

## **HISTORIC STRUCTURES FRAMED WOOD IN LIGURIA. UNDERSTANDING DIAGNOSIS, PRESERVATION**

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The timber-framed wooden structures are one of the major building systems employment evolution protagonists of wood in the civil construction sector over the centuries. Construction systems created by the first inhabitants of the earth today are an unmistakable sign of culture reached by the man skilled in the use of this natural material that has been able to adapt to different architectural requirements in the various contexts in which it was used. In the well-known Ligurian territory it has applications in single historical building parts: ceilings, roofing, as often fake stairs

Less other applications like construction to frame the late nineteenth century will pose to the attention of the manufacturers with new housing proposals across the Great Exhibitions where you can touch the evolution of the overall production system from agricultural to industrial with all your derivatives

The need to regulate industry and machinery production flows in this sector is evident in its proposal of these systems by themselves and with other attached materials are proposed in interesting housing solutions and service sectors in Liguria

The importance of knowing this Heritage, its manufacturing technology and its disorders is the goal of these experimental university experiences that open up in fact an interesting line of research and knowledge dissemination Preservation of these models coming to make a contribution of knowledge also in Local Figure

На протяжении столетий решетчатые деревянные конструкции, являясь одной из основных строительных систем, играют ключевую роль в эволюции использования дерева в гражданском строительстве.

Начиная с первобытной эпохи, человек научился умело использовать этот природный материал, найдя ему достойное применение в различных контекстах и архитектурных решениях.

В Лигурии решетчатые конструкции широко применялись в исторических зданиях для

сооружения перекрытий, крыш, лестниц и фальш-сводов.

В меньшей степени использовались рамочные конструкции, которые привлекли внимание строителей лишь в конце 19го века благодаря крупным выставкам, на которых можно потрогать рукой новинки производства в жилищной и других отраслях, от сельскохозяйственной до промышленной.

Эти конструкции, одни или в сочетании с другими материалами, приходят на помощь индустрии и производственным циклам, предлагая интересные решения в жилищной сфере и третичном секторе в том числе в Лигурии.

Целью этих университетских исследований как раз и является открыть это Наследие, его строительные Технологии и Патологии, способствуя Сохранению и распространению этих моделей в Лигурии.

## 1. INTRODUCTION

### 1.1 Wooden frame structures

What are *wooden frame structures* ?

What are the most widespread areas in a context such as Liguria where in the past the wood has apparently had a very limited use?

Where are the potentials? Where are the limits?

And above all, what are the precautions to be taken for their conservation?

These are the main questions we started from with a targeted research in 2015. (COST, Open Call Collection: *Resilience of timber framed cultural heritage objected to natural hazard and climate change*: OC/2015/2) Within this broader research we included two dissertations, still in progress, at the Department of Architecture of the Polytechnic School of Genoa; in particular we involved of the area of architectural restoration and technology.

The first of the two thesis, prof. Daniela Pittaluga, correlators prof. arch. ing. Giorgio Mor arch. Gerolamo Stagno, is carried out by Linda Secondini and Silvia Gelvi. It was aimed to operate a first census of wooden frame structures in the Ligurian area.

Liguria has mainly used the stone for its construction, more rarely the brick and much less the wood. The wood, in effect, in historic buildings was used mostly for the structures of horizontal elements, for roof structures and window frames. One of the questions to which an answer has been sought with the thesis was to verify the actual heritage of wooden frame structures in this territory (see capp. 2,3).

The second thesis, prof. Daniela Pittaluga, correlator arch. Gerolamo Stagno is carried out by Anna Bruzzone. It had the aim to investigate the specific degradation phenomena of this type

of structures, highlighting the particular vulnerability and suggesting appropriate remedies and desirable maintenance (see cap. 4). (D.P.)

