cogoleto participated in voluntary work to help the progress of the construction) began excavating foundations for the new church around the perimeter of the old one, still in use at that time. 1878 was the year of construction of the new building (the largest church): the letters are much more numerous and refer to the progress of the works. The documentation is enriched with estimates and payment receipts that allow us to trace the companies and artisans involved in the construction site. The first phase of the work, for which we have documentary evidence, concerns the consolidation of the bell tower structure, which also required raising the floor level of the church under construction. Therefore, the first pillars of the nascent construction were connected to the reinforcement structure of the bell tower; after that, they proceeded with the construction of two more pillars and the arches of the lateral chapels at the Sancta Sanctorum. This reinforcement suggests that the new building originated near the presbytery. The greater thickness of the wall connected to the bell tower, which is still visible today, is the consequence of these reinforcement structures. Subsequently, they constructed the supporting walls to reinforce the new roof, removed the existing choir, and demolished the pre-existing sacristy. Then they began to think about the choice of the wattle for the vault of the new church. Once the masonry was finished, the reinforcement work on the roof began between February and March 1878, entrusted to specialized artisans. The “wall plate beam” (wooden beams placed along the perimeter walls of the building to bind the walls and to guarantee a better distribution of loads) were placed first, then the ribs. The works suffered some slowdowns, probably also due to the sudden collapse of a part of the vault of the central nave of the old church, which still remained within the perimeter of the new building. Once the construction of the perimeter walls was completed, the demolition of the remaining part of the previous church began: the population actively collaborated. The new church roof was most likely built in two phases, first on the side parts of the church and then above the presbytery and the orchestra: this was deduced from the analysis of written documents (arrival times of the various materials on ancient site yard). Very special solution, the building to be demolished was kept on the side until the new perimeter walls construction around it and part of the roof were completed. We retrieved a very detailed list of the construction expenditure item; engineer Giuseppe Mazzardo filed it on June 26, 1877. This list includes the quantities of materials recovered from the old church (see Tab. 1). We understand that the purpose was to obtain savings by recovering as much material as possible from the old church, especially from the ancient cover (see Tab. 1).

Architectural element	Quantity	Unit Cost (lire)	Total Cost (lire)	Savings (lire)	Savings (%)	Note
Roof structure and cover	980.00 m^2	12.00	11,760.00	4,760.00	40.5	Recovery of timber and slates from the roof of the existing church; lime and sand provided free of charge by the population
Wooden floor frames and wooden ceiling	75.00 m^2	10.00	750.00	250.00	33.3	
Arched ceilings	730.00 m^2	5.00	3,650.00	1,650.00	45.2	
Cover with slates on the sides	190.00 m^2	9.00	1,710.00	310.00	18.1	Probable recovery of existing church slates
Iron chains	4,000.00 kg	0.50	2,000.00	1,000.00	50.0	Iron recovery of the existing church; free labor blacksmiths in the country
Unexpected costs	-	-	1,720.00	-	0.0	-
Total (including other elements)			96,076.00	53,076.00	55.2	
Total net final cost				**43,000.00**		

Tab. 1. *Detail of costs and savings regarding the roof and the vault.*

Most of the expected savings concerned the construction of the roofing system for the new building; in fact, the subsequent recovery percentage values were envisaged: arched ceilings: 45.2%; timber and slates for reinforcement and roof covering: 40.5%; wooden floor frames and underlying ceiling: 33.3%; roofing with slates on the recess of the sidewalls, external part: 18.1%. In addition, a saving of one-third of the total cost of the windows was expected, but without specifying the number and type of reusable artifacts from the previous church.

Fig. 3. *Diagrams with the percentage of recovered material from the previous church for the roof's construction. From left (in red): recovery of arched ceilings, recovery of timber and slates for the roof, recovery of wooden floor frames and underlying ceiling, recovery of the lateral part coverage.*

Finally, regarding the iron ties, of which a 50% savings was expected, the altars and balustrades, for which a saving of 47.1% was assumed. Some considerations can also be made regarding the overall construction costs of the church of Santa Maria Maggiore. Engineer Mazzardo's forecasts indicated a total cost of 96,076 Lire with an estimated savings of 53,076 Lire. According to others [5], however, a plausible estimate of the total expenditure for building construction could be around 80,000 Lire. If we trust this second source, the savings would be lower than those initially foreseen, even if in any case of a certain weight.

