ARCHITECTURES OF EARTH IN CALABRIA

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Abstract
The thesis has been done on the town of Lamezia Terme and it is aimed at the recovery and identification of the local construction technique of this area. For this purpose, the research integrated the study of geometric significance, building materials and their degradation analysis. Nowadays, there has been a loss of the empirical knowledge, handed down for centuries. This research aimed to collect and identify some of this knowledge through interviews with the elderly and the masons, who know the local building construction.

The research had firstly begun with the identification of building types on an urban scale. Then, it evolved within the investigated area, to the scale of special technological features with specific characteristics. At Lametina region, it is clear that these constructions built in raw earth, reached 5-6 floors above the ground. During the investigation, from the researched archives, it was concluded that the area of the historical buildings was built after 1783. Therefore, it should have inside of the masonry a wooden structure called "*Casa Baraccata*". This is an appropriate technology similar to the "*Gaiola Pombalina*" used in Lisbon, after the earthquake of 1755. It consists in a bearing structure formed by three-dimensional beams and pillars in wood, made through (solid connection of) joints and nails. However, to preserve the wooden structure from decay, the structure was concealed within the masonry, which makes it difficult to be identified. The earthen raw walls have a significant thickness at the base (over 1m) and a tapering of approximately 20cm in every floor above. The walls of the top floor have a consistent thickness of about 30cm obtained by laying the bricks placed above. Another special feature of the area is the "Muratura Civata" (the outer wall made with small pebble stones and fragments of brick earthenware), a wall built with a lot of care. Whilst this is a "not finished" parietal; it is intended to protect the earth masonry from the atmospheric agents, which implies the use of a layer of earthen plaster.

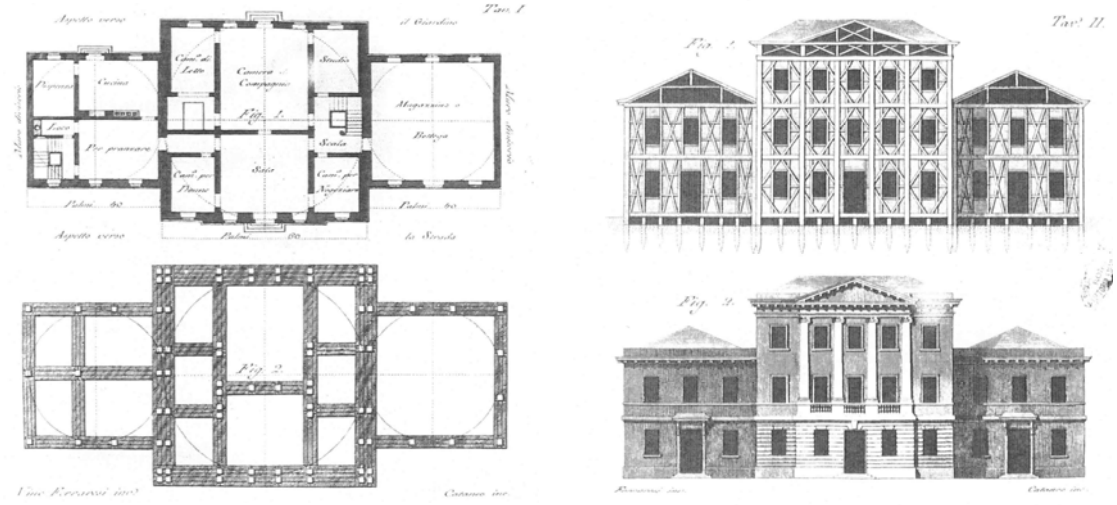

Fig.1 – Constructive patterns of "Struttura Baraccata" in G. Vivenzio,G (1788). *Istoria de Tremuoti,* vol.2, Napoli.

