The industrial heritage of the Veneto between memory and project: what technology for conservation and reuse?

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ABSTRACT: As regards the Veneto area, the panorama of the structures that can be classified in what is commonly defined as the Industrial Heritage is vast and compound and reflects the driving richness of the North-East. It is fully legible when investigating the historic roots of the industrial phenomenon, through the first signs—in town planning and building—of its appearance in the territory, and when seeking any traces that still survive. The language of technology is, in fact, more than ever an essential part of architectural language and, in these particular constructions, it is expressed in rigorous constructive forms, characterised by an honesty of expression that is associated with the clarity and solidity of the layout which features maximum simplification, even with solutions that may be demanding from the structural point of view. Sometimes they also possess innovative elements of great interest on the building scene of the time, regarding both the introduction of new materials and the way of using them, which was often unprecedented and pioneering.

1 FOREWORD

The panorama of the structures that can be classified in what is defined as the industrial heritage of the Veneto is very vast throughout the territory and constitutes a great wealth and a resource to be exploited, but also to be protected.

In our territories the birth and development of the factory were profoundly linked with the rhythms and times of agriculture, with which they have maintained a constant relationship. Early industrial structures were therefore influenced by rural building tradition and by the its characteristic materials (masonry and wood), which, in turn, directly conditioned both its shape and its constructive features. Only in works on a large scale and in those inspired by models from beyond the Alps, gradually introduced in the largest centres starting from the last years of the nineteenth century, are more free and original expressive forms encountered, produced by the introduction of the materials of the Industrial Revolution (cast iron, steel and, later, reinforced concrete).

The traditional constructive technologies (loadbearing masonry in brick and mixed brick and stone and roofs and floors of solid wood) would continue to survive indefinitely, till the mid twentieth century, for example in the realisation of the Hoffmann kilns for baking bricks and in the construction of industrial chimneys. But their use would also be prolonged in the factories located in the more peripheral industrial districts or, on the contrary, in the most intensely man-made and representative environments, such as the old town centre of Venice, where the masonry shell would continue to be given a high-profile tectonic role (along the lines of the first examples of the Stucky Mill, the Tobacco Factory, the Maritime Station etc. . . . ) and where the iron structure would be used alongside the traditional wood structure and even replace it until the arrival of reinforced concrete. Only much later, from the Thirties of the twentieth century, would traditional masonry techniques be widely used, first in a hybrid form with the introduction of reinforced concrete (in new buildings and in alterations carried out on previous structures for maintenance or reuse) which would finally replace it.

The use of reinforced concrete has given rise to original and at times unprecedented forms and pioneering construction experiences, which today deserve to be preserved and suitably valorised.

2 REINFORCED CONCRETE IN INDUSTRIAL BUILDINGS

2.1 Its diffusion in the Veneto in the 20th century

The diffusion of reinforced concrete in Italy came about much later than in other European countries, only as from the first years of the twentieth century, especially in the districts affected by the industrialisation processes in the North, such as a Piedmont,
Lombardy, Liguria and the Veneto. And in the Veneto the poles of industrial development at Schio-Valdago-Thiene, Verona and Venice-Porto Marghera were the main driving centres for the success of the new material, able to assimilated the innovation brought by Hennebique’s French patent and the great potential offered by its application.

The industrialisation of the territory was in fact the real driving force of the renewal of the building world, which was still stubbornly anchored to the tradition of masonry construction, because the introduction of the new material – reinforced concrete – made it possible to achieve rationalisation processes both in the sector of urban infrastructures (bridges, roads, subsidiary services, pipelines, etc.), and in the sector of structures intended to bear high loads and characterised by large spans and high flexibility, such as the factories with their large machine rooms, large warehouses, silos, hangars, indoor markets, etc. It also made it possible to ensure good resistance to fire and an expectation of long durability, which only later would be endangered when the problem of its behaviour over time was revealed, also in relation to the environmental conditions which with time had become more and more aggressive.

In the first period of its success, the new material was at an advantage on account of its particular characteristic of being able to be integrated in traditional masonry construction, at first only in horizontal structures (beams and floors), and then also for internal pillars (taking the place of cast iron and iron).