What are the reasons for these disparities between the different sources? We can assume a smaller quantity of recycled materials or a too optimistic estimate of the amount of free labor. In addition, the site documentation testifies to a different choice of methods for some work phases than the initial forecasts, which could be another explanation for the difference. However, on the saving of materials for the roof structure of the church, it seems conceivable from the data consulted that there was a substantial adherence to the estimated recovery percentages.

3. THE STRUCTURE OF THE CURVED PROFILE ROOF

The indirect sources consulted in archival research did not provide any detailed survey of the roof structure. Below is the result of a detailed on-site survey carried out on the roof in the portion currently accessible. A particular effort had to be made in studying the details and reading the stratigraphic signs on the wood (this aspect is usually little developed in the archaeological research of the elevation of historical structures) [6]. It was decided to proceed with a detailed survey of the curvature of a portion of the roof (the one located in the middle) and to consider all the others with a similar profile. The first section of the profile, with a lower slope, was found considering different leveling planes. Linear measurements in cartesian coordinates were also carried out for the portion with a steeper inclination. It was so possible to trace the exact profile of the wooden rib. The restitution was facilitated by the comparison with the intrados profile already detected during the diagnostic analysis of the reed vault (the diagnostic analysis was performed according to a precise protocol, see [7]). Subsequently, all the ribs making up the roof and the secondary framework were surveyed, thus understanding the complete distribution of the structure. The structure of the curved profile roof is therefore made up of twenty-one wooden ribs, nineteen of which are 10 cm thick (made up of 2 side-by-side boards) and the remaining two, symmetrical with respect to the centerline of the vault, 15 cm (made up of three tables placed side by side). The ribs have a particular profile, rounded in the intrados, while the extrados has a particular profile that characterizes the roof. Along the extrados profile, the slate slab roofing anchoring marks can still be seen, even if the slate slabs were removed. To the main transverse framework of the wooden ribs, the secondary longitudinal framework formed by wooden boards, 4 cm thick, arranged at a center distance of approximately 1.5 m, is connected by nailing. These boards are placed perpendicular to the surface of the vault. Each board has special holes in which the "pacconcelli" of the underlying reed vault are housed (the 'paconcelli' are small rafters that form the load-bearing structure of the reed vault).

4. HYPOTHESIS ON THE PREVIOUS CHURCH: THE CHURCH OF 1554

A first hypothesis on the previous church (the ancient 16th century church) was formulated based on indirect sources: iconographic and cartographic images [8,9] of the Cogoleto area, reports of pastoral visits to the church of the 16th and 17th centuries, and details in the archival documents on the percentages of materials to be recovered from the old church for the construction of the new church of 1877. In particular, all the sources from the 16th century to 1876 describe a church that has not changed in volume and has only undergone transformations in the furnishings and finishes. Nevertheless, what shape did the 16th century church roof have? Is it possible that the shape of the previous roof was also recovered in addition to the recovery of the timber? Did this second hypothesis allow a more significant recovery of material? Otherwise, for the roof of the 1877 church, the curved profile shape was made using smaller wooden elements connected, allowing for a good recovery of material. At the moment, we cannot give a precise answer to many of these questions yet. In fact, portions of ancient wood and connecting elements with different wood added later were identified in the part that it was possible to inspect. Various marks and engravings have been found on several elements. The elements on which the direct analysis focused were signs of previous workings, traces of fastening elements of different shapes and sizes from those of the 19th century, and particular graphic signs that suggested ways of recognizing the single element for its relocation. These same signs (predominantly Roman numerals engraved on specific portions of the wooden boards) are present on some but not all of the elements. This detail, for example, made us think about possible material integrations with new ones. To date, we reserve the right to complete the vault inspection on parts that are not visible for now. Based on these first elements, one of the most accredited hypotheses is that the ancient parish church of Cogoleto (the 16th century one) also had a curvilinear roof. Moreover, these latest analyses made it possible to confirm the hypothesis on the shape of the old roof with a reasonable degree of certainty.

