QUESTIONS ABOUT EDUCATION AND TRAINING

The school of Architecture of the University of Genoa is characterised, at least since the last ten years, by a huge number of teaching courses devoted to historical building technology (in the degree course, in the School of Specialisation in Building Restoration, within the PhD course in «Building and Environmental Recovery»). This probably depends, among the others, on the fact that Genoa has one of the biggest European historical centres, that has been developed, since the Roman period till XIX century, with continuous stratifications. The knowledge of ancient building techniques becomes therefore a crucial issue, especially to preserve the historical heritage from wrong interventions, that could damage materials, load bearing structures and the image of the historical city.

Among the different disciplines that study the ancient construction, the paper deals with one specific discipline, the «technology of the construction», which main goal is to analyse the building in its physical consistency (materials, elements, structural behaviour and state of conservation and/or decay). Of course this discipline could not be seen as autonomous but should be integrated with other analytical tools and methods, sometimes more scientific and less «qualitative», like chemical and geological analysis on materials, archaeological introspections, archivist analysis.

A «technological» analysis of the historical building, in fact, looks at the object as a product of a building civilisation and aims to interpret the relations between materials, working tools and methods, building construction practises, shapes and spaces configuration, building settlements rules and models and building yard’s organisation (Blachère 1966; Dupire 1981).

Anyway, the significance of building constructive analyses exceeds the pure historical «curiosity». The focus point is the objective of this kind of studies that seems like a journey through a centuries-old heritage of human skills that keeps the cultural values of a city or a landscape and, at the same time, it is continuously under modification (Cacciari 1993; Gregotti 1984; Pedretti 1997).

The paper is focused on the role that this kind of teaching could joke inside the university and professional education and deals, therefore, with the following relevant nodes, not only focused on the knowledge of building construction progress but, moreover, on the influence that the construction technology had in the past, and still have, on our contemporary culture:

- the purposes of the construction history studies,
- their validity inside historical disciplines,
- their role in relation to general questions regarding the future of our tradition and the way to innovate it.
THE ROLE OF THE KNOWLEDGE OF ANCIENT BUILDING FOR THEIR PRESERVATION

Ancient builders in Genoa and inside the Ligurian region were able to develop a complex construction tradition using simple and poor materials (stone, wood, slate) and facing an hostile landscape. Nevertheless, they created a variety of technical solutions that are nowadays difficult to be understood, especially using the contemporary calculation methods. The first correct approach, facing an old building, is to look at it trying to understand the nature of materials, the way to work and to put materials together in order to create elements, and the structural conception of the whole building. This kind of investigation fits together with other historical studies, from which is different, but at the same time complementary, because it is based on a synthetic, qualitative and sometime intuitive view. Few examples could better explain this crucial issue.

Pitched roofing structures in Genoa from XVI to XIX century

In the historical buildings of Genoa and Ligurian region it is possible to discover a strong relationship between the load bearing masonry structure and the roofing system. While the vertical load bearing structure was heavy and massive, made by incoherent stone and brick masonry using as less as possible mortar between joints, the roofing structure was more light and elastic, to avoid any structural failure, especially in the angles.

Since the Renaissance and till XIX century, in fact, ancient builders used a unique and fine technology to cover residential buildings (the «palazzo» and the «villa»), different from all the other Italian countries. This particular technology allowed to realise a closed system, with diagonal beams supported by another structure and, consequently, the angle of the building was not interested from any thrust. The kind of roof that derives is solid, but at the same time a light and elastic structure, similar to the ship shell. Like the shipping technology, in fact, the roofing shell is supported by a primary structure like the wooden ribs, reinforced by other supports (Galliani 1984; Galliani and Franco 2001).

This particular system is characterized by a structural behaviour that is completely different from the other traditional wooden roofs: the principal beams are located on a massive part of the external wall, close to, but not over, the angle, that is a weak point of the incoherent masonry vertical structure, Figures 1,2,3,4. The braces are supported by other beams so that, in spite of their length, they are thin and light. All the structure is then stiffened by a wooden planking, that contributes to the whole resistance of the roof. Each element is not separate from the others, like in the contemporary building, but is part of an integrated system, like an «organism», where each part has a specific role and determine, but at the same time depends on, the whole.

This very particular technology lasts from the Renaissance to the industrial revolution, when the use new materials, especially iron and cast iron beams, starts to modify structural conceptions.

Flat roofing structures in Genoa from XVI to XVIII century

There could be found lot of examples of particular techniques in the traditional building yard. Another example, that is just a pretext to develop more general problems, is the way to solve, in the past, another huge problem: the flat roof, used as a terrace.

As we know, the flat roof is one of the major issue of the Modern Movement, but at the same time is one of the main technical problem, because of water infiltration. Ancient builders did not have at their disposal steel or reinforced concrete beams to cover huge lengths in terraces, neither waterproof membranes to protect inner spaces from rainwater. Nevertheless, they developed a brilliant solution to solve both the problems: the way to cover enormous length (also 10 meters) and the waterproofing. They invented a double roofing system: first they were used to build a pitched roof, made by wood structure and covered with a slate mantle, to guarantee protection from rainwater. Over this structure they built a flat terrace, supported by parallel brick walls, as lighter as possible. This goal was reached through a very light, but at the same time resistant, load bearing structure, made by thin bricks arranged like a «castle» made by play cards, Figures 5, 6. In case of infiltration of rainwater from the terrace, the pitched roof did not allow its penetration inside the building and the inner spaces. The technical innovation, in this case, is not in
the material but in the way to dispose it and the resistance of the structure is guarantee by its shape.