1. INTRODUCTION

The research is born from the collaboration between the town of Lamezia Terme and the University of Florence. It was meant to be a base of departure to constitute a competence of active vigilance between the town administration and the private building activity. This work was focused on the existing heritage and towards the buildings that, not specifically bound, are submitted to the custody of the “Zona A” of the city-plan. Today guaranteeing a correct planning, realization and vigilance regarding building and urban interventions is not enough. It is necessary to promote the right knowledge to improve the quality of the interventions and to provide the documentation of each one’s operational experiences to draw useful methodological indications for the operators of the sector. The collection of constructive techniques and materials inside the building object of study is not exhaustive in comparison to the range of problems related to the recovery of historical buildings. However, this introduces a vast range of technical solutions, such as the constitution of a base for the operations of recovery.

The primary objectives of this research are:

- To inform all the stakeholders involved in the field of building and restoration, of the building actual conditions, and of limits and precautions with which they must operate;
- To provide them with a useful documentation to understand whether to intervene or not, when the intervention is on minor building components;
- To press the town administration to transform the acquired knowledge in "ordinary" activity, so that the study and the experimentation on the constructive tradition becomes a heritage for people who deal with restoration and recovery.

In many restorations, a generalized and often hasty use of the modern techniques, based on an ideology of the technical progress that sinks the roots in the Modern Movement, more than on demonstrable economic and structural necessity, leads to defective if not partial results. This requires new and radicals interventions to make up for the committed errors.

It becomes of fundamental importance the long-term behavior of the new technologies adopted in the interventions of restoration, in comparison to preexisting ones. New and different technological structures, endowed with elasticity and different behaviors, in comparison to those proper of the buildings in which they are inserted. If the transmission of the loads is disregarded when compared to the logic of the original balances, its the modern technical and technological solutions that provoke the worst damage to the building. From this perspective, an aspect of priority importance is the professional work necessary to propose some pre-modern techniques. The art to build is handed down with continuity from the fifteenth century to the Industrial Revolution; substantially unchanged until the workers born in the first years of last century, which can be considered as "privileged witnesses" of constructive techniques that would otherwise disappear. The re-acquisition of this cultural heritage cannot be resolved in the simple repetition of the old jobs. This is intended as a "smart" work by understanding and acquiring the "secret" jealously guarded and handed down, so it can be interpreted in a modern context, and be adopted in areas where particular materials and old construction techniques are no longer available and reproducible.

Examples of building types that are made using traditional techniques and the use of earth building in various forms, present in Lamezia Terme are varied, primarily because of the region’s autonomy, not only economic and social, but also of the practical and artistic sense of the different actors involved in the construction. For the earthen technique, as well as for the remaining constructions, we can observe a building type that develops spontaneously, but also a more cultured one that, within the limitations of

materials was able to make the most of the technical possibilities and expression. The houses present today are a mixture of many shades, proper of a cultural heritage obtained from the multiple encounters and meetings between these two building types which, over the centuries, have lessened their distance by multiplying the variety and artistic details of the buildings. The shapes of the historical buildings, handed down spontaneously as a dogma, have now assumed the role of communication, transmission of thought and knowledge.

The active effort implemented during the reconstruction period after the Second World War, deleted values and traditions of local architecture, homogenizing and standardizing. Thus, it debased the structures shapes, the signs of low-cost and low-quality housing, anonymous building, and as in every place, making a faint memory, the deep meaning of constructing with "fragments". The conservation of historical centers, and considering the seismic phenomenon widely present in the region, inevitably introduces a comparison with the construction technology used over the centuries, including their genesis and their evolution.

2. SOCIO-CULTURAL HISTORICAL CONTEXT

2.1 Knowing before taking actions

Fig.2 – Facade of “Muratura Civata (credits: author)

To safeguard and preserve the historical centers, it is necessary to know them thoroughly. A knowledge that does not move from the logic of the gain and short terms of typical of contemporary way of building, but from a careful study of the criteria and devices operated in the past. Although the earthquake-proof solutions existent at the historical buildings cannot be compared with current techniques and legislation, they are still a key to a proper recovery of the built heritage.

The space, open or closed, natural or artificial, should not be taken into account for the possibility of exploitation or serial repetition, but as *unique place,* with its ancient laws, and as the sedimentation of human experience. Applying the concept of “*Genius loci”*

to the town of Lamezia Terme, we can see how the social and economic conditions of the agro-pastoral world and climatic factors have influenced its location, in relation to the territory, and more specifically, the structure of the particular building types. The range of building types in earthquake zones has traditionally been marked, in its evolution, from the fear of the earthquake. Time, before science, has tested the sites that people have chosen to live. But sometimes the necessity or geologic conformation, primarily influenced the choice of the site, putting at risk the safety of the population.