## **2 Notes on the wooden homes of the late nineteenth-early twentieth century in Liguria**

- Premise. Between 1750 and 1790 the English culture develops in original form and complete the poetics of the Picturesque which consists of the traditional antithesis drop between Garden and Architecture on the one hand, and natural landscape on the other, that is drawn between nature and wildlife. You have the merger into a single vision of an aesthetic nature, poetry, painting, garden and architecture, which is referred to as Art of Landscape, culture landscape. The poetics of the Picturesque, although implicitly affects all romantic experiences, is realized above all in the Landscape Garden or English Garden, in eighteenth-century gothic (in fact referred to as "picturesque Gothic") and architecture of the Cottage, conveyed through a widespread manuals and specialized publications. In the Anglo-Saxon culture, the poetics of the Picturesque influence - starting with the second half of the eighteenth century and throughout the nineteenth century - a vast artistic literature, consisting of the Treaties and the layman manuals laying down the stylistic models for the villa, the house suburban and country house or cottage in the service of the new patrons of the middle-class bourgeois. These works, often referred to as the pattern books (books of models), are characterized by very synthetic theoretical propositions and issues, such as primary support for the illustrative material, an original aesthetic ideal. They reflect the taste in vogue in the late eighteenth century culture: the rediscovery of folk architecture, rural environment, and the vernacular morphology; the culture of revivals; the rediscovery of the national architectural tradition, seen as rich source of stylistic repertoires. To the rural house and its romantic aspects relates directly *Essay on British Cottage Architecture*, published in London in 1798 and in 1804 by James Malton, which contains forty of housing models. Special mention must be given to *Rural Architecture* (1822-1836) with 96 projects boards, and *Designs for Ornamental Villas* of 1827 of M.P. Robinson, because, for the first time, are published project in the style of Swiss Chalet, that is, more generally, inspired spontaneous building of the Alps. (This type of architecture has its main source in the work of modeling Graffenried and Sturler, *Architecture Suisse*, Bern, 1844). [Cfr. Patetta, cit., Pp. 9-41].

– In the "new Genoa", the neo-Gothic, which in the meantime take the field as part of the bourgeois burials of Staglieno, develops progressively in the hilly upper middle-class neighborhoods. In 1891 the city was equipped with a water funicular, crowned by a small station of arrival-cottage Alpine-neo-Gothic style, made of iron, glass, wood and brick, and with a very minute decorations, "almost a lace profiling the eaves and pierce elements of the external rifasciamento." Once again the place that the type: the hilly or mountainous, but also the promontory overlooking the sea, are crucial for the adoption of the types of Castelluccio and the chalet (cf. MF JUBILEE, cit., Pp. 63, 66- 67. See bibliography on the next page).

- Villa Koerting in Pegli (1891): The adoption of certain stylistic features more properly attributable to the type of mountain chalets (endorsed in the villa annexe) - elements that

connote in qualifying measures the nineteenth-century architectural culture of the "picturesque" - appears in this If it dictated by the use of compositional models directly drawn from the large publications of the time. Crucial in this regard reveals the contribution represented by Sketches of Chalets (see photo), which, compiled, presumably in the academic period, the same Haupt, are published in 1886 by the journal *Memories of Architecture*, along the lines of what had already occurred, since the early 800, with the spread of the themes developed by the European manuals (the reference to the famous books of Anglo-Saxon pattern that have the most diverse typological variants of English cottage and the cottage across the Alps, is most evident ).

- Construction of the chalet company Rinaldo Piaggio and C. Sestri Ponente, project and construction supervision arch. Richard Haupt. Performed entirely in pitch-pine wood that the company imported from Florida. Haupt had already conducted earlier studies on the new construction technology of wood through the development of some sketches of chalets, making a diversity of spaces, according articulated hierarchical formal resolution of prospects: the supporting structure with pillars and rafters in the plan view ground, is opposed to the upper floor to the uniform coating studded planks, whose arrangement is inspired by the American model of the balloon frame, in line with an industrial process that follows American standardization techniques. It could be reflected by a direct connection between the choice of the architectural style and its type in relation to its intended use (= mountain chalets ephemeral architecture), in line orientation eclecticism of the late nineteenth century. In very minute to lace decoration, directly attributable to the English model of gingerbread (molasses and ginger cake) - derivation latter, of alpine chalets of nineteenth-century Germany - are discernible obvious stylistic similarities with the arrival station of the funicular built in water 1891 in the form of Gothic Revival cottage to connect the city center with the hilly district of Circonvallazione a Monte. The Piaggio chalet is then faithfully rebuilt for the family of the same Haupt for Dellepiane family under the Righi funicular railway.

- Other examples Columbian Exposition of 1892: Colombiana Liquoreria Brothers Ravazzi - a Swiss vaguely "structure" performed in pitch-pine on a project. Vittorio Storchi - the Zolezi coffee and Brewery Switzerland, a chalet built by engineer John Crocco on the ramparts of the walls of Prato.

