HISTORICAL CONSTRUCTIONS IN EVERYDAY LIFE

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Abstract. In many countries (and particularly in Italy) people live among (and inside) historical constructions. The maintenance and retrofitting of such buildings is common practice for real environmental conservation. Since “history” is a long “story” that always gives rise to new issues, a wide range of construction techniques and engineering versatility are the basis for approaching this issue.

Three recent case histories (in which the authors have been involved as designers) of the practical renovation of old buildings are presented in this paper, all related to the same region (northern Italy) but very different in terms of the age of the buildings, the purposes of the involved works and the techniques of construction. The unifying approach is the architectural and engineering intention to keep significant old buildings still alive, not only as memory of the past but also for the needs of modern everyday life.

1. The project of the new offices of the Court of Monza, in a dismissed site that includes archaeological ruins, 15th century foundations and several constructions that have been built and modified during five centuries to accommodate (in sequence): historical residences, a convent, an orphanage, and other minor accommodation. The main architectural purpose was to obtain modern office spaces and facilities without altering the “genius loci” of the site located in the centre of an historical town.

2. The retrofitting of a rural house that was damaged by an earthquake, to obtain a luxury country villa. Both the poor quality walls (made by adobe) and the sophisticated brick vaults of the existing building have been preserved to show that the good work of not-engineered people’s skill can go together with modern methods of earthquake resistant design.
3. The recent renovation of the façade of the first skyscraper in Milan that was built in the early 1950s, in a period when the technologies of the glass-steel facades were not available in Italy. The architect of the original project (Luigi Mattioni) chose to simulate the light look of the American skyscrapers, using precast reinforced concrete frames for each window, with a cladding of majolica tiles, now progressively collapsing and dangerous for the roads below. A durable restoration of the maiolica tiles was technically impossible. A new cladding of a composite (granite and glass reinforced plastic) thin layer was adopted. The result is a perfect image of the previous shape of the façade. The building still stands among the new international style skyscrapers as a “landmark” of Milan and as a historical memory of the success of its reconstruction after World War II.
INTRODUCTION

Historical constructions are usually seen as “monuments”, i.e. buildings that people “look at”. However in many countries (and particularly in Italy), people live among (and frequently inside) ancient buildings that are, for the same age, “historical”.

Many modern buildings too (say: less than one century old) may be considered historical constructions, even if they are not monuments. For example: remainders of some traditional way of construction, buildings that marked the urban profile, buildings that testify the evolution of the country by means of their many modifications…

Conservation or/and innovation of these constructions requires sometimes important actions.

The engineering and architectural approach for the design of works on these types of historical constructions differs from the one used for “monuments” for at least two reasons:

a) The building technologies of the monuments have been already well classified and deeply studied.

On the contrary, non-monumental buildings show a tremendous wide range of building technologies, therefore versatility and open-mindedness are the basic skills required from architects and engineers to approach the design of the conservation and the rehabilitation of very different actual cases and very different needs.

b) The reasons for saving the monuments rest in themselves. For the other historical buildings, the reasons of conservation depend on their possibility to remain “alive”, as part of the everyday life. Since life changes, the rehabilitation for their different use is often a necessary condition for their conservation. The skill of the architect and of the engineer must often solve these two contradictory instances: renewal and conservation.

For all above-mentioned aspects, the science of designing works on non-monumental historical buildings is based on the observation of real cases. Three of them, in which the authors have been involved as designers, are presented in the following.

EXTENSION OF THE JUSTICE COURT OF MONZA

Monza is known around the world for its “Formula One” motordrome. Few people abroad know the aspects of this historical town: it was the capital of the kingdom of Italy from the 6th century to the 8th century of our era. Monza developed particularly from the 17th century up to the 20th century, during which it was one of the main centers of the Italian industrial revolution. Its civic centre, still very active, is a dense assemblage of buildings in which different periods of construction overlap.

The actual Justice Court lies inside the civic centre, in a single block, planned and built in the 1930s. Its actual size is largely insufficient for modern needs and must be doubled. The story (three decades long) of the different options for the solution of this issue will overcome the limit of this paper: the conclusion was the choice to expand the actual Court in a block aside, where the ruins of old buildings were standing.

