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What Future for the Skyscraper? A Sustainable Recovery of Rai Building

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Abstract: The aim of this work is to analyse the recovery methods and strategies of a high-rise steel building, an approach to restoration of the modern that may not always be based on specific standards and pre-established procedures. In the present case, the report raises the topic of the recovery of a structure from the 1960s, a symbol of International Style and Rationalism, commissioned by the State TV and built on the project by Domenico Morelli: the RAI skyscraper in Turin. Since this is a unique work in its design and architectural choices, the approach to a possible recovery begins with a detailed knowledge of the structure, through the analysis of documents, testimonies of the time and the architect's concept. Subsequently, the analysis of the current state of the structure, focuses on the presence of asbestos and methods of remediation of this harmful material. In harmony with the architectural sign, we propose a technological, regulatory and sustainable adaptation, through solutions that concern the materials, services and areas of the skyscraper, moving from a global vision to a meticulous focus on details. The final proposal involves the skyscraper's application for LEED certification, issued to buildings with low environmental impact.

Key words: cultural heritage, skyscraper, rationalism, architectural current, conservation

1. Introduction

A high-rise structure, typically made of steel, concrete and glass, is often referred to as a "skyscraper", meant as a loss of sight tower, for the observer who admires it. When we talk about these buildings, we always refer to the challenge of heights, futuristic projects and the continuous innovation that these modern monoliths have been expressing for more than 80 years. However, we forget, or often do not know, the whole of the built heritage that constitutes the architectural history of this type of building.

There are towers, icons of the 1950s of the last century and more recent buildings, which require restoration or in better recovery situations, if they are in conditions of degradation and abandonment. The latter case concerns the RAI skyscraper in Via Cernaia in Turin, a building designed as a symbol of the flourishing company of the 1960s with the introduction of innovative techniques for the national construction landscape. The use of structural steel and architectural elements such as curtain wall, served as disruption to the typically Italian masonry and concrete building tradition, referring to the International Style of the time. Furthermore, the building artefacts, the structure and the finishes constituted hybrid systems of prefabricated production, distant from the mass production standards nowadays. This aspect raises considerable difficulties in the approach to the restoration and recovery of these structures, which must represent a careful path of study, knowledge and compliance with the founding principles of the original project. This research work aims to provide the means of intervention for careful recovery, based on the study of the peculiarities of each structure and not on uniquely applicable techniques. In this case, the position of the complex in the

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increasingly developing urban context poses the need for sustainable action, especially from an environmental point of view, for the risk of asbestos and the degradation affecting the perimeter of the building. The method of recovery started from the study of historical documentation (floor plans, testimonies and interviews enclosed in monographs guarding the skyscraper); the in-depth study of asbestos remediation methods required particular care and attention, because of the widespread presence of this harmful material inside the structure. Finally, the research and the observation of different approaches to the recovery of constructions similar to the complex under consideration provided the necessary tools for a comparison of the topics covered.

Among the restorations carried out on tall buildings in the city of Turin it is necessary to mention the example of Torre Littoria, a project originated by the architect Armando Melis and the engineer Giovanni Bernocco in 1933 and restoration curated by Pier Giovanni Bardelli in collaboration with Giuseppe Valetti in 1981. A careful critical study of the symptoms and causes of degradation was carried out through the analysis of the different facade subsystems, in different conservation states, good for travertine slabs in a state of serious degradation, for example, for balconies. The restoration project of “therapy”, as the designers call it, considered the highly symbolic value of the artefact. The cause of the degradation diseases has been identified both in construction deficiencies and in maintenance interventions before restoration. The methods of intervention were chosen between three alternatives, distinguished in degrees of incisiveness: repairs located both on the concrete elements that make up the frame of the railings and on the glass-bending insoles; localized interventions on the railing of the parapets but with a total makeover of the glass-insoles; radical refurbishment of the balconies with the forecast of demolishing the entire concrete part until the metal warp is closed. The final choice was based on the second variant of intervention, based on architectural and economic considerations. The success of the restoration at the beginning of the 1980s is demonstrated by the lack of pathological occurrences in the succeeding years [1]. A romantic renaissance of these buildings represents a sort of perpetual and eternal status that can be donated to buildings, as long as there is maintenance, care and attention to recovery itself (Fig. 1).

