A new load bearing structure for the conservation of the roofs of the Molino Stucky in Venice (Italy)

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ABSTRACT: A new structure will be built over the roofs of the Molino Stucky. The main aim of the intervention is to preserve the historic and technical dichotomy of the two different roofs of the mill: the former carried out in 1895 using sheds with wooden trusses and vertical supports with cast iron pillars and the latter in 1905, built in reinforced concrete with air vents.

1 INTRODUCTION

The area object of the present contribution, inside the group of buildings of industrial archaeology known as Molino Stucky in the Giudecca isle in Venice, is that called Pastificio, that also includes some outbuildings (Fig. 1). The Pastificio was built with a first intervention that took also advantage of a previous structure belonging to the cloister historically present on the isle called San Biagio Isle, facing the Giudecca canal (Fig. 2).

This building was built on the design of the architect Ernst Wullekopf from Hannover, who signed the whole restoration project of the cloister carried out in neo-gothic style in 1895, in order to give a final architectural and functional structure to the Molino, that started working ten years before, in 1885, and that had had in such a short period of time an increase in production.

The first intervention, carried out in 1895, was enlarged immediately after, in 1903, on a project probably made within the Molino Stucky staff.

The whole group of buildings of the Pastificio, when in 1955 the whole production plant of Molino Stucky was no longer used, was considered a not relevant part from an architectural point of view by all those who analyzed and designed it again in the attempt to give the whole group of industrial buildings a role and a function within the urban texture.

This explains the fact that all the projects, including the last one dated 1992, devised after the constraint imposed in 1988 by the Monuments and Fine Arts Service on the whole real estate, foresaw the destruction of this quite large part of the group of buildings.
This part was considered not significant in all its aspects, both from the historical and aesthetical point of view.

It is, on the contrary, absolutely necessary to understand the role played by these buildings inside the Molino Stucky complex, in order to carry out a conservative restoration, possibly with neither destructions nor new constructions. By doing this, it is possible to understand the assumptions that lead to the preservation project, and to the choice of covering with a complex structure both the historical parts of this architectural sector of the Molino.

Even if the architecture of this monumental expression of industrial archaeology since 1955 up to now has gone through the whole range of different intervention possibilities coming out of the evolution of a conservation theory, however it has always given rise to a feeling of awe and silent admiration, both in the initial lack of interest in the Fifties and Sixties and at the time of greatest attention from historians and restorers in the Seventies and Eighties.

All the following projects, even if they paid more and more attention to the preservation and historical value of the industrial archaeology, considered useless to preserve and to understand the meaning and historical reasons that had brought to the Pastificio architecture inside the Molino Stucky.

Not considering it as an empty space, available for every use, it became necessary to evaluate which function to give the pasta factory spaces, in order to chose the new function without significantly altering not only the external look of the architecture, but also its role and meaning.

Studying in details not only the birth and following expansion of this industrial architecture, but also work organization, technologic plants and functional solutions, an important discovery came out and justified among other things the necessity of a total constraint such as the one imposed in 1988 by the Monuments and Fine Arts Service to preserve Molino from the steady threat of projects not correct from the methodological point of view and speculative from the point of view of the economic investment.

2 HISTORIC NOTES

The area where the Molino raised, San Biagio isle, was purchased by Giovanni Stucky, family native of Switzerland, once by Gioacchino and Alessandro Wiel who wanted to invest in the Venice area.

In fact they had bought the island and in 1871 had asked to widen the foundations facing Giudecca canal to be able to set up an activity connected to wood processing. Wiels were not allowed to widen the bank, event that brought them to the decision to sell San Biagio island to Giovanni Stucky.

![Figure 3. The production in XIX century.](image)

![Figure 4. The one-storey building of the Pastificio.](image)

The island had become property of the state in the Napoleon's age with a Napoleonic decree dated 1809 and in 1895 became property of the company Bordier-Fabris from London and the Pastificio was set up in 1895, since Giovanni Stucky thought it was suitable to extend Molino activity to the production of cookies, pasta and other finished products as a support to the mill activity (Fig. 3).

The Pastificio so set up in 1895 used a building already existing in the cloister modifying it from the construction point of view. Instead of the ancient structure of the XVI° century a two-storey building with thin walls and large windows was built with floor and covering in wooden framework supported in the middle by a row of cast iron pillars lined up.

Besides the existing building a large one-storey construction covered by sheds supported by a thick mesh of cast iron pillars was erected in the South (Fig. 4).

The two-storey building is still existing even if the covering has got lost, whereas of the shed building there are still only three rows of covering and almost all the cast iron pillars have got lost.

From the stylistic point of view, the two-storey building strangely shows the re-proposal of technical-constructive styles taken from the English civil Gothic
architecture, so differentiating itself from the group of buildings whose style takes root in the German Gothic.

