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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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Viale del Risorgimento, 2

40136 Bologna - Italy

Phone: +39 051 2093155

Email: info@artecweb.org - tema@artecweb.org

Media Partner:

Edicom Edizioni

Via I Maggio 117

34074 Monfalcone (GO) - Italy

Phone: +39 0481 484488

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EDITORIAL

REMARKABLE HISTORIC TIMBER ROOFS. KNOWLEDGE AND CONSERVATION PRACTICE

Part 1 - Construction history and survey of historic timber roofs

Luca Guardigli

DA - Dipartimento di Architettura, Università di Bologna (Italy)

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The culture of timber structures dates back to the origins of construction and extends its branches to the industrial era when the culture of metal structures gradually replaced it. This phenomenon crossed all of Europe, developing particularities in different geographical areas and simultaneously becoming characteristic of other parts of the world. The function of covering and protecting buildings with timber elements, in particular large spaces such as theatre halls, church naves, or warehouses, has been implemented using construction types of considerable invention even more than static analysis. The outcomes are often unique in their kind and based on the wisdom and competence of engineers, architects, and master carpenters, who made their advancements following cultural, technical-scientific, and socio-economic factors.

Today these timber structures represent a fragile heritage threatened by natural and anthropic actions, and they are mainly the subject of fragmentary and episodic research activities, often dictated by the occurrence of fires, collapses, damage, or imminent dangers. Nevertheless, the study of historic timber roof elements has reached good dissemination within the scientific community, considering its relevance for the more general issues of use, conservation, and safety of the built heritage. The conservation of valuable carpentry works for their safety poses interesting challenges since operating on artifacts built in the context of extinct or radically evolved technical cultures is never trivial. Their modifications over time, their state of conservation, and their interaction with the rest of the buildings are often unknown and not easily predictable.

This special issue has the ambitious goal of helping to outline the current international panorama of research on historic timber roof structures, especially those with

great span or peculiar technical relevance. The collection of papers is divided into two volumes: the first is focused on the history of timber roof construction, and the second is on the investigation, analysis, and intervention for roof preservation.

This introductory contribution is written to comment on construction history. The studies are developed by researchers from different countries and disciplines. Some declare in their career to work in the field of Construction History; others belong to other sectors such as Historic Building Conservation, Building Survey, or Historic Building Structures. As it is well known, in the Italian academic context, the distinction between sectors in the field of civil engineering and architecture (ICAR) is relevant, and it favors the isolation of research and discourages the integration of different working methods. As mentioned on the website of the Construction History Society, “Construction history is not blind to the importance of conservation and repair work, but it is focused on establishing and studying the history of building construction and not on how buildings should be repaired”. In any case, understanding construction history is vital for all those involved in the maintenance and repair of historic structures. Therefore, the first aim of this collection is to fill the gap among different methodologies and approaches.

Most of the studies presented here are based on bibliographic and/or archival research, illustrating innovative approaches to knowledge and documentation. These studies may rely on historical treatises and handbooks, reminding us that the dissemination of knowledge in Italy and Europe passed through treatises and handbooks or the transfer of expertise among architects, engineers, and master carpenters. From this perspective, the histor-

ical-typological profile of notable timber roofs, with a focus on structural concepts, construction details, and joints, is fascinating.

Some studies go directly to the origin of wooden trusses. According to Nicola Ruggieri, indirect evidence of roof carpentry organized as a truss system seem to have been found in the Mediterranean basin, at least from the Iron Age. However, these are isolated cases that probably did not have a decisive influence on the evolution of the roofs in the immediately following eras. Full awareness of the potential and systematization of the truss system occurred in the Roman scope, and only in Late Antiquity did such an organization of the roof structure start to be notably widespread, especially in the basilicas. In the conceptualization process of trusses, a considerable contribution is to be recognized to the Etruscan and Phrygian civilizations. The author gives us examples and evidence to support his statements on lost timber artifacts of ancient times.