Fig. 1 Urban context in which rises the Skyscraper Rai. The new Porta Susa Station is identified; vintage photos kept in the personal archives of Domenico Morelli and Tullio Finzi, by Riccardo Moncalvo and Ferdinando Ruffa - © 2020, Reworking of the authors.

2. The RAI Skyscraper in Turin

Since the end of the 1950s, the broadcaster had expressed its intention to set up its headquarters in a single complex that would contain all the offices needed to carry out its administrative and management functions. It was thought of as the city of Turin, where RAI had its birthplace, starting the first radio broadcasts in 1927 and television experiments in 1949 [2]. The project was entrusted to the Turin architects and engineers Domenico Morelli and Aldo Morbelli, who faced many problems related to the study of solutions that could combine the needs of the client with urban restrictions design, structural problems of statics and volumes available for a structure of this caliber. The building, realized between 1962 and 1968, was constructed on an area of 3375 square meters, with a total surface area of 112 thousand cubic meters, of which 75 thousand above ground; in particular, the useful surfaces are 23 thousand, of which 18 thousand above ground, distributed in 18 floors for a height of 72 meters. The work boasts the most daring design choices of the time in many areas; among them, materials such as structural steel and glass façade panels — curtain wall — were used to give lightness and transparency to the structure.

Constructed in derogation of the building standards of the time [3], the building represented a courageous act, for which the most modern techniques were used for calculating and verifying state-of-the-art conditions that, in addition to the use of materials made available by technology in constant progress, recently applied in Italy of those years. At that time, characterised by the building boom, only cities such as Milan and Rome drew inspiration from the grandeur and avant-garde of American skyscrapers, such as the Seagram Building in Manhattan from which the creators of the RAI building drew their inspiration [4] (Fig. 2).

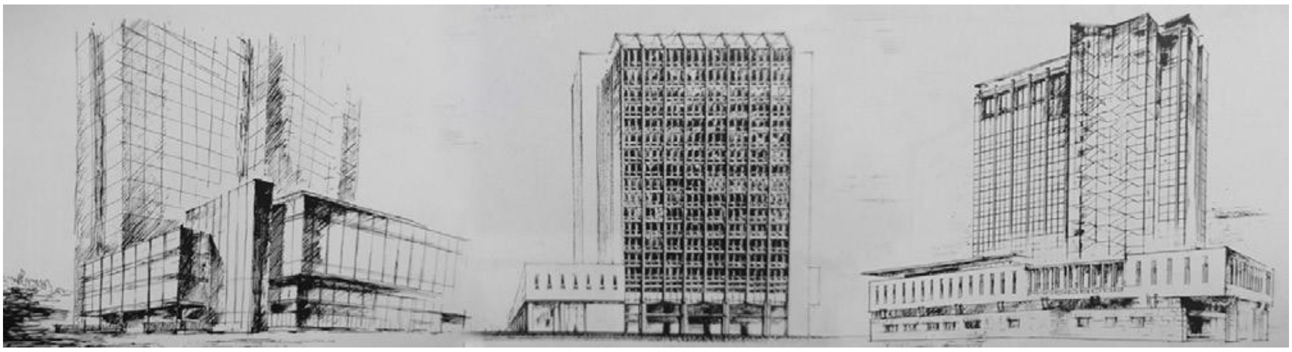

Fig. 2 Initial studies, almost definitive version: sketch of the corner between Via Guicciardini and Via Ruffini; perspective from piazza XVIII Dicembre; perspective from via Guicciardini corner via Cernaia. - © 2020, Reworking by the authors. Drawings kept in the Domenico Morelli Archive at the Central Library of the Faculty of Architecture of the Polytechnic of Turin.

In addition to the materials, the innovative methods for calculating the foundations, the design of the structural steelwork, the bracing provided for the load of the wind along the surfaces of the tower, the inclusion of the work in a nineteenth-century historical context (as is that of Via Cernaia, marked by the presence of the characteristic arcades, n.d.r.), are the merits of the building and the solutions to the major problems with which the designers had to contened.