The Molino Stucky as a whole showed that it had intentionally projected in a dichotomous aspect:

- Along the banks of the main canals there are the tall buildings, with a strong stage-charge, where the revolutionary wheat processing by drop takes place, a technological discovery that justifies the vertical development of the most significant buildings present in the industrial building plot;
- in the rear part activities supporting the wheat processing by drop from above take place; in fact, Stuckies as entrepreneurs thought it was advisable to insert a side-activity connected to the Molino, that is Pastificio (Pasta factory) that did not require tall buildings but a large area on a single storey to host a horizontal activity that immediately proved such a great potentiality, that eight years later it was already necessary to carry out an enlargement.

There are two different and dramatic plays of highs and within the conservative restoration intervention it has been deemed necessary to foresee the construction of a new complex structural element that, hanging above the structures of the Pastificio, allows to preserve the shape of the original coverings as well as the material of the original structure.

3 ABOUT THE PLAN

The problem was solved coherently with the basic choice, that is to consider all the dispositions of masses and the architectures inside the building plot equally meaningful, so getting rid of any prejudice of value, both historical and aesthetical (Fig. 5).

After a series of studies, among those functions that, inserted inside the Molino Stucky, would have not caused destruction problems as for its historical shape it has been considered suitable to create a Congress Centre.

In fact, due to the particular role of Venice inside the tourist system, presently in the classification list of the towns hosting congress activities, it is at the eighth place only, in such an important sector for an economy strongly based on tourism. The number of congresses that Venice hosts every year is very high, whereas the final number of participants is in proportion very low. Therefore this sector turns out to be damaged in its potentiality since the town can only meet the demand of meetings with a reduced number of participants, whereas it cannot expand further since it can neither propose an auditorium nor a hotel with a sufficient number of rooms to meet the functional and organization needs that a maxi congress has.

Therefore it has been considered suitable to join the two covered areas subtended to the Pastificio, that is the one built in 1895 and the other one added in 1903, in order to offer a congress room able to host 1500 people, so endowing the town with a fundamental instrument to play a more significant role inside this economic sector where the lagoon-town seems to have a great development potentiality.

The connection of the two covered areas takes place with the elimination of the partition wall between the two volumes and the large room is realized preserving the two original coverings. In the part built in 1895 there are still in loco only some of the original sheds, the others have got lost due to the lack of care and interest of the company owning it at that time, and therefore they will have to be proposed again with the same technique, the same shape and using where possible original materials. In the part of the Pastificio added in 1903 the concrete covering was supported by a series of pillars that had obviously to be restored since they were no longer in accordance with the standards to play their static function in a public place and especially in case the new function was that of a Congress Room.

Therefore, since it was necessary to coat them completely to give them again a correct static function, or to dramatically intervene on the original iron reinforcement, so altering the material they were originally made of, it has been considered suitable to eliminate these vertical pillars but not the covering with air vent, so that both outside and inside, the two different covering solutions carried out in 1895 and 1903 were still well visible.

At this point the problem of how supporting these two coverings, the shed covering in the Northern part of Pastificio and the concrete one with air vents in the Southern part of it, raised. The first easier solution was the proposal of a bridge structure external to the coverings made up of two parallel beams marking the development of the walls originally parting the two spaces, so becoming in their turn testimony of pre-existing structures. Then a series of projects have been
slowly developed with more and more complex structures able to support from above the two coverings whose design is so different.

For a long time it was thought of building two parallel structures, equal and symmetric, extra-volumetric projection of the two historic partition walls existing in plan. The final idea was that, being the coverings different as for static, structural conception, construction technique and used materials, it was necessary to find different solutions for the new load bearing structure.

4 THE NEW STRUCTURE

The two coverings were deeply different and different had to be the proposals concerning the supported structures (Fig. 6). Symmetry and parallelism of the two elements, proposed in the previous solutions, were no longer possible. The new idea brought to the creation of an external bridge, made of two different structures working together but in which the two main components are deeply differentiated (Fig. 7).

On one side there is a plane metal beam, whose camber opposes to the concrete covering it has to support; this beam is placed in such a way that, since it operates at a height not excessive in relation with the covering, it opposes to this and supports it at the same time (Fig. 8).

The shed covering, on the contrary, requires to be supported a series of high tie-beams supporting it and going to be inserted precisely where there were the capitals of the cast iron pillars originally supporting it. Such covering, since it has a triangular section, needs tie-beams coming from above with a great acute angle.

In such a way the new articulated load bearing structure for the roofs of the Molino Stucky was devised. It allows to support and preserve the two historical coverings that have been forced to live together in a single envelope covering a wide space that permits 1500 people to take part to a congress simultaneously.