In the Veneto, the first constructions to use reinforced concrete date back to the very first years of the twentieth century, coinciding with the development of the French Hennebique method, of which they faithfully reproduce the type. They are slabs with a reduced thickness (with rectangular or square dimensions) resting on a crossed frame that is lower than the floor composed of secondary beams fixed into the main beams, which in turn are connected to the pillars by means of brackets with variable section.

Only later, from the Twenties of the twentieth century, do we gradually witness the evolution of an expressive language of the new material itself, able to interpret the union between the structural performance and the physical technical performance peculiar to the factory, and new types of construction become established. These are formed in such a way as to ensure structural reliability even for quite high loads, both fixed and moving (bridge cranes, stacks of deposited material, machinery with vibratory movement, etc.), through solutions able to guarantee, at the same time, both large glazed surfaces of the shell (on sides and top) to illuminate the work areas, and openings for disposing of vapours and fumes and controlling the change of air.

The result was load-bearing frames made entirely of reinforced concrete cast on the site with vertical point support structures, on square or rectangular mesh, which configure spaces with considerable flexibility and which “draw” the rhythm of the surfaces of the façades and mark the skyline of the spatial development of the volumes. These result in new, unprecedented expressions, full of strength, which show their constructive logic on the outside and are sometimes characterised by interesting architectural features.

From the typological point of view, the following four recurrent forms may be distinguished in industrial building (Nelva, Signorini, 1990):

- Structures having a frame complete with floors resting on beams and pillars, developed also on several storeys, with broad windows between the pillars on the perimeter walls, for non heavy work;
- Complexes based on the coupling of modular mesh of different heights to allow internal lighting with large windows;
- Sheds for heavy work (bridge cranes) with roofing of lattice girders and lighting obtained from windows between the floors located at different heights and from windows in the perimeter walls;
- Sheds with modular mesh with dimensions that are not too large, but generally very extensive horizontally, able to guarantee diffused lighting with shed solutions (machine room and weaving room in the G.B. Conte factory at Schio, 1906) (Fig. 1) or buildings with skylights obtained in various ways in flat roofs (spinning room in the G.B. Conte factory at Schio, 1906) (Fig. 2).

The photos no. 1–9 show some significant examples of the surviving industrial heritage in the territory of the Veneto, consisting of buildings of normal and pre-stressed reinforced concrete, chosen among the many still to be seen (sugar refineries, spinning mills,
Figures 2 and 3. Layout of the shed roofing structure of the machine room and of the flat roof of the spinning room at the G.B. Conte Woollen Mill at Schio (1906) (Il Cemento, n. 1, 1909, year VI).

kilns for making bricks, but also the milling industry, commercial activities, etc. ... made of reinforced concrete.

2.2 An innovative shed roof

Alongside the many examples made by better or lesser known designers, we wish to mention a structure built at Schio for Lanerossi s.p.a. on the site of the old "Francesco Rossi" factory along the Roggia Maestra at the end of the Fifties of the twentieth century. The building, on a large scale inspired by bridge-building techniques, is distinguished for the unprecedented typological solution of considerable structural and economic interest (Figs 4–7).

It is the sorting shed built in the years 1958–1961 by the Guaraldo firm to a structural design by the professor engineer Bruno Dall’Aglio. Particularly suitable for large-span roofs with only perimetral supports, the structural layout of the building combines the classic pitched shed roof, made with the usual floors of brick and reinforced concrete, with the use of stiffened flexible arches supporting the beams that define the borders of the windows, acting as chords, and makes it possible to obtain a surface free from structural impediments.
with a span of 40.0 m. The designer commented, “Having considered a sequence of flat pitches with the same inclination forming the actual roofing and having realised the necessity of edging said pitches with beams defining the borders of the windows on vertical plains, I recognised the opportunity of exploiting the flexural rigidity of the beams as a ‘compensating’ rigidity to collaborate with flexible arches that would support them. Each pair of beams belonging to two consecutive pitches and lying on the same vertical plain are therefore horizontal elements that stiffen the arch developed on the same plain (…). With that in mind, it is useful to consider the particular adaptability of the constructive layout for large-span roofs with only perimetral supports, observing the quasi independence of the unitary dead load with respect to the span”.