2.2 Constructive evolution over time

In the construction of a building, there are different stages, some of which are not always continuous. In most cases, especially in ordinary buildings, the construction of an historic building did not stop at the original phase, but was subjected to successive changes and transformations that could have changed in a more or less consistent way, the substance and the outward appearance of the building. With this in attention, it is possible to classify ordinary buildings also on the basis of completeness, deriving from the construction stages of each building or part of them. The requirements of durability and maintenance are complementary, and assume a central role in the conservation strategy of an architectural reality, but also in the strategy of conservation and environmental balance. Durability is usually understood as the ability of a material or component to keep unaltered over time its physical, morphological and performance characteristics. Related to the individual components of the construction, reliability must satisfy the capacity to maintain its function unaltered.

At the same time, durability depends directly on the preservation of the object and then on the maintenance. It triggers a negative relationship between the two concepts, namely the higher the capacity of the item (or rather, the whole building) to maintain unaltered over time its own characteristics, the less there will be interventions. It is known that a brick building rejects the insertion of "prosthesis" made up of materials, extraneous to its construction; also, from a strictly mechanical point of view, inserting reinforced concrete structural elements, disowns the wall construction, intrinsically discrete, transforming it into a continuous structure that alters the static behavior.

3. CONSTRUCTION SYSTEM

3.1 Elements of Connection

Today more than ever we must worry about the loss of quality of historic wealth, because little attention is devoted to the maintenance of the facades and the attention to materials of historical buildings. The connection devices may be divided into:

- Connection between the wall and land;
- Meshing between the stones forming the wall;
- Connection between wall and wall;
- Connection between roof or ceiling and wall.

The bumps are easier to predict if they are of the following type:

- Cylindrical hinges around, which rotates an outer wall when it is overturned away from the plane getting away from the transverse walls;
- Injuries that goes through a wall, from one band to another, separating portions originally continuous, or separating orthogonal walls along their intersection;
- Leakage of the beams of the floors from their site;
- Sometimes the expulsion of stones out of a wall that is too loaded and connected.

The walls are made of small parts without cross linking components (diatonic) to ensure the monolithic. The absence of these, leads to lesions in the wall and then generates a structural weakening. Another important aspect is the lack or otherwise deficient amounts of mortar in the joints, which promotes the slippage of the elements

of masonry, with the consequent reduction in the thickness of the wall. The lack of connection between the elements, insufficient connection with the masonry, poor distribution of thrust and the overlap of coverage are actually compromising the wall on which it lies. The study of these details provides, if properly oriented, a vision of the whole structure, its behavior during the earthquake and the possibility to predict and prevent damage resulting from any connections.