In the tier that has led to the solution of the external carrying structure to the Auditorium of the Congress Centre, another problem has been raised at the same time: how to design the bearings of the new structure.

Also the shape of these bearings went through the changes already analysed. In fact initially the ground structures had been foreseen outside the Auditorium area and were just related to the bridge. Later they were considered architectural elements inside the Auditorium and have also assumed their own autonomy and a shape that is made visible letting them emerge above the coverings.

In fact, like modern chimneys, they should account for the formal and material trait-d'union between formal solutions of the carrying structure and the whole architectural set surrounding the Auditorium. The choices that have led to the final solution of the elements that support on the ground the bridge structure, have been influenced by the conditions of the soil on which they have to be placed.

Being in a lagoon-area and being not possible from an historical point of view to foresee the existence of foundations, they have to be created out of nothing. Therefore, a piles underpinning, typical of the lagoon-area, not difficult to evaluate and built since similar
works were made to support the tall buildings of the Molino since 1885, has to be carried out. The Monuments and Fine Arts Service, that has steadily co-operated evaluating the different proposals, has decided that the final project, keeping into considerations the objective difficulties, has reached all the targets posed by the methodological choices arranged and agreed upon above. It has considered suitable, in this case, that in the Molino Stucky group of buildings, where the prevailing logic has always been not to destroy and not to build, it was correct to realize a totally new, external, not practicable sign, in order to preserve a dichotomous covering differentiated as for epoch, construction technique and formal features. In fact this is integral part of that image that the Molino Stucky gives of itself due to the innumerable possibilities of crossing it at different levels, and therefore to perceive it in the endless play of superimposing, fitting and differentiating of the different coverings that characterize its architectures as a whole, both if they face the island shores and if they are founded inside, behind the water scenery, to represent that piece of work town that Molino Stucky was in the industrial story of Giudecca and in the social story of last century Venice (Fig. 9).

5 DESIGN OF THE STRUCTURE

The work is carried out by means of an arch framework with no thrust, made up of a single bay metal caisson, whose span is about 50 m. Such framework supports, by means of proper tie-beams made up of high-strength metal round bars, two floors located beside the arch, the one in concrete and the other one with a wooden structure, according to the so-called shed method. The arch is made up of main double T-section beams in solid-walled steel with constant high vertical cores, connected on top and at the bottom by two plates with variable width, 30 mm thick.

The caisson is duly stiffened by a transversal St. Andrew’s cross wind-bracing that increases its torsion strength. Whereas the tie-beams that support the floor in bricks and concrete are directly joined to the metal arch, those supporting the wooden floor are joined to circular hollow profile poles that raise the suspension point. Floors are stiffened by a metal structure frame that allows their suspension in the intersection points. The arch rests at its ends on concrete piers, duly inclined in order to effectively contrast the unbalanced horizontal component of the thrust coming from the coverings.

Stresses have been calculated with the traditional methods of the Construction Theory, based on linear elasticity and with the computer help. As for section control, it has been used the semi-probabilistic method of limit states according to the Eurocode EC3.

5.1 Standards and materials adopted

For the design of the structure the national codes and regulations for the design, execution and control of reinforced concrete and steel structures and for the determination of loads and overloads have been taken into account.

The steel to be used for the new structures is Fe 510 type, according to UNI 7070 with mechanical characteristics in compliance with prospect 2 II° of CNR 10011/88. The concrete mix for reinforced concrete structures has a characteristic strength equal to $R_{ck} = 300$ Kg/cm². Controlled steel type FeB 44 K has to be used for conventional reinforcements. The bolted joints are high-strength joints in classes 80.9 and 10.9 according to standards UNI 3740, whereas for the welded joints electrodes type E 44 class quality 3 or 4 will be used. As for automatic welding, threads, flows (or gasses) and the executive technique used for control preliminary tests will be used.

Molino Stucky restoration intervention has also involved recovering large part of the final covering mantle. Original tiles, which were of the Marsigliese type, have been replaced with other clay tiles. After an accurate analysis and a careful selection of clay, it has been possible to reproduce the same type of product originally used, in order to reach an intervention as far as possible in line with the original coverings.

5.2 Structural analysis

The load analysis including structure dead load, permanent and live load, plus the ribs in the case of the concrete covering and the dormer windows in the case of the wooden covering, gave for the concrete and the wooden roof structures a total load respectively equal to $1000$ kg/m² and $650$ kg/m².

The construction was studied with tri-dimensional structural models. Calculation of displacements and
stress parameters for different loading conditions has been carried out using an automatic calculation programme with finite elements. No seismic loading conditions were analyzed, as the area where the structure will rise is not interested by seismic phenomena.

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