For these and other reasons, the RAI skyscraper represents a piece of the history and heritage of our country. It is an example of the building boom in Italy over the years 60 and the state-of-the-art techniques, research and method that characterized the engineering design of that time. Even today it is a unique jewel for Turin, the first skyscraper born in the city with the amazement and criticism of the citizens, which remains abandoned to itself, corroded by the degradation and the name given it of "skyscraper of death" due to some deaths due to mesothelioma probably caused by asbestos fibres inside. It is a work of rare beauty that deserves to be brought back to life, through a sustainable recovery plan that can combine today and advanced existing technologies, with the original structure and the guidelines of the architects who built it.

2.1 The Architectural Design: The Layout and the Internal Structure

In the study of the distributive characteristics of the project, the combination of the different solutions has been obtained a complex of buildings consisting of three low bodies along the streets and a central tower body of eighteen floors above ground and two underground, for a total height of 72 meters.

The skyscraper, overlooking the square, rises behind the sleeve of Via Cernaia, with which it is connected through the lobby on the ground floor, the fully glazed atrium that constitutes the hall of honour accessible from under the arcades. The secondary entrances were located in Via Ruffini and Via Guicciardini, whereas the vehicle access ramp to the underground is placed on the corner of the square. Access to the floors of the tower is allowed by four fast lifts and a double flight of stairs positioned in adherence; the latter, were designed inside a glass tower, connected with the skyscraper through a "bridge" in which the services are based; there is also a service elevator for all floors, including the underground. Along with the two vertical heads of the skyscraper, there are also two emergency stairs: of the two, only the one in Via Ruffini is up to standard.

Two stairs serve the structural bodies on the streets: one on the corner between Via Guicciardini and Via Ruffini (the reinforced concrete tower covered in stone), the other in the joint between the sleeve of Via Cernaia and the skyscraper, both equipped with a double lift. In the two basement floors are located the garage and the premises of the archives, plants and warehouses.

2.2 The Materials of the Complex: The Reinforced Concrete, The Structural Steel of the Tower and the Glass and Aluminum Coating

In the design of the building, were mainly used reinforced concrete and steel elements. The basements, made of reinforced concrete, act as ballast of the entire complex, able to anchor the skyscraper to the ground; furthermore, exposed to the lateral thrust of the wind, it discharges at the base the stresses suffered, through the shock elements present in the steel skeleton. The elevator rooms, also in reinforced concrete, form the central core of the tower. For the realization of the structures in elevation, however, we chose steel, a material that can guarantee the structural lightness and the possibility of covering the large lights of the floors. The pillars, of the rectangular tubular section, vary in size every three floors, thinning as you climb in height. The beams of the floors are double T, except those perpendicular to the facade, consisting of two "C" that protrudes beyond the beam and "embraces" the external pillars, inside of which pass the vertical pipes; the latter goes up over the 18th floor for about 3 meters with glass closing walls. The horizons of the skyscraper are made up of thin slabs in c.a. on a corrugated sheet.

Of the entire building, the skyscraper's supporting structure, in particular, is an interesting solution from an engineering point of view. The rectangular plan has two lines on the head and a lateral appendix that forms the glass tower of the double flight of stairs. The structural mesh provides a quadruple row of pillars, linked to the transverse beams: 11 vertical frames placed at a distance of 5.00 meters from each other, are bolted to the main and secondary beams; the floor is made of corrugated sheet welded to the secondary beams, with steel mesh and a concrete jet of hot water equal to 4 cm. To absorb the horizontal stresses due to the considerable height, transverse diaphragms and bracing structures were also provided, which absorb the wind thrust from the facades and distribute it to the foundations. At the base of these structures, at the foot of the windward frames, an anchoring system with pre-compression cables has been studied, to ensure the whole structure to the ground and avoid any detachments of the column with the support surface. The internal columns have flanges, welded in the workshop, to which are bolted the main and secondary beams. In the outer node, however, the perimeter beam is set back 16 cm to have the external columns completely exposed: in this way, the connection of the main beams with the pillars is made by bolting through a T-shaped stump welded in the workshop (Fig. 3).

Fig. 3 In sequence: bases of the columns of the intermediate frames and of the steel skeleton against the wind; detail the diagonals of the brace frames which are in annular sections and which have been assembled by means of bolting in place; front view of the various stages of assembly (assembly, frame, slabs and jet slabs); lifting of the main beam assembled at the foot of the work. Vintage photos kept in the personal archives of Domenico Morelli and Tullio Finzi, by Riccardo Moncalvo and Ferdinando Ruffa - © 2020, Reworking of the authors.