4.1. IS THE VAULT OF SANTA MARIA MAGGIORE AN “INVERTED KEEL ROOF”?

The shape of the church roof built in the1877/78 appears unusual for the historical period in which it was built. The “inverted keel structures” are quite rare and, in any case, appear to be prevalent in other geographical areas and periods much earlier than the one under examination [10]. We, therefore, immediately tried to investigate whether the shape of the building, despite the apparent similarities, was really classifiable as an “inverted keel roof” and, if so, what the reasons for this choice could be. The new form for the coverage of the church of Cogoleto (Fig. 4) probably did not respect the project drawn up by the architect Dufour (the first designer in charge of the project). In fact, in a drawing of the façade project of the new Parish Church of Cogoleto, which could be attributed to Dufour, the church is represented with a double-pitched roof, different from the one actually built. Confirming this is the book *Maurizio Dufour: nell’anno 25° dalla sua morte*. It seems to support the hypothesis of a discrepancy between the planned roofing system and the one actually built. In fact, in the book, the author Luigi Traverso writes the following about the Church of S. M. Maggiore: «He did [Maurizio Dufour, ed] the design of the parish church of Cogoleto, but he did not direct its execution: various defects are proof of this appearing in that building, and especially in the anomalous shape of the roof» [11]. In documents dating back to the construction site period, the figure of Dufour appears marginally, while the letters of the Venetian architect Gioacchino Zandomeneghi, a former collaborator of Dufour, are more frequent. The design changes could be motivated by the desire to recover the material of the previous church as much as possible. In fact, as already reported, at the time of construction, it was estimated to make the roof with a recovery of about 40% of slates and wood. The direct observation of the structure also confirms this: the wooden ribs of the vault are made up of small boards suitably shaped and nailed together, which makes the hypothesis of reuse plausible. Numerous of them are engraved with numbers and symbols, perhaps indicating the reference points for assembly used when laying the roof reinforcement (Fig. 5). From some appraisals dating back to 1900 [12], the roofing system in question was built with the express intention of not placing chains that crossed the church ceiling transversely. This choice is compatible with an inverted keel structure that reduces the horizontal thrusts on the sidewalls on which it rests. However, from the same documentation, it also emerges that the ribs are made of poplar wood with common riveting, while inverted keel structures, as far as known to date from the literature, are usually made with better quality wood and with pieces of dimensions such as to require a limited number of rivets. Suffice it to say that about 1200 trees, corresponding to 1,200,000-1,400,000 m^2 of a forest, were used to build the five-lobed roof of the Church of San Zeno Maggiore in Verona. Furthermore, the choice of the type of wood in San Zeno was very accurate: larch wood was preferred, which had excellent mechanical characteristics and low combustibility. The material, before being used, also underwent numerous treatments: left for about a year under running water to purify it from microorganisms, it then underwent a drying process of about 24-36 months [12]. Nothing to compare, therefore, with the material and techniques used for the church of S. M. Maggiore, whose construction, as we have seen, was characterized from the outset by strong economic requirements. In Cogoleto, there were no particular structural reasons to justify the construction of a roof of this type as the stresses to which it is subjected are mainly of a static type. The construction of a roof with standard triangular trusses placed above a self-supporting wooden vault would have resulted in a lower height of the nave, maybe even lower than that of the previous church that the local population wanted to enlarge. Otherwise, scissor trusses could have been built, but this would create a risk, the generation of thrust on the walls. The greater use of "inverted keel" structures in Venetian buildings is justified because they rest on unstable ground and are subject to frequent settlements and consequent dynamic stresses [13]. From a careful observation of the boards that make up the portion of the curved rib in the Ligurian structure, it can be seen that the wood fibers are not parallel to the board's shape. This fact shows that no curvature has been impressed on the material used but that the boards have only been cut according to this shape. This evidence constitutes a further aspect that would distance the technique used in the church of Cogoleto from that practiced in naval carpentry. In Cogoleto's case, the wooden vault seems more responsive to the characteristics that Philibert De l'Orme described in 1561 (Fig. 6) for the construction of cheaper wooden roof structures with the use of small planks [14, 15] (De l'Orme 1561-2009). This construction method is an evolution of ship hull roofing which, while maintaining some structural characteristics, makes it possible to use lesser quality timber (see Cancelleria di Blois, 15th century). However, the vaulted roof of the ecclesiastical building of Cogoleto is not entirely relevant even to the techniques of De l'Orme as the assembly of the pieces of timber is carried out differently. In fact, the transversal framework is not made up of boards passing through the ribs with mortise joints but instead of nailed and shaped elements according to the center distance between the ribs. This difference, however, could be linked to the greater or lesser familiarity of the operators with some construction techniques rather than others. In fact, these changes can be included as "variations on the theme", often unavoidable in construction practices when there is a change in time and/or a difference in a geographical context. The intrados of the vaulted structure of Cogoleto is covered with a reed ceiling which has made it possible to have a painted score for the nave of the church. The extrados of the structure housed the roof consisting of roofing slates. Subsequently, following structural problems in the early 20th century, the curved profile vault was covered by a two-pitched structure on wooden trusses.