When the authors started the architectural and the structural design they were amazed that none of the people living in town remembered this building in use. The documents had memory of a convent, the house of a rich clergyman, an orphanage and other minor accommodations. Even the property of the area should be decided in Court.

The “Soprintendenza”, the Italian authority on historical buildings, issued an obligation to save only a part of the ruins, allowing their renovation: the other part could be demolished and rebuilt, with the same size.
At this point the main issue of the design of the new building was clear: an architectural complex that includes historical renovated structures and modern constructions, all complying with the modern needs of the offices of the Justice Department, and connected with the adjacent Justice Court through a steel bridge. The following figures show how this was achieved.
It is worthwhile noting that in the central court of the previous “convent”, an underground parking (three stories deep) was planned.

When the excavation for the underground parking started, some underground archaeological remains showed up exactly in the middle of this underground structure. Instead of abolishing the parking facilities, a deep belt with a pile-sheet structure was built around the historical remains and most of the surrounding parking space was still available (figure 4).
A stayed cable steel structure has been designed as a roof above the ruins, that remain visible through a glass curtain (figure 5). By this way, an unexpected accident during the construction has been converted into an opportunity for the civic centre: a small urban “museum”.

From a structural point of view, in this compound different structural technologies coexist: retrofitted masonry structure (figure 6), rebuilt timber floors (figure 7), reinforced masonry arches (figure 8), reinforced concrete structure and new rebuilt masonry arches (figure 9).

Figure 4: Excavation for the underground parking, and pile sheet around the archaeological area.

Figure 5: Prospective view of the central court.
Figure 6: Retrofitting of masonry with a stainless net into the plaster.

Figure 7: Rebuilding of collapsed floors, using timber + reinforced concrete connected structure.
Figure 8: The masonry structure of the arcade during strengthening works.

Figure 9: Connecting the new r.c. structure to the retrofitted masonry, through a rebuilt masonry arch.
3 AN ADOBE HOUSE IN ITALY

During the earthquake of Alessandria (Italy) in 2003, many rural buildings near Novi Ligure (at the feet of the northern Appennino mountain) suffered serious damages and some of them collapsed. From the structural survey that followed, a rather surprising feature of those buildings emerged: the walls were basically made with raw ground (mostly clay): a technology known abroad and investigated by structural research as “adobe” (see for instance ref.1). The absence of any net inside the clay was a particularity of the present case.

Apparently all these buildings were made before the 20th century, when the area was devoted to poor agricultural activity (now a highly industrialized region).

Many of the buildings damaged by the earthquake have been demolished and replaced by modern structures. A similar commitment was given to us, as engineers, for one of a partially damaged building of this type to obtain a modern country “villa”. However the very preliminary inspection and tests showed that inside the raw clay an interesting structure existed, namely: some columns and vaults made of brick. The vaults were very thin (only 5 cm with stiffners 10 cm thick) and apparently suffered no damage at all (figure 11).

![Figure 9: Frontal view of the adobe house after the earthquake.](image)
Figure 10: Lateral view of the adobe house, showing structural damages.

Figure 11: Existing brick vault (from above).

This finding was a kind of challenge for us (modern engineers) with respect for old (probably self builders) farmers that applied sophisticated structural shapes to compensate their lack of resistant materials.
Figure 12: Strengthening of the vault with reinforced concrete.

A finite element model (shell elements, figure 13) was used at the beginning to understand the basic behavior of the vault. As expected, the tension stresses inside the vault depend very much on the horizontal restraints at the supports. Since we could not trust the horizontal reaction of the wall (especially in connection with seismic actions) the strengthening of the vault was based on a reinforced concrete horizontal belt, cast above the supports of the vault: (d) in figure 12.

Figure 13: F.E.M. Undeformed and deformed shape without r.c. belt.