The knowledge of ancient technology is therefore and first of all necessary for any operation on the historical heritage, both for its conservation and for its modification. The courses organized in the School of Architecture intend to prepare the students to face practical problems using a logical approach for the investigation and the understanding of general behaviour of ancient buildings, apart from the specific cases.

Unfortunately even nowadays it is possible to assist to many invasive and incoherent interventions that transform, where not demolish, ancient structures, just because technicians are not able to understand their behaviour and to trust their performances anymore.
TRADITION TOWARDS INNOVATION

The knowledge of ancient construction technology is not only important for the conservation and restoration of the built heritage: it is the key for the innovation, that is the real essence of any project and design process. Any innovation in fact, even if it aims to break a tradition, comes up from a deep reflection on the tradition itself. This is a general sentence that is valid for materials, elements, structures, for the whole building. Any contemporary architecture, if it is a good architecture, even if it wants to fight against the past, has its basis on that (Colquhoun 1989).

Following this principle, it is possible to find different examples of new design that solve the conflict between tradition and innovation.

The following example comes again from the genoese tradition. The object of the project was the restoration and structural rehabilitation of an old convent of S. Ignazio (dating from the XVII century) for the new Historical Archive of the Columbus fund. The complex contained a pre-existing villa, from the Renaissance period, later annexed to the convent. All the buildings of the complex have been seriously bombed during the World War II, and no one of them was anymore covered.

The main problem to solve, among the others, was the construction of a new roof to cover and protect the inner spaces of the villa, which stuccos and frescos, in fact, were damaged by rainwater.

The first question raised by the experts involved in the project (A. Buti, G.V. Galliani, A. Sibilla, 1990) was about the way to built again the roof structure for the villa. Was it possible to build a new roof similar to the original? And how was the original? No historical documents were found neither any original trace was available. Nevertheless, the knowledge of other examples, as above explained, allowed the experts to advance some proposals. The idea to build again a wood structure like the traditional systems was discarded, at least for two reasons: the impossibility to find long beams as good as the original ones and the lack of ability of contemporary carpenters and builders.

Anyway, the knowledge of ancient structures helped the experts to design a new roof, which structural behaviour is similar to the original one. The main façade of the villa is in fact composed with a wide opening, creating a loggia, in the upper part under the roof, and this opening should not be pressed by any force deriving from a new covering, Figure 7.

The adopted solution consists in a new structure, made by laminated wood, that is supported by the same parts of the load bearing masonry that probably supported, in the past, the original roof, Figure 8.
The path traced by ancient builders guided the contemporary technicians, that expressed their innovation both in the choice of material and in the structural conception.

The examples that have been considered in the paper, limited to a very specific and restricted context, could easily be extended to a larger field. Every new architecture, if it is really good, is based on the knowledge of the past, not only from a formal point of view, but also from the constructive and structural point of view. This is true especially looking at famous masterpieces, that contribute to define new scenarios in the history of architecture and building construction, Figures 9, 10, 11, 12, 13, 14.

Figure 7
The main façade of the Renaissance villa inside the Convent of S. Ignazio in Genova, Italy (XVII century), before restoration and roof reconstruction.

Figure 8
Reconstruction of the roof of the old villa, with laminated wood elements and a new structural conception, with the same structural behaviour of the original.

Figure 9
Peter Zumthor, Thermal Bath in Vals, Switzerland, detail of the wall (1990–1996). The building is a contemporary interpretation of ancient roman bath and, at the same time, of the traditional alpine buildings in the surroundings. The constructive technology re-interpret the massive stone masonry, characterized by the stratification of horizontal layers, using local gneiss stone, disposed in layers, as a formwork for the reinforced concrete casting.
A confrontation between La Saline Royale d’Arc et Senans, France, by Ledoux, and a private villa on the Lake of Garda, Italy, designed by Carlo Scarpa. The column, as a classical element, is not only used by Scarpa to recall the pure shape, but again is a massive structural element, made by stone or concrete disks overlapped.

Gilles Perraudin, vinery in Chemin des Salines, Vauvert, France (1996–1999) and the Pont du Gard. The architect choose a place nearby the famous roman bridge. Instead of using a contemporary high tech language, like he is used to do, the architect has been influenced by the presence of the great roman infrastructure. He decided to use the same stone, extracted in the surroundings, coming back to the oldest way to put one piece on the other, without using mortar. The innovation is just limited to the organization of the building yard, where new technology allow to rise the building just in few months, in spite of the weight of the stone blocks.
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Figure 14
Eladio Dieste, storehouse in Montevideo, Uruguay (1979), double curved vaults. The engineer invented and created new structural typologies, like the reinforced brick vaults, using a traditional and poor material, thin bricks, to define complex and double curved vaults, which shape contribute to the structural resistance. His work could be seen also as a development of the catalan «boveda tabicada».

REFERENCE LIST