The adoption of this material for the construction of the load-bearing structure has allowed obtaining different characteristics that solve the static and distributive problem [5]: vertical and horizontal structural elements with the minimum encumbrance, allow to obtain wide lights for the environments; the lightening of the structures in elevation produces a decrease of the loads that weigh at the base, thus allowing the execution of direct foundations; the quick components assembly allows the prefabrication in the workshop, limiting the only bolts and welding on site. In addition, the need to have a free portico at street level made it difficult to provide bracing on the ground floor. For the upper floors, vertical and horizontal bracing structures were designed to limit the elastic deformation that the skyscraper would undergo under the wind, thus returning the stresses to the underlying reinforced concrete structure through a special anchoring system at the interface between the two materials.

The facades were made with the curtain wall system (or continuous facade) in anodized aluminium and crystal glass, an example of the search for lightness and durability at low maintenance costs. For the cladding of the beams, GRINATAL was used, an aluminium and silicon alloy in purple-grey, while the porches on the ground floor are covered in *Diorite della Balma*, a grey stone.

To complete the structural elements of the building complex, there is the roof at the top of the top floor of the skyscraper, made of a corrugated sheet with the ceiling in c.a., supported by cantilevered steel beams, placed in continuity with the supporting skeleton. On the top floor are also located the technical volumes for elevators and other services.

This architectural typology, characterized by a mesh of vertical pillars and horizontal elements, in which the facade pillars meet the curtain wall, belongs to a building technique that reached the highest expression of those years in the international scene, especially in the United States. A special example is the Seagram Building (1958) by Johnson and Mies van der Rohe in Manhattan. The building has architectural elements common to the RAI skyscraper: from the porch to the facade, you can recognize the principles typical of Rationalism. The designer Morelli stated that the building following a study trip to New York [6] inspired him, to give Turin an example of the Modern Movement that was also a symbol of avant-garde architecture of the 1960s.

3. The Skyscraper

3.1 The State of Fact: Abandonment and Degradation

The RAI skyscraper in Via Cernaia, during its fifty years of existence, has been the subject of maintenance work and plant renewal that, although overall have kept the constructive characters, in detail, they modified the architectural sign. The structure in prefabricated steel of the fire escape, placed in front of the skyscraper, in correspondence with the sleeve of Via Ruffini, for which the old staircase designed by Morelli in prefabricated steel grids has been decommissioned, to comply with stringent safety regulations and ensure a suitable and more efficient escape route in case of danger. The few maintenance works on the facades, which took place over the years, were carried out with no attention to the original materials. From careful observation, we could observe chromatic discrepancies and widespread degradation phenomena that affect the stone cladding (with smog and chemical agents), the grates of the ground floor (rust red colour and therefore oxidized), the iron struts and the transoms of the facade (Fig. 4): the metal profiles show evident signs of superficial wear and detachment of the varnishes, as well as punctual phenomena of oxidation, mainly due to the action of environmental factors (pollution, atmospheric agents, humidity, etc.) and the natural ageing process of the components that make up the facade cladding. In the interior, the aluminium curtain-wall frames have serious sealing problems due to the deterioration of rubber gaskets, resulting in widespread infiltration problems, punctual corrosion, impregnation of ceiling panels and bulging of the floor.

Many of the works contained in the structure have been removed and kept by the property, while those more voluminous or made specifically for the environments of the skyscraper are still found inside: in addition to some desks and wardrobes in precious wood, the fabrics and the moquette of the managerial plans aged from the time, the points light and the chandeliers Venini of Venice and the boiserie of the laboratory of Giambone in the hall of honour, constitute a historical-artistic patrimony of inestimable value (Fig. 4).

Fig. 4 Elements of detail degradation of the building: the outdoor area, an aluminium frame, the boiserie in the entrance hall, the curtain wall.

In the eventual recovery, it would be desirable a careful restoration of these artefacts and their prudent protection.

Finally, the gradual relocation of RAI employees to their new premises in Via Cavalli 6, which ended in 2014 [7], has resulted in a state of neglect: the complex is invaded by wild vegetation resulting in the generation of degradation, representing a refuge for vandals and homeless. To avoid further phenomena of this type, the perimeter of the building has been fenced by the will of the Municipality of Turin [8] waiting for an intervention of next-but not yet defined redevelopment.