The retrofitting of the walls against seismic action (figure 14 and 15) was based on a traditional technique: a “sandwich” made of:

a) An internal layer of new bricks (12 cm wide), cast in the same place of a removed internal 12 cm layer of raw clay.

b) An external thin layer of reinforced concrete, with a similar thickness of an external removed raw clay.

c) Since the total thickness of the walls remained unchanged, a layer of the original raw clay as central layer of the “sandwich” is saved (thickness from 15 to 30 cm).
Figure 14: Multi-layers retrofitted walls.

Figure 15: Underpinning of the vault with masonry.
Figure 16: Design section for the retrofitting of walls and vaults.

Since at any floor the brick wall (a) was made first, the vaults were always supported and did not need scaffolding during all the present works (figure 16).

Above the vault a ballast of lightweight concrete (e) was cast with a topping of a thin (5 cm) layer of r.c. (f), acting as horizontal diaphragm and connection to the external r.c. layer.

We think that a valuable achievement of this project was saving the memory of the original structure (raw clay and brick vault) and its anonymous smart builders, inside a luxury modern “villa”, that has now the possibility to survive strong earthquakes.
4 THE FIRST SKYSCRAPER IN MILAN

During World War II, Milan suffered severe destruction because of bombing by military aircraft.

The reconstruction was a matter of pride and also an occasion to adopt modern building models. Like in the post-fire reconstruction of Chicago after 1871, the skyscrapers showed up in the post-war reconstruction of Milan: the first was the one in figure 17 (finished in 1954).

At that time Italy had poor experience (and a lack of material) for steel structures. The quickest solution was to adopt modern architectural shapes using traditional materials, particularly: reinforced concrete.

In the building of interest, the Architect (Luigi Mattioni, ref. 3) designed large windows and aluminum lining to conform with the glass-steel facades that already were used in U.S..

The external wall was then made by a reinforced concrete precast frame around each window.

To obtain a “glossy effect” the concrete was cast together with a ceramic cladding with small size tiles. At each story a string course of cladding, made of a folded aluminum sheet, was cast.
The result had a great effect and the building was known as the “Grattacielo di Milano” for a long period (figure 16).

50 years after its completion, the weak aspects of this technology came out: the small tiles started to collapse in some zones, especially around the joints between precast panels or where the rain could penetrate the tile cladding (figures 18 and 19).

On the contrary, outside of these zones, the bond of the tiles to the precast concrete was still very strong, and there the tiles could not be removed without degrading the concrete. On
the other hand the reconstruction of the tile cladding “by spot” will not stop their progressive decay.

A drastic solution was first studied: to cover the entire façade with a new aluminum-glass cladding. This would give the building an “international style look”, as was done for other skyscrapers in the same area of the town. A test of this type of solution was attempted (see figure 20).

![Figure 20: A material model test for aluminum cladding.](image1)

Surprisingly the owners and the tenants of this skyscraper were strongly against this “modernization”.

So we then studied a solution in which the tiles would be covered by glossy granite panels, glued to the tiles and anchored to the precast concrete with mini stainless pivots. The thickness of the granite should be minimized to avoid overloading the existing structure and therefore a fiber reinforced plastic sheet was glued to the 2 cm thick granite in the marble-cutting factory (figures 22 and 23).

![Figure 21: Fixing the granite cladding by stainless pivots.](image2)
Figure 22: Typical sections and view of the new renewal of the cladding.

Figure 23: Detail of the pivot, granite and glass reinforced plastic panels.
Figure 24: View of the final shape for the facade.

Figure 25: Detail of granite cladding.
The renewal was completed with the substitution of the aluminum cladding with a stainless steel folded sheet, laying over thermal insulating panels (section B-B in figure 22).

When the works were finished (and the scaffolding removed) the “new” Grattacielo di Milano looked practically the same as when it was born (compare figures 17 and 26). It stands now aside a new group of “international style” skyscrapers as an “historical monument” of our history of the 20th century (figure 27).
Figure 27: Now a day skyline with the “Grattacielo di Milano” at the right hand side.

5 CONCLUSIONS

The three examples above show how in very different situations we may adopt solutions in which the memory of the shape and the original construction technologies can coexist with modern techniques and actual needs.

REFERENCES