The stiffened flexible arch is freely developed above the roof with a rise of 9.0 m; its axis has been assumed as a funicular line of the permanent load uniformly distributed along the chord.

The edge beams, the pillars and the arches are of reinforced concrete, the tie beams of pre-stressed reinforced concrete and the shed floors of clay/cement mix with the joists laid according to the straight lines with the highest slope.

The prototype conceived and prepared in the sorting shed at Schio was taken as the basic model for working out the project of the Marzotto factory at Valdago, optimising even more the quasi independence of the unitary dead load with respect to the span. The resulting space in the weaving room has layout dimensions of 57.80 x 156.50 m covered with twenty consecutive pitches supported by ten arches. In the new structure the theme of the collaboration between arches and beams is further developed, consisting of the transmission of a pair of consecutive pitches to each arch. The stiffening system is thus composed of the four beams forming the edges of the afore mentioned pairs of beams arranged on the vertical plain.

The Municipal Administration of Schio has promoted steps for buying both the shed buildings of the Conte Woollen Mill and the sorting shed at the Lanerossi Factory so that they can be suitably recovered and restored to the town’s use with a new function.

3 A SUSTAINABLE RECOVERY FOR THE INDUSTRIAL HERITAGE?

In recent years in our country there has been a progressive awareness of the buildings in the industrial heritage, which has led to the refining of a culture of the recovery project aimed specifically at preserving them while respecting the original particular features of stratified memory in the man-made context and at valorising their residual potentials.

There are many reasons that make the interventions for the recovery of the industrial heritage competitive, on condition that they are assessed globally and refer also to parameters of quality as well as quantity, which include achieving a good level of sustainability. For this purpose the recovery of old buildings alone allows the saving of the resources necessary for a new building and makes it possible to keep down the consumption of vast surfaces of land. However, the essential condition for the survival of the old buildings is to ensure that they will have a function that will restore them to the production circuit, to all effects.

The evaluation of the transformability of these bodies concerns on the one hand their load-bearing frame and, on the other, the shell that encloses them, which in turn is closely connected to the frame.

With reference to the first aspect there is the widespread presence of relatively simple, repetitive and sturdy, types of loadbearing structures, characterised also by high internal flexibility (notable spans for distributions organised internally on point support structures), which generally allow good integration of the layout, favoured by the types of the structures themselves and by the presence of spaces intended for containing various types of equipment (integrability).

The original vertical bearing skeletons are in the majority of cases loadbearing brick masonry or reinforced concrete, or mixed structures, only rarely steel, while the floors and roofs are sometimes of wood, more rarely steel or reinforced concrete. This generally results in the possibility of adapting them to the current criteria of structural reliability without requiring too much work or upsetting the original systems, resorting to extraordinary maintenance work carried out over a period of time (generally to remove the effects of neglect, especially if the building has been unused for a long time); there is also ample possibility of adapting them for new uses, to be assessed case by case. This is above all due to the fact that the structures were originally intended to support high accidental overloads of...
Figure 8. View of the Marzotto factory at Valdagno during construction 1961–1962 Span 60 m (from the P. Guaraldo catalogue). The structural layout is a development of the solution realised at Schio for the construction of the sorting shed at the “Francesco Rossi” Woollen Mill (figs 4–7).

Figure 9. Another view of the building site of the Marzotto factory designed by professor engineer Bruno Dall’Aglio.

both a static and dynamic nature and the movement of people and goods, but they were also able to resist significant thermal stress, often accompanied by the aggressive action of chemical agents used for various purposes in industrial processes.

As regards the second aspect, that of the strategic decisions for the shell, these must consider the thermal-hygrometric and acoustic aspects and the levels of performance that generally ensure the comfort of the internal environments with relation to the intended new uses.

When they are not made of a loadbearing structure of solid bricks, the shells are generally composed of curtain walls enclosed between the links of the loadbearing skeleton with beams and pillars, almost always visible on both the outside and the inside.