- The project of the exerciser Stadium of Gymnastics Company Ligure "C. Colombo" Columbian Exposition was entrusted to the architect. Richard Haupt and Eng. Vittorio Storchi. Of great interest, the construction plan, the colonnaded structure that surrounds the inner square, consists of a truss continues with wooden trusses. This solution, designed to accommodate the lateral paths and a raised grandstand from the ground, very closely resembles the two-tier structure inside the factory by Rinaldo Piaggio in Sestri Ponente. The architecture of the front of the arched structure is characterized by four towers with coverage to northern intonation-oriental-Gothic spire 25 meters high. Like the configured solution for the Piaggio chalets, Haupt opt, in the basement, for a decoration hanging arches of gothic style, while the lace tunnel usual marks the eaves of the roof of the wooden towers. All together conceived by Haupt - and in particular, the bodies tower - anticipates two years, on the typical plan and the architectural language, the pavilion of the Sport designed by Giuseppe Sommaruga to riuntite Exhibition of

Milan in 1894.

- The chalet is also used to type in part, at least until the end of the second decade of the twentieth century, in building structures having decorative and formal apparatus of eclectic / Liberty brand, which function as elements of crowning to define stylistic hybridisms. One of the most significant examples still in existence, is the building in Via Sampierdarena civ. 2 (S.D., but before 1917), originally built to house the headquarters of the Navy League and used in later times as the seat of U.S.L. In the roof wooden roof recalls quite clearly the type of alpine chalets, both in decorative party (the Tunnel of hedging drooping lace) as the supports of the projecting elements, also in wood. There are many examples in this respect: in construction private residential, worthy of note is the Villa Dellepiane in Via Private Piaggio 33 (1904-1905). Before making the arch. Gino Coppedè in the development plan of the new upper-middle-class neighborhood of the ring road in Monte wanted by Erasmo Piaggio, the villa, already cited by Haupt, recalls, in form and decorative roof detail, related to architecture solutions of the mountain chalet in a mixture of secessionist ideas. ( R.F.)

## **2. Historic buildings framed in wood instrumental methods of knowledge**

The developed methodology for a systematic and in-depth knowledge of the timber frame construction also investigated the status of the materials through instrumental tests can identify specific points of vulnerability of the buildings themselves.

Taking into main consideration as one of the critical elements of the wood that generates degradation is the humidity and particularly the wet systematic chin that generates first degradation xilofago with moisture of the material up to 20% thereafter mycotic over 30% up to the complete loss of each mechanical strength with rot, have developed surveys on some significant points of repeating them systematically buildings where possible for each case examined.

The methods applied still ongoing include.

The knowledge the species inherent conducted with samples using micro carrots with suitable mechanical puller speed of light then analyzed with a player of the Tree Core Reader section also useful to determine along the radial sections conducted other degradation diseases.

The determination of the electrical resistivity method inherent in the percentage of moisture.

The determination of surface density surface with hammer Pyoldin wood zone where more develops woodboring degradation and then mycotic.

The deep measuring always conduct density electronic drills.

Investigations on identified as the grounding of the wooden structures (ground construction area and the area of foundation elements in elevation plane) and (nodes uprights transoms) involved healthy and degraded areas and can then establish a local relationship between the individual and then buildings.

In particular, it is also proceeded in the presence of coating treatments and were also considered secondary panel elements and collaborating.

The buildings examined represent a constructive champion also durability being mostly built with more than 50 years of life even when subjected to maintenance activities for which you are trying to draw up tables.

The sample of buildings is seen in the progressive growth of cases surveyed that are periodically inserted.

This investigation developed on buildings even closer to the water, however, differentiated typological situations ranging from contact with the water itself on the beaches to see house near to the seaside buildings located a few kilometers; Also this exposure will be considered in final evaluations on critical points as their exposure.

The set of data collected include the Historical Archive of documentation as available will provide a complete picture on building types on their technologies and from the point of view of the individual elements also of the links between them and the material including durability treatment.

From this amount of data it is assumed to process the experiencing both a first Inspection Protocol also differentiated for the kinds to be applied case by case basis.

In most urban and territorial scale is expected to achieve a reference Electronic catalog which also includes the drafting of a grassy code for the conservation of buildings and their restoration. (G.S)

### **3. Most Relevant Categories And Experimental Sheet**

In the Ligurian area there's no cultural heritage about wood bearing structures, however we located a considerable number of wooden framed buildings constructed between the end of the 19th and the beginning of 20th century. These were the years of the International Expositions in which new construction models were designed and brought to many areas, included Liguria.