In the German area, a research project has been focused on reconstructing the lost wooden structures of a more recent past; this is the case of Clemens Knobling, whose aim is to reconstruct the destroyed Munich roofs on the basis of archival sources and archaeological research on the remains of buildings. The results show a great variety of structures, constantly reflecting the current developments in roof construction. Among them, there are also quite experimental solutions. The results are presented as detailed scale models. Italian influences are often evident in these roofs. As Knobling reminds us, every region has peculiarities in building construction, and, in fact, there have been systematic studies on roofs within cities and regions, like in Basel, with the work of Thomas Lutz and Gerhard Wesselkamp, or in Thüringen and Sachsen-Anhalt with Thomas Eißing's work.

Belgium also has a remarkable heritage of historic timber roofs traced back to the 12th century. Louis Vandennebeele notes that this country's interest in historic timber roofs grew during the 19th century with the Gothic revival movement and the construction of national identities. New light was shed on medieval timber structures in European countries through publications by architects such as Augustus W. N. Pugin or the Brandon brothers in the United Kingdom, Eugène E. Viollet-le-

Duc in France, and Friedrich Ostendorf in Germany. In Belgium, the architect Pierre F. Langerock compiled several volumes on important Flemish buildings in the 1880s, with particular attention to roofs. This comparative typological analysis is an essential aspect of the research on timber structures.

The open roof structures – that is, open to the interior and without tiebeams – of Norwegian stave churches were studied in the mid-19th century and attained interest even outside Scandinavia, as Robin Gullbrandsson remembers. The development of buildings archaeology and the advent of dendrochronology in the 1970s and 1980s got a foothold even in Scandinavia, giving birth to new methods and raising questions in the research on medieval churches, often revising earlier stylistic datings. Wood construction, more than any construction element, show peculiar solutions to specific problems; this is due to the flexibility of the structural system, its adaptation to building transformation, and its properness to substitution. The accurate study of wood is fascinating because it needs attention and a deep look into detailing, for example, carpenter marks. Scarce attention to detail has led to inadequate and inaccurate interventions. Gullbrandsson reminds us that people can properly maintain and preserve only what they know.

Some studies show the transformation of timber roofs over time, including partial or complete replacement or integration with elements made of different materials. This is the case of the Bruntál Tower (Czech Republic) analyzed by Lucie Augustinkova, an example of a poly-functional half-timbered tower modified in the 16th and 17th centuries. Very similarly, some studies in Italy give a critical description of significant projects due to the complexity of the technical-construction choices or the importance of the building.

Original solutions are investigated by Enrico Genova and Giovanni Fatta in the residence of the princes of Butera in Palermo. These include timber trusses of the roof, partitions and ceilings on the second story of the examined part of the building, and metal and timber elements used to hang partitions and ceilings from the overlaying trusses. The restoration works offered the opportunity to enlarge the documentation: surveyed buildings can be conceived as a comprehensive repository of

information about Sicilian timber structures and their technology from the 18th to early 20th century. In particular, the use of suspended building components such as floors or partitions was not marginal in the architectural heritage of Sicily, although recurring solutions have not been clearly defined yet. It is feasible to think that these solutions were found to cope with Sicily's scarcity of wooden elements.

Similar insights on suspended ceilings, with a similar approach to one in Palermo, are also offered by Arianna Tosini in Rome. In this case, the research is not only supported by a detailed survey but also by the reading of early 19th century texts by Jean-Baptiste Rondelet and Giuseppe Valadier, illustrating two different criteria for creating coffered ceilings: in the first one, the coffered ceilings are directly connected to the roof trusses, providing for the lining of the tie beams; in the second one, the coffered panels are nailed to wooden frames hanging from purlins placed over the tie beams.

The study aimed to highlight the importance of these building techniques of the coffered ceilings in the churches of Rome. So far, this topic has not been explicitly addressed. In fact, according to the author, there is a lack of a detailed illustration of the different structures built and a broad picture of the different construction typologies, while studies of ceilings in the field of art are highly developed. Studies usually focus on the diffusion and the evolution of forms over time, starting from the second half of the fifteenth century to the early twentieth century. Preserving the structure of the coffered panels and the richly decorative and chromatic quality repeatedly required interventions, even of considerable extension, to prevent collapses, replace damaged parts, and restore various surfaces. However, the lack of knowledge on the topic and the scarce consideration of the ancient wooden carpentry, especially when used above the extrados of the ceilings, led to inappropriate interventions, up to the complete replacement of the ancient technological system.