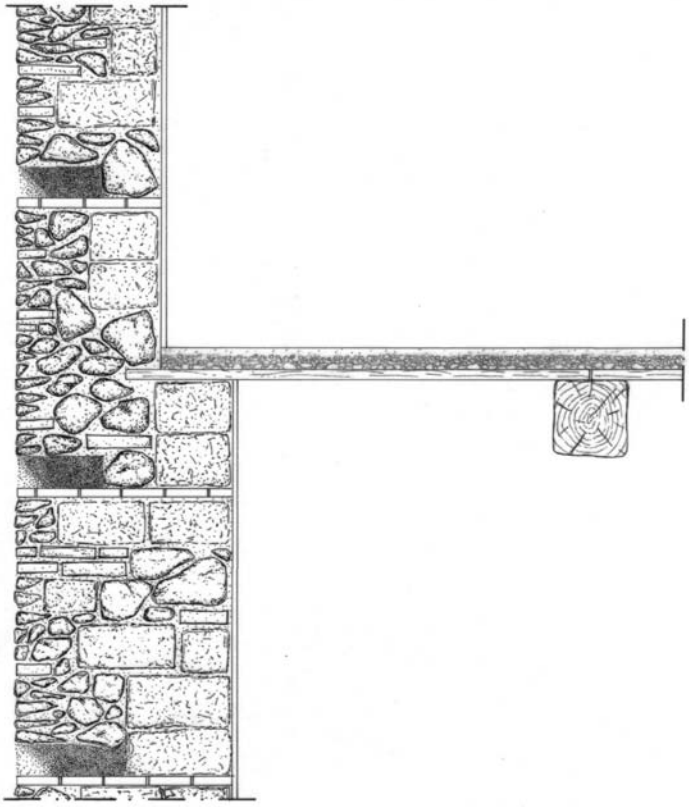

Fig.3 – Section - Wall thinning and "Civatura" (credits: author).

Elements of connection

The lack of connection between the walls, between ceiling or roof and wall, between wall boxes are common in Lamezia houses. A typological study of the area showed that the volumetric and planimetric evolution determined by a progressive blockage of free areas, changed along with the owners and their needs. Wall boxes are not always originally closed with the four perimeter walls constructed simultaneously. It is typical, however, that a housing cell has only three sides constructed together, if it comes combined with a pre-existing one; or just two, if it comes from the blockage of a yard; or just a wall on the street, if it fills space between two houses.

3.3 Intervention strategies

The criteria for intervention on weak and compromised buildings as those analyzed, designed to restore an efficient static behavior and to ensure an adequate response to seismic action should consist essentially in putting in relation the mechanisms that caused these diseases (or damage) with the design solutions. The structure of a building must be red correctly by trying to understand the origin that caused (or may cause), the mechanism of injury, addressing the choice of the intervention to the origin of the problem. A typological study of the historical center shows analytically the evolution of the urban fabric for the subsequent blockage of spaces. Subsequently, constructions designed are coupled with preexisting ones exploiting the boundary wall. Wall boxes are not always closed, which is not always carried out simultaneously and

with due between the four perimeter walls. It is common that a housing cell has only three or even two sides built together.

4. DEGRADATION

4.1 Principal forms of degradation

In a context of low or no maintenance, degradation occurs very rapidly. In the absence of direct intervention on the covers and drainage systems, rainfall results in an increased degradation of masonry structures accelerating their erosion. In the absence of a culture of recovery and restoration of buildings, the historical and architectural heritage, goes slowly lost, as well as construction techniques related to it. Direct observation confirmed that structural lesions result from the lack of building skills, which was due to walls that are not properly connected, (expansion/contraction of the material) that are clearly visible in the joints and execution of continuous walls.

Another relatively recent type of deterioration, related to the age of the construction, are the changes in external pavements that can generate water circuits damaging the foundations of buildings. Currently, the street pavement is often replaced with asphalt layers impermeable to water, particularly in the cement-type paving. Degradation is most evident at the base, with lesions, erosion and decay of enticement mortar of bricks and spots of mold, but also disruptions due to changes in road surface and growth of vegetation. The main enemy of earth construction is meteoric water, which comes in contact with the wall surface when there is not the ongoing maintenance in the roof. Degradation becomes visible with the runoff of the earth mortar around the lintels, until it causes structural cracks.

PLANS OF CONSERVATION AND INTERVENTION

5.1 Structural adjustments

The assumptions underlie in the methods of calculation must be met in construction practice with appropriate precautions and techniques of execution. Otherwise the theoretical measure of safety would lead to unreliable results. The two fundamental requirements to be pursued in the works of adaptation are: the achievement of a good level of resistance of the wall structure to the horizontal actions, linked to the possibility of having high shear stresses; as well as the certainty of having horizontal devices that can validate the hypothesis of their stability in the floor and their articulation with vertical structures. If the intrinsic characteristics of masonry structures do not provide sufficient values of shear stresses, the first requirement is met by designing and executing works of consolidation for the walls. While obtaining the second requirement, it is necessary to act on the attic structures and their links to the masonry.