3.2 The Presence of Asbestos, Suspicious Deaths and the Transfer of Offices in via Cavalli

The main cause of abandonment of the RAI skyscraper by the property is due to the asbestos presence within the complex. Most of the buildings built until the early 90s, indeed, contain asbestos on several levels. Even in the building of Via Cernaia was established the existence of the killer fibre, the massive presence of which along with long periods of exposure, would have caused serious forms of the disease in some subjects, rapidly degenerating into deaths [9].

For this reason, according to the press, the RAI building in Turin was unjustifiably described as "the asbestos skyscraper", still associated in public opinion with the dangers caused by this harmful material [10]. According to the judgment of the Supreme Court [11], concerning the death by pleural mesothelioma of an RAI computer technician:

> "The beam, both horizontal and vertical, was strewn with flocked asbestos applied with the spray technique in compliance with a fire-fighting prescription of the time of the Fire Department. Asbestos was located inside the suspended ceiling, in the bearings of the [...] systems in technical compartments where the cables that needed ventilation passed, as well as in the electrical panels, behind the ceiling lights, electrical sockets and plumbing and air conditioning, behind toilets [...] and in water and diesel tanks."

In particular, the insulation of the ventilation systems contains chrysotile asbestos, such as the floors and the bearings of the pipes, while in the flocked asbestos there are traces of amosite. Moreover, the presence of fibre in the jets of the floors of each floor of the skyscraper has been ascertained. Firms working on the construction site, some RAI employees and the press also corroborated this information.

Nevertheless, plant maintenance work led to the damage and drilling of panels containing the material, which was therefore released into the air as an airy fibre. These operations took place until 1991, the year in which it was decided to adopt measures to avoid further dispersion of fibres: in 1992 the first interventions of encapsulation and confinement of manufactured products, in particular of suspended ceilings (through ASBESTOP confinement of the bearing systems), in addition to the total remediation of the dining room and part of the floors in the common rooms up to the fourth floor.

However, despite the precautions on the health risks of the workers, the property preferred to transfer the nearly 600 employees to the headquarters in via Cavalli 6. Although the first sales auctions gone deserted, in April 2021 there was a purchase proposal from a private company, now under negotiation [12].

Meanwhile, a group of RAI engineers constantly monitor the situation of the skyscraper in collaboration with the A.S.L. (local health authority), through visual inspections and environmental monitoring, carried out by sampling and measurements of concentrations of airborne fibres with SEM method (as of June 2019, 2 fibres/litre of air were detected by scanning electron microscope.

3.3 The Reclamation of Asbestos: Techniques of Management and Safety of the Phenomenon

Since asbestos has been recognised as harmful to human health, with its subsequent cessation of use in 1992, the problem of reclamation and disposal has been raised with the entry into force of Italian legislation [13]. Especially in 1994 with the D.M. of 6 September, the Ministry of Health issued the rules relating to techniques for the detection and analysis of artefacts containing asbestos, the planning of removal or fixing activities and the disposal of the material.

A fundamental aspect not to be underestimated in asbestos reclamation is the analysis of airborne fibres, which can be separated from the element in degradation and remain in suspension in environments for long periods, because of their size of very few micrometres. For this purpose, in the assessment of risks and therefore in the powers of intervention, the materials are classified in terms, friable and according to their use and the percentage of asbestos they contain.

In particular, to execute the remediation, the inspection of the structure is performed through the camping of suspected elements containing asbestos, the risks and the measures necessary for the containment or the removal with subsequent disposal are evaluated, the work is carried out in compliance with safety measures for workers and the environment by returning the building structure free of harmful materials.

The remediation is performed for:

• **Complete removal of asbestos products:** process that eliminates any potential source of risk through the complete removal of materials with subsequent replacement of the same

• **Encapsulation:** consists of the treatment of asbestos with covering products that incorporate the fibres and lock them in the matrix of the material, acting as a protective and insulating film.

• **Confinement:** a method of installing a sealing barrier separating asbestos from the occupied areas of the building (bulkheads, sealing suspended ceilings, roofing, etc.); if it is not associated with an encapsulating intervention, the release of fibres takes place in the cavity inside the confinement.