Daniela Pittaluga stresses how studies on timber structures should be complete, 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. Specifically, she wanted to show the entire path of the analysis conducted in one church in Liguria and list the individual steps by which it was possible to draw, in the end, a weighted conclusion. Tiziano Mannoni used to say that it is not the quantity of data collected that makes history but the critical analysis of those concerning the problems. In this regard, this research highlights the extent to which critical analyses help arrive at a fruitful conclusion. The result of the study was also to discover wooden vaulted roofs that have elements in common in the same region.

According to Angelo Landi and Emanuele Zamperini, the constant comparison of the bibliographic and archival data with that of the real and present consistency of an important church in Cremona, Italy, its construction techniques, wood species, and decay not only allowed to understand and interpret the construction and maintenance acts, framing them in the more general social and economic context of the time, but also made it possible to expand its history beyond the boundaries of the original construction, although split into two phases, towards the numerous, and sometimes minute, maintenance works during four-hundred years of service life.

Finally, the history of roof construction is traceable between memory and innovation. The memory has to do with roofs because structures often lose their original configuration, and the initial concept is forgotten when elements are deeply renovated. Roofs usually consist of statically undetermined structures, and they are the result of the expertise of the master builders of their time; newly renovated configurations may follow the principles of the Science of Construction. New restored solutions come from the loss of confidence in the old construction or from the belief that the new science and the new building practice bring a consistent improvement in structural safety. Perhaps, this merely derives from the total lack of knowledge of the old techniques, in other words, from memory loss.

The presented studies are based on accurate research on historical documents and surveys, considering the conservation state and the structural behavior of the original structures. Detailed surveys are also the basis for the rehabilitation of the roofs. With the term "memory", we stress the importance of building tradition, expressed

through the choice of wood, the knowledge of how to join the pieces, and the experience gained in thinking about the element arrangements and the installation sequence. The studies trace the life of roofing systems, from their conception to their current configuration, through the alternation of the memory of the construction tradition and technological innovation. When technical innovation goes beyond the construction tradition, in a certain sense, it modifies the extent of knowledge. The word tradition brings with it the terms “*tradere*”, or “betray”, which represent the process of transferring knowledge over time, accompanied by a continuous renewal, a continuous rethinking of the same things. Today, in fact, not all the steps in the design and execution process of roofs are known. The direct observation and the geometric survey of these structures are perhaps not sufficient to complete all the knowledge; we could probably approach the understanding of historical techniques by trying to reconstruct the original objects, using the materials available at the time as far as possible. Of course, if we wanted to redo those objects today as they were and where they were, we would be forced to use the tools offered by our current technology, which suppose greater precision in processing and greater control of the quality of materials, ending up with different products. In fact, today, we are prone to reduce work-related risks and increase the per-

ception of safety – or objective safety – during the life of each construction. In any case, the construction tradition is an essential aspect of the restoration field. According to Paolo Marconi, more than twenty years after the 1972 Charter, modern technologies applied to ancient structures have revealed their limits in many cases.

For this reason, some recent trends push towards the recovery of a pre-modern tradition in architectural restoration, reactivating past techniques. In Italy, a revision of the ministerial charter of 1972, especially for architectural monuments and historical sites, promotes an approach to restoration based on teaching traditional techniques, combining resources in local raw materials, environmental factors, and cultural traditions. The aim is to re-evaluate a type of intervention that consists in the alliance between properly collected and disseminated historical knowledge and professional and entrepreneurial forces (from the associations of builders to craft associations) in order to re-propose a vision of the physiological mutation of architecture that confirms the philologically active role of restoration, guaranteeing the significance of the artifact and a conscious continuity. The life of these structures through centuries testifies to this continuous process of memory transfer and transposition and continuous translation of knowledge through maintenance, renovation, and reconstruction operations.