We defined 3 categories:

- Residential buildings

Most of all have a foundation made by stone material on which is based the timber framed structure. Residential building are influenced by the "villa with tower" in eclectic style, widespread in these years in the Ligurian territory.

Most of all are second story buildings. The frame structure is pointed out thanks to the different material used for the external wall.

These buildings have similar resistant structure but haven't the same material in the external wall. We can find planks of wood, bricks placed to form a decoration and, in an isolated case, fibre cement panels in a villa built between 1920-23 by S.A. Eternit

- Bathing establishment

These kind of buildings are characterized by reinforced concrete pillars on which is based the timber framed structure. These building are simple with an unique and open space covered by a four pitch roof. The perfect conservation of these manufactures, constantly exposed to

seawater and sand, is made possible by a constant and periodic maintenance of the timber wood (they are made by “pitch-pine”).

- **Public Infrastructures**

Alongside the Genoese part of the railway line there are some big warehouse without walls. These are made of a modular timber framed structure with a big roof that allows the loading and downloading of the train’s cargo.

There is an isolated case of a waiting room made by a simple frame structure with timber walls, in the Rigoroso Station, a village in Piemonte.

There’s also a single funicular wood’s terminus that connects the historical city centre of Genoa with the heights at the back. It is a building composed by two blocks crossed by the rail.

A dense network beams, covered by a corrugated sheet, arm the roof that connects all these three areas. (S.G)

### Experimental sheet

An experimental sheet was made to be a relevant instrument to understand the building technique used for the analysed edifices. Moreover it tries to underline the analogies between them. Our aim is to create an experimental practical code for frames, in order to systematically classify and store the building procedures.

Many of the buildings are inhabited or in use and it was a limit, as the characterizing elements couldn’t be analysed with an invasive approach.

We reserve therefore a chance to provide constructive assumptions as compatible with the visible structure.

This sheet is divided into two sections; the first one is at a macroscale level, while the second one has a microscale focus, pointing out the technical details.

In the first section we can find the building general information, included address, owner, land-register data and ground features.

In fact our specific attention is direct to the external shape and the way it is perceived.

In the second part, we move on to a deeper analysis of the building, making a difference between the elements of the resistant structure and the envelope ones.

In the resistant structure we analyse:

- The kind of foundations and its relation with the soil (the wood durability is mainly influenced by the isolation from the ground)

- The structure of the frame system, simple or composed, the conformation, and the hystorography. Many buildings were expended by the years. We specify for each building if there are any changes from the originally structure.

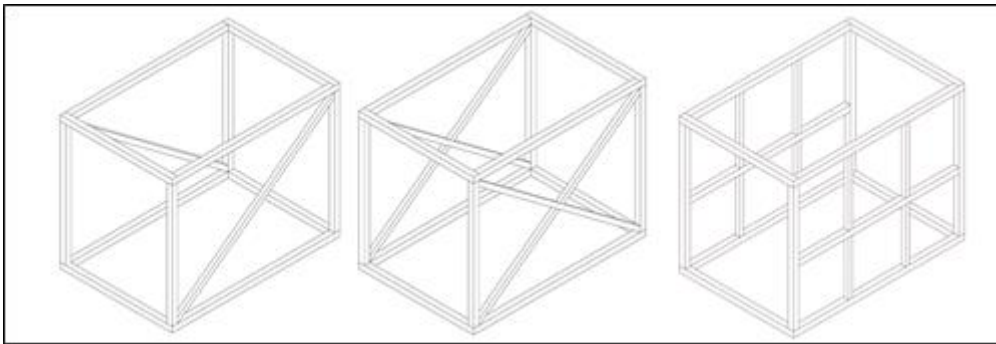
- The secondary load bearing structure, that is the strut or St. Andrew’s cross, specifying the material and the localization in relation to the load bearing sistem.

- The horizontal floor structure
- The roofing system

We then analyse the envelope system, meaning the elements that compose the internal and external frame walls. We describe the characteristic, the material and its arrangement.

Finally we describe the load-bearing structure, the numbers of its elements and the characteristic of its joist. You can find a summary table at the end of each chapter. There are also a special area for notes and drawing useful for the inspection report.