The latter represents the current roof under which the previous structure has remained until today. The appraisals dating back to the early 20th century highlighted the need to build a new roof system above the wooden vault. Four main reasons led to this decision: 1. the reinforcement of the vault showed severe deformations accentuated by the absence of reinforcement tie-beams; 2. the slates of the roof covering were subject to lifting and falling; 3. it could not be considered a definitive roof for a church whose ceiling was susceptible to decorations of value and duration; 4. the repair work already carried out was not conclusive. Therefore, based on a project by engineer Bianchi, it was decided to build a new gable roof above the curved roof. This new roof is intended to give the church a new roof while protecting and preserving the historical one [12]. It was also planned to place four iron ties in cor-

Fig. 4. *A - Detail of the curved profile roof now devoid of the roofing mantle and protected by the gable roof. In the foreground, the reed vault of the inverted keel vault can be seen. B - Detail of the lower part of the ribs of the curved roof. C - Diagram of the curved roof structure (Image source: Accomasso 2019).*

respondence with the axes of the internal pilasters. The archival documents also made it possible to trace the list and measurements of the wooden carpentry and hardware needed for its construction. Therefore, comparing these measurements with those of the current structure during the direct survey operations was possible.

The particular shape of the 19th century roof (Figs. 7 and 10) did not prove to be adequate and problem-free. So why was that shape adopted? Could there be other reasons besides the recovery of material and the choice of an appropriate shape in terms of size and pushing action (as mentioned above)? We have relatively sparse news of the old church: it is known that its consecration dates back to April 11, 1554 [12] and that the complex already appeared to have the volumetric consistency of the church, which was then demolished in the 19th century. Other inventories of the 17th century [12] describe the movable and immovable property belonging to the Church of S. Maria di Cogoleto. From these papers, no substantial differences can be deduced from the building of the previous century. Even the pastoral accounts of the 18th and early 19th centuries and the cartographic and iconographic representations of these centuries show a church with a volume similar to that of the 16th century one: from all this, it can be deduced that there have been no substantial changes throughout this period. It can be assumed that the recovered wooden material may actually belong to the 16th century church. From these data, therefore, it would seem not so unlikely that the particular shape of this roof can consequently date back to a period in which, also in other territorial contexts, the first times "inverted keel" appeared. If this first hypothesis were confirmed, there could also be another reason for the revival of the curvilinear roof of the new church at the 1877 construction site: it would be, in fact, a revival of a model rooted in the collective imagination of Cogoleto for well over three centuries. To date, the elements in our possession seem to be going in this direction.

Fig. 5. *Details of some wooden ribs engraved with Roman numerals.*

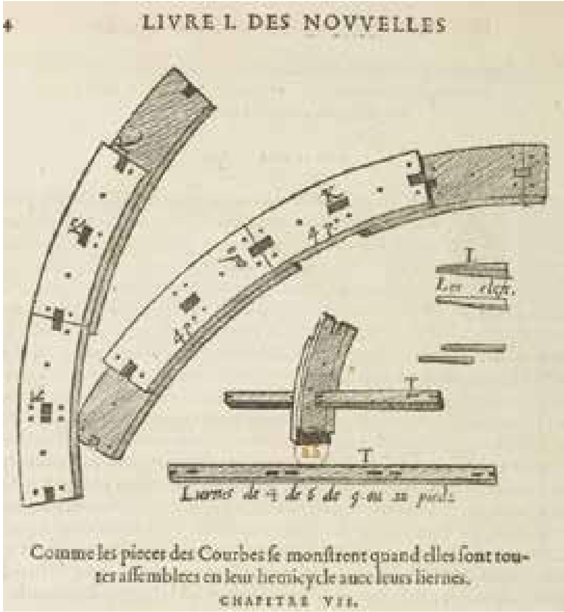

Fig. 6. *Detail of a wooden rib in which the trend of the wood fibers can be seen. Fig. 12 Drawing by de l'Orme on assembling small pieces of wood to construct his invention. (Image source: de l'Orme 1561, p. 43).*