In these cases they are composite, discontinuous surfaces, with frequent openings, on which may still be seen traces of the transformations carried out on the factory over time. These surfaces are nearly always unsuited to perform the closing function and require specific intervention to correct their performance (introduction of ventilated cavities, etc.).

In most cases it is fairly easy to ensure good levels of natural lighting and ventilation of the premises, considering the particular features of the shells of the old factories, as has been demonstrated by many examples of recovery, while it seems to be more difficult to guarantee the thermal and hygrometric insulation of the closures (vertical, top and bottom) without altering the features of the old systems.

With reference to the possibility of reconciling examples of sustainable development with the need to transform the old industrial structures to adapt them to new functions, a series of aspects are summed up below which should be assessed in the design stage:

1. The structures are generally composed of well-designed, sturdy loadbearing skeletons, suited to resist high static and dynamic loads (structures with loadbearing masonry, spatial frames in reinforced concrete well wind-braced by cores and septums, mixed loadbearing masonry structures of brick and pillars, beams and floors in reinforced concrete) and are therefore adaptable to new functions, as long as they are compatible;

2. The loadbearing structures in reinforced concrete are very often used only on the inside, while the shells are made of massive loadbearing masonry, suited at the same time to ensure long-lasting behaviour of the structural skeleton they protect and good thermal inertia of the shell;

3. The interiors are generally well lit with large windows on the façades and/or with diffused overhead lighting obtained from windows created between roof slabs located at different heights or from various types of skylights in the flat roofs or from shed solutions;

4. The “out of scale” dimensions, typical of the built spaces of industrial factories, allow a good degree of transformability; they also allow the adoption of “double shell” solutions, aimed both at not loading the weights of the new overloads on the pre-existing structures, when the latter are unable to support them, and at solving the problem of ensuring the energy efficiency of the shells, without altering the visual impact of the original building;
5. In old industrial structures there are wide spaces, in which it is possible to install the equipment for the centralised management of the microclimate and for the backup of the natural circulation of air in the cavities (very often there are already many air ducts that can be easily used with the necessary technological integrations);

6. On careful analysis, many structures are themselves machines of systems that are suitable for being updated and exploited, using innovative solutions widely available today, but applying these together with traditional low-tech technologies of proven efficiency obtained by the recovery of the original systems.

On the other hand there are problematic aspects to be considered in the assessment of transformability for the recuperation of old buildings:

- Guarantee of acceptable levels of structural reliability and of fire resistance, without radically altering the structure and its image;
- Necessity of protecting the loadbearing skeleton from the direct exposure to the agents of decay, especially in the case of slender reinforced concrete structures, successfully reconciling it with the conservation of the particular characteristics of the work;
- Necessity of guaranteeing a good level of internal comfort without altering the value of the structure, taking skilful action on the shell.

4 CONCLUSIONS

What role should be assigned to technology on the horizon of the project, a decisive and strategic act, between the extremes of conservation and reuse, to be understood not as antagonists, but rather as poles between which to choose case by case, with relation to the particular architectural and technological-constructive features, while respecting the pre-existing elements and their recognisability over time?

The following general criteria may be listed:

- Reinforced concrete may be successfully subjected to restoration interventions of not only a cortical nature (that is, concerning only the concrete cover of the reinforcement), but also of a structural nature, that is concerning significant portions of concrete, but it must then be suitably protected against the aggression of the environment (both with local treatments and by excluding direct contact with the outside);
- The principle of the maximum respect of the original characteristics and of the original materials and technologies must be safeguarded, when the interventions concern the preservation of buildings of special architectural or historic-documentary interest;
- The suitability of the integrated use of traditional and innovative technologies must always be considered in interventions aimed at restoring old buildings for new functions, paying the maximum attention to the legibility and recognisability of the new interventions as distinct from the previous ones;
- Preference should always be given to the exploitation of the inherent potential of the old buildings to accept innovative energy solutions based on energy saving and aimed at sustainability, always trying to integrate the innovative approach with the existing traditional elements;
- The valorisation of local expressions of recent history must be stressed in order to favour the cultural identity of the territory and to establish hierarchies in the quality of the man-made fabric around the traces that best represent it, as historic, social, documentary and aggregating values.

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