To achieve this, requires a great design sensibility that is constantly refined through critical observation of facilities conditions, proportionate to the objectives that must be pursued, even at the light of the economic implications associated with the intervention of adjustment, to be able to frame it into a proper cost-benefit context. Bearing in mind the severity of the seismic action and the tragic consequences related to insufficient structural behavior, it is better that in transactions of adjustment importance be given to the achievement of the bearing capacity. Adopting criteria of intervention that sometimes may appear economically burdensome are the only way to ensure a reliable behavior of the structure and maintain long-lasting features. A better or worse quality of the wall construction depends on the greater or lesser inclusion in the device of big stones, whose dimensions would cover more than half of the thickness, but also on their proper disposal and lodging.

Indeed, the aim is always to achieve well-woven walls where it is not conceivable any vertical division of the section into two vestments outside of the autonomous behavior. The connection between the two sides of the wall section is necessary so that the

structure can take a monolithic transversal behavior during oscillations induced by seismic actions. This connection is obtained through the seizure of overlapping stones, or using diatoms (stone loops that bind the two opposite faces). The resistance of the wall is ensured by a mechanism of transmission of loads through accidental contact that does not lead to collapse.

5.2 Normative Issues

In Calabria, laws related to earthen architecture are virtually absent, as well as the connection between operational capacity, availability of traditional materials and professional training for both technical and working staff. The regional administration shall adopt rules for a *typological consolidation.* In the urban centers of Calabria, it is possible to apply the principle of *recovery of quality,* since the quantity of houses is now overflowing with needs. So, typological rehabilitation can be a resource for the region, which only requires proper planning.

It is the responsibility of local governments, waiting for detailed planning, to provide *extraordinary* and *ordinary maintenance.* It has already been noted how the lack of maintenance, raises exponentially the seismic vulnerability of earthen buildings. Considering also the settlement and typological characteristics of the historical building, the problem of maintenance cannot be left to the individual owner, but must be community value.

Another aspect not to be underestimated is that the current rules in Italy together with regional laws of Calabria do not promote the conservation of built heritage but in some ways hinder it. All actions that are undertaken should have respect for the environment and aim to reduce costs, and intrinsic values of “*minor architecture”* that was born spontaneously in places capable of providing, today as yesterday, the resources required for its maintenance and for new construction.

One option is to return to the traditional intervention practice and identify the existence of materials in the region, taking into consideration that raw materials are generally non-renewable assets. It is possible to propose organic and dependable choices for the availability of materials for building restoration. A possibility is to turn to some local firms for the material retrieval, with the explicit request of the redevelopment of certain stages of the process to adjust the current output to the characteristics of the conservative recovery process.

This hypothesis is not utopian, if we consider that most of the companies currently in operation in the region are craft companies, with a staff of fewer than five. In addition to this, equipment and machinery used for simultaneous production could be considered obsolete, compared to current technologies, but would be suitable for the production of some manufactured goods required for conservation recovery operations. This compromise is a balanced mediation between safeguarding of the natural environment and the need for preservation of cultural and historical construction techniques, which have to be implemented with the *recovery* and *conscious conservation* of the historic centers.

Technical standards alone are not sufficient to restore the culture of building in masonry; in fact, they are often viewed as a rigid prescription, rather than as basic elements of design grammar. Improving the ability to constructively control the bearing masonry has also spread the habit of "using" the rules rigidly. While the technical rules have the force of a calculation procedure that simplifies a structure with high value of uncertainty, high sophistication calculations collide with uncertain and imprecise for the same preparation of the material.

6. CONCLUSION

Interventions on buildings with historical, architectural, construction and artistic value must be made by adopting a multidisciplinary approach aimed at defining the best path to recovery. Buildings have a number of architectural and historic characteristics that are necessary to be absolutely unique. Urban and morphological location of buildings leads to a further consideration: the cover for their constant visual presence can be considered as a fifth facade, and for their variety of shapes and fragmentation of the image they are of equal value to formal facades. This should trigger different actors for the renovation process of the area, with morphological, aesthetics, functional and financial care, needed for the effective valorization of this heritage that belongs to humanity.

A lot of tacit knowledge have been passed between the *master* and local cultures to be able to make a thorough investigation, but the building stock that has to be investigated is large as well, so new technological solutions are not slow to emerge. Revenge of the raw will be possible if people and especially local government, will come side by side with the scientific community that is getting interested in this resource, but it is also necessary to introduce specific legislation for the technology of earthen building, able to meet and compete with the contemporary needs of citizens.