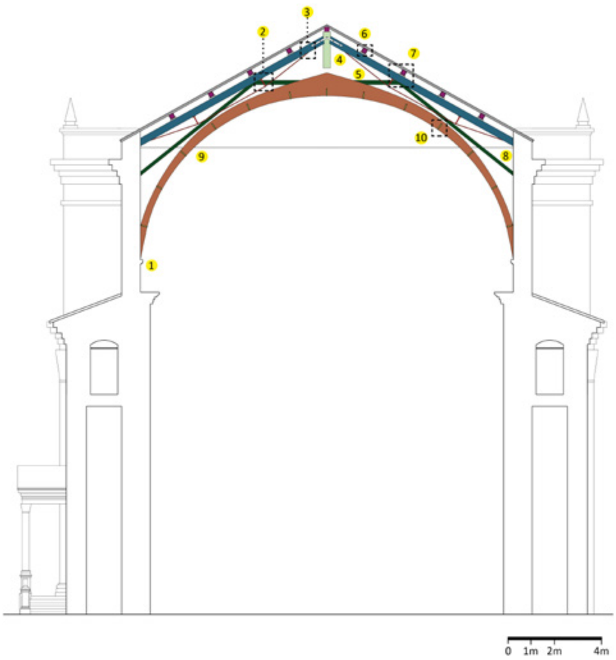

Fig. 7. *Cross-section of the curved profile roof and detailed images of the same (Image source: Accomasso 2019).*

5. OTHER CASES OF INVERTED HULL COVERAGE IN LIGURIA

In Liguria, other cases of wooden vaulted roofs have elements in common with that of the church of Cogoleto. In particular, two of them appear to be in a geographical area adjacent to Cogoleto and are chronologically contemporary with each other and the 19th century Cogoleto's structure. The first is the former spinning mill of Arenzano [16] (Fig. 8). The main frame of the roofing system consists of ribs with a partly curved and partly straight profile. Commonly its shape could be considered an inverted keel, although there are some differences with this typology. In analogy to the church of Cogoleto, the resistant section of the elements corresponding to the warps is obtained by joining wooden boards and not by curved woods: the fibers of the wood of the curved rib portion are not parallel to the shape of the board. Adopting this form could be motivated by the intention to decrease the entity of the horizontal thrusts by unloading most of the load vertically to the walls.

Fig. 8. *Former spinning mill in Arenzano.*

Fig. 9. *Former Martinez Hospital.*

The second building is the former Martinez Hospital in Pegli (Fig. 9), the roofing system of which, in 2006-07, was the subject of an in-depth diagnostic investigation [17]. The wooden frame of the roof is made up of a series of curved beams made up of several elements, in the longitudinal and transversal directions, joined together using nails at an irregular pitch of about 95 cm. The elements making up the beams have an average thickness of 4 cm and a height of about 22-24 cm. The ribs made with a series of reduced dimensions boards nailed together represent an element of similarity with the vault of the Cogoleto's church. Instead, the two shapes of the roofs appear different: while the former hospital of Pegli tends to have a pointed arch, the Church of S. M. Maggiore is more similar to a round arch. At this point, the question may arise whether there is a connection between these similarly shaped structures and whether, in some way, we can speak of reciprocal influences. For the moment, this part of the research is in progress as, at present, there are still several elements that cannot be given a precise chronological location.

6. CONCLUDING REFLECTIONS

«However, the distance that separates the simply probable from the very probable and the truthful is great. In order to know which category a final paper corresponds to, one cannot rely on the properties of the language used and the pleasantness of the graphic sign, as is sometimes led to do. Only by examining the path taken will it be possible to ascertain whether reliable conclusions have been drawn from correct premises» [18].