In the last chapters you can find details about the wood quality-characteristic and a reference to the possible construction wear. (L.S)



*Most common secondary load bearing structures taken from the Experimental Sheet*

#### **4. Monitoring of conditions**

After the identification of a considerable number of wooden framed structure buildings, in the territory of Liguria, it's basic for us to investigate the state of conservation from the structural point of view, with high regard to the durability of the materials put in place.

From this requirement, the need of patenting a fast, simple and efficient method to allow also a not experienced operator, to have a basic knowledge of the artifact regarding both the technological state of the building and the conservation of the materials.

To provide this task, a filling paper is still being developed.

The still under study tab includes two parts; a preliminary one investigates the state of conservation of the building technology and investigates the elements' connection considering the building as a system, the second is more specific and investigates the state of conservation of every single wooden element.

For the creation of the schedule (card/dossier), it was decided to investigate a selected sample of four buildings, each of them can be placed inside a standardized type identified in this study. By a first sight-classification of timber elements and by instrumental diagnostic tests (percentage of humidity inside the wood, material hardness, essence) the degradation phenomena results very similar for every building.

First common data to all inspected buildings is that the essences (wood) they are made of are never native, but they come from other regions; 90% of the timber belongs to the family of



conifers, the most common species found are spruce, silver fir and pine. This phenomenon highlights how the technology of wooden truss construction was imported in to the region and it also explains why some renovation or restoration interventions to these buildings has often been degrade bearer. The lack of knowledge of the subject by some local craftsmen has made possible that incompatible materials such as wood and concrete were often combined in the buildings; this habit has produced devastating effects on the wood that show in the presence of rot, decay and insects. The most deteriorated elements are the ends of the beams in pillars, where they stand on the floor and the surfaces of the same beams where they are juxtaposed to the walls.

Proximity to the sea, summer heat and very wet air's temperature, are not sufficient to cause material degradation; but added to a lack of maintenance works or to careless conservation interventions, this climate conditions may be dangerous to the wood durability.

The following are some average data obtained by instrumental surveys.

Average humidity of timber inside the buildings results less than 20% (a good result), in a range between a minimum of 10% and a maximum of 37%.

Mechanical condition of material is generally good, the toe of the wooden hammer seldom exceeds values of 20 mm except in deteriorated areas where values exceed even 35 mm. (A.B)

## 5. Conclusions

One of the first results from the research that has taken place in Liguria in relation to the presence of buildings with wooden frame structures was as follows:

- Contrary to what is assumed in Liguria there are a good number of examples of wooden frame buildings. The largest number of buildings surveyed today relates to constructions of the nineteenth and twentieth centuries. However, some rare case of older buildings have been found, however. It should be emphasized in this regard that one of the inherent limitations of these structures is their vulnerability to degradation, especially the one caused by water (in proportion fire damage appear to be less frequent, but equally, or even more, dangerous)

- A high result was the preparation of a "knowledge card", a sort of file including all specific information. This procedure of knowledge was, as indicated in paragraph 3, rather laborious and difficult. From an examination of the state of the art, we didn't find much it is seen information about these newer structures in the recent technical literature rather limited. Paradoxically, however, even though it often happens, the most recent are the less known. The occasion of the census of these structures is therefore also an opportunity for an *in-depth knowledge* of these particular architectures. The "technology to wooden framed structures" was found to be particularly versatile for different purposes. The research in question, as specified well in paragraphs 3, highlighted how the use of this construction method is specific for smaller buildings (in support of bathing facilities), both services (railway warehouses, funicular stations ...), and for buildings richer and more articulated (the various villas) (see cap.2). These buildings are technological and constructive architectural variants that the specially designed card records punctually.

People often say "Know to preserve" and that's what was done. This fact leads to a further result.

- The preservation of these structures as evidence of a particular model of understanding the construction. This part was handled in strict accordance with the realities of protection in the area. The simple structure of the reporting, the knowledge card has the added benefit of specifying the different characteristics of these structures. This first knowledge has wanted to also associate a specific study on the vulnerabilities and the degradation of these structures. The intent of this study will lead to identify the correct interventions and the recommended ones. It could also be used as a "guideline" for further interventions, showing the various possibilities according to the personal budget. This tool could be a real help for the institutions in the area to preserve the real value of these structures. (D.P)



Pictures in order from left to right: *the funicular wood's terminus, eExample of residential building, sample of bathing establishment, the "red house" an ex warehouse, railway warehouse in Pontedecimo station, Survey with Pylodin Hamm, Test with Hydrometer.*

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