When working on a building in seismic areas, to repair it, reinforce it or adapt it, the designer must impose a precautionary approach, because any intervention, even the most careful and discreet one, can alter not only the environments and context, but also the possible conditions of constructive homeostasis reached by the entire remains of the building over its history.

A well-planned project helps the adoption of the most suitable solution to the case, but also to *plan a maintenance program over time.* The whole documentation may seem superfluous, excessive and expensive to the client, factors that affect the already high cost of maintenance. In reality this is not always true because any action drawn up in reference to this methodology would be able to recoup the initial costs over the years. This would give each building the opportunity to have an accurate and complete *survey* of the actual state, so that it is possible to update it whenever an intervention will be necessary to make an intervention on the facade as well as in the interior.

A document of this type is the *optimal base* to start a systematic routine of maintenance and repairs over time, a kind of *booklet of the building* to mark the timing, nature and methods of maintenance interventions. In this case, either the owners, or more generally, the municipal administration (which *should* monitor the interventions), have the control or at least the *synthesis* of the operations carried out. At the same time the building, through planned and continues interventions, will be kept *alive* efficiently, postponing aging as long as possible.

Bibliography

Baratta, M. (1906). *Studio sulle nuove costruzioni in Calabria dopo il disastroso terremoto dell'8 settembre 1905*. Modena.

Barucci, C. (1990). *La casa antisismica: prototipi e brevetti*. Roma: Gangemi ed.

Bertagnin, M. (1999). *Architetture di terra in Italia*. Monfalcone (GO): Ed. Edicom.

Borrello, E. (1948). *Sambiase, Ricerche per la storia della città e del suo territorio*. Roma: Stabilimento tipografico Carmelo Cappotto.

Cardella, Ferdinando (December 2006). *Decadenza e Recupero delle architetture della città dell'illuminismo- il caso della Baixa Pombalina di Lisbona,* Dottorato di Ricerca in Scienze e Tecniche delle costruzioni civili, Università di Pisa, Dip. Ingegneria Civile.

Cavalcanti, O. and Chimirri, R. (1999). *Di fango, di paglia…* Soveria Mannelli (CZ): Rubettino ed.

Cerandini, V.(cured by) (2003). *Area gecanica*. Reggio Calabria: Gangemi ed.

Curioni, G. (1885). *Raccolta di progetti di costruzioni in terra ed in muratura*. Torino: Ed. Negro.

Giffrè, A.(1991). *Letture sulla meccanica delle murature storiche*. Roma: Kappa ed.

Giuffre', R.; Foti, G. and Trombetta C. (2003). *I Linguaggi della riabilitazione: problematiche di estetica e dei materiali nelle tecnologie del recupero*. Soveria Mannelli (CZ): Rubettino ed.

Laner, F. and Barbisan, U. (1983). *Terremoto e architettura: il trattato di Eusebio Sguardo e la sismologia nel settecento*. Venezia: Cluva universitaria.

Migliacci, A.; Mola, F. and Tattoni, S. (1988). *Consolidamento e recupero dei centri urbani*. Milano: Clup.

Pasta, A. (1992). *Restauro antisismico*. Palermio: Dario Flaccovio Editore.

Pesso, L. (1876). *Sul consolidamento delle fabbriche nelle Calabrie contro i danni dei terremoti*.

Principe, I. (2001). *Città nuove in Calabria nel tardo settecento*. Roma: Gangemi ed.

Storelli, F.(cured by) (1996). *Habitat e architetture di terra*. Roma: Gangemi ed.

Tobriner, S. (1997). *La casa baraccata: un sistema antisismico nella Calabria del XVIII secolo*, in Costruire in Laterizio, nº56.

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Ettore Pelaia graduated in Architecture in 2009, at the Faculty of Architecture in Florence. With the thesis of his master degree, he ran for the "Prize for studies and researches on earth constructive systems" promoted by the National Association of Earth Towns and Laterizi Brioni srl, receiving a Special Mention.