Specifically, we wanted to show the entire path, and we intended to list the individual steps by which it was possible to draw, in the end, a weighted conclusion. Tiziano Mannoni used to say, «it is not the quantity of data collected that makes history, but the critical analysis of those concerning the problems taken into consideration», and in this regard, this research highlights the extent to which the critical analyses help arrive at a fruitful conclusion [18]. In Liguria, therefore, there are other cases

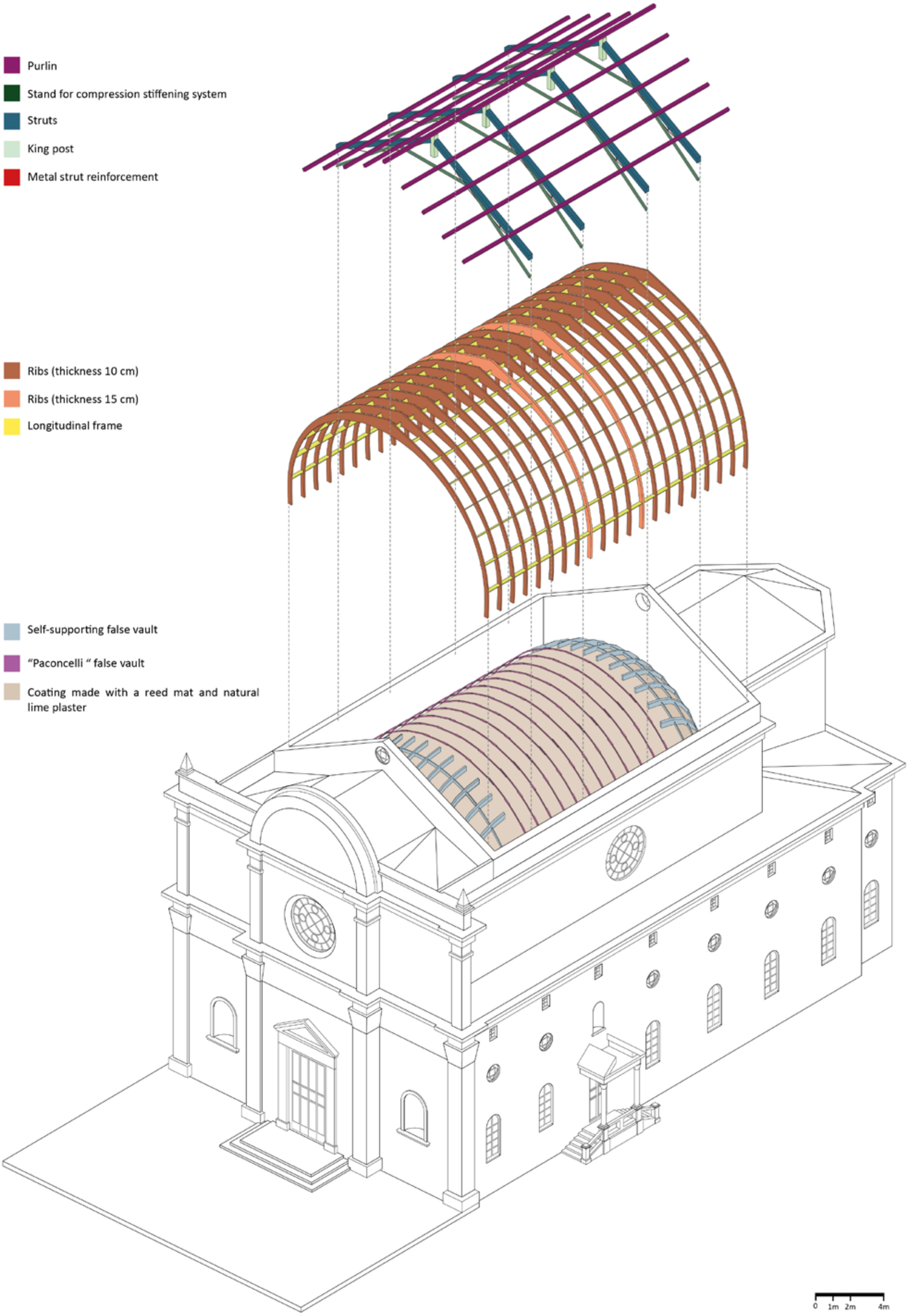

Fig. 10. *Roofing of the Church of S. M. Maggiore. The axonometric summary section (Image source: Accomasso 2019).*

of wooden vaulted roofs that have elements in common with that of the Church of S. M. Maggiore in Cogoleto. In conclusion, buildings with vaulted roofs in wooden carpentry are not unusual. However, it is difficult, and even simplistic, to classify such structures under rigid categories such as overturned keel or De l'Orme's invention. Often they are the result, as in the case of the Church of Cogoleto, of artisans' knowledge handed down from generation to generation. Elements of relevance to antecedent construction techniques are not excluded, but there is no evidence that these craftsmen can be considered shipwrights experts in naval carpentry [19]. Finally, it should be emphasized that the vaulted roof of the Church of Cogoleto was built in 1877-78 with the dual purpose of supporting the false reed ceiling and supporting the external roofing; in 1900 proved not to be able to perform both functions. Thus the truss structure was created, and a new roof structure was created above it. The considerations that can be made following cases such as the one described are various and articulated. In the future, further and more in-depth studies will try to answer the question of whether the case examined is the result of an intent to imitate the oldest inverted keel roofs (in which the variations present are "uncontrolled" elements) or whether it is a" development" of a new type of roof with a curved profile (with consciously desired elements and technical solutions different from the tradition). Another element to be explored is how much the tradition of shipwrights and the tradition of woodworking for boats has influenced the choice of a curved profile roof not so easy to make. could be a dendrochronological analysis of some of the boards of the wooden ribs of these vaults. Dendrochronological analysis on wooden boards of vault ribs could be a good future research activity; it could help undertending more deeply the history of this church and the other wooden structures. Another question still open, and which will be investigated in the future, is the following: «Could buildings covered with curved roofs built after 1877 in the area surrounding Cogoleto have drawn inspiration from the roof of the Cogoleto church? Can relationships and similarities be established? Can we speak of an impact of this type of coverage in the surrounding area?». In all cases, however, the approach to be taken in any restoration works will be the same: whether the example studied is a simple re-proposal, or an attempt, more or less successful, to imitate different construction models or a chronological variant that is configured in a certain time and a particular area as a "chronotype" [20–22], it is good that this structure is preserved. In conservation, it will be necessary to maintain the shape and, as seen from the analysis, also to take care of the more banal signs such as riveting, joints, and other minimal technological details. However, the maintenance of these structures will be, as Riegl affirmed, preserving the memory of a singular moment of an evolutionary process. As far as restoration is concerned, a maxim that it could be helpful to adhere to comes from a different disciplinary sector and can be recognized in Bloch's words: «The spectacle of research, with its successes and troubles, is rarely boring. It is the beautiful fact that spreads frost and boredom» [23]. Therefore, leaving structures like these to the future, even with the doubts and questions we have seen, will enrich the knowledge of pre-industrial historical structures. Paolo Torsello used to say in this regard, «[…] a good story does not limit itself to telling, but opens up new perspectives of thought... in short, it is not a truthful deciphering of the world but a provocative opening of horizons of reflection» [24]. The complexity of the fact-finding investigation, on the other hand, provides us with suggestions on how to carry out any restorations: paying attention to the preservation of the shape of the artifacts is not enough. Keeping the materials and the most minute construction details is also necessary. Sometimes, as in the example illustrated, it is precisely from these elements that important, if not decisive, information can be obtained. Thus this research can be an essential study for the knowledge of this particular structure that, in the words of Alois Riegl, still represents a singular moment in an evolutionary path [25].

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Consulted Archives: ACC- Archivio Comune Cogoleto, ASG- Archivio di Stato di Genova, ASCC-Archivio Storico Civico di Cogoleto, ASABAP-Archivio della Soprintendenza Archeologia, Belle Arti e Paesaggio per la città metropolitana di Genova e le province di Imperia, La Spezia e Savona, ASD-SV- Archivio Storico Diocesano di Savona Noli, ASS-Archivio di Stato di Savona, BAV- Biblioteca Apostolica Vaticana, ACPC- Archivio della Chiesa Parrocchiale di Cogoleto.

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Authors contribution

"Conceptualization, methodology: D. P., Investigation: C. A., Funding acquisition, resources: D. P., Supervision: D. P., Writing original draft: C. A., D. Pittaluga, Writing-review&editing: D. P. Authors of paragraphs 1, 2, 3, 5 are C. A. and D. P., of paragraphs 4, 4.1, 6 and D. P., photos and drawings are by C. A. (except those for which specific attribution has been provided)".

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