In any type of intervention, provision must be made for the construction and testing of remediation in a confined area. A recirculation and air filtration system shall be installed, to prevent asbestos fibres from escaping from the construction site, and a measurement of active fibres concentrations over the entire duration of the work.

The presence of an area of decontamination, equipped with equipment rooms, shower room and changing room in which workers can store their personal clothes. Every worker must have PPE (personal protective equipment) consisting of a mask or respirator with special filters, a one-piece suit with separate headgear and footwear covers (then classified as waste at the end of operations) or washable cotton. The waste obtained is packed and removed safely from the construction site area in double containers in polythene, the big bags, then disposed of in the appropriate centres.

At the end of the work, the reclaimed building can be returned only after evaluation of the absence of asbestos residues and the acceptable concentration of fibres in the atmosphere (2ff/l), a measurement performed by scanning electron microscopy (SEM).

Table 1 Main types of asbestos-containing materials and their approximate fiber release potential (M.D. 6.9.1994).

Materials	Use	Friability	% of Asbestos
Spray coatings and insulating coatings	Sprayed on load bearing structures steel, as thermal acoustic insulation	High friability and high fiber release potential	Up to 85% amosite and crocidolite
Insulating linings for pipes, tanks and boilers	Coatings of pipes carrying fluids, boilers, etc.	High friability and fiber release potential if not covered by intact sealant	All types of asbestos mixed 6-10% with calcium silicates
Products in asbestos cement	Flat slabs for suspended ceilings, non-load-bearing partition walls	Non-brittle, may release fibers if degraded (abraded, perforated) or deteriorated	Usually 10-15% chrysotile
Various products with asbestos (bitumen, vinyl tiles, paints, PVC, mastics, sealants, ...)	Flooring, thermal containment paints, sealants	Possibility of release if cut, abraded or perforated	0.5 to 2% for mastics and adhesives; 10 to 15% for vinyl-asbestos floors and tiles

4. The Proposal for Recovery

The condition of abandonment in which today the RAI skyscraper pours represents a problem not only for the building itself but also for the urban area in which it is included.

The methodology is developed from the study of the urban context where the building is located. With the rapid development of the road axis between Corso Inghilterra, Piazza XVIII Dicembre and underpasses of Piazza Statuto, the redevelopment of the nineteenth-century arcades and the realization of the new train station of Porta Susa and the Intesa Sanpaolo skyscraper, surrounding the complex concerned, has appeared a new urban hub in rapid expansion: it is understandable therefore that in this context a building of large volume in progressive deterioration placed in such a relevant position, is an emergency to be resolved as soon as possible. Based on these issues, the dilemma has repeatedly arisen as to whether the complex should be demolished or recovered [14].

An economic assessment in the event of demolition would reveal costs of dismantling structures and disposal of materials (in particular harmful asbestos) which would exceed those of a possible recovering.

It would also mean a very serious loss for the Italian architectural heritage of a historical symbol of Functionalism, the Modern Age and the International style. Finally, the evaluation of the peculiarities of the materials and construction techniques applied to the load-bearing structure (bolted steel) and the painstaking study at the base of the project (static calculations and the realization of counter-winds) constitute an advantage in favour of recovery. Although ideas for re-use and modernization of the building have been presented on several occasions, both by the Municipality of Turin and by individuals interested in the management of the complex [15], to now there is no decision on the future of the skyscraper.

However, a sensible recovery proposal is both necessary and urgent.

From the consultation of the cadastral documents, the building is not constrained as an architectural historical asset but is subject to landscape-environmental limits [16]. Therefore, a proposal suitable for the case should preferably preserve volumes and architectural characteristics of the building, in compliance with the original project, while providing for an adaptation of the plant and technology of the complex. The works of the Hall of Honour and the coatings of the management plans, for example, constitute an artistic heritage of value, to be preserved and protected.

It would therefore be appropriate to consider the idea of recovery both from the point of view of the conservation restoration techniques of a modern building and the need to adapt a building of the last century to the performance characteristics required for a modern structure, especially considering the most significant problems arising from the careful analysis of the state of affairs of the skyscraper. In particular, it must be understood that the technical-constructive aspects of the work are those typical of modern construction and therefore characterized by the evolution of the techniques of the twentieth century.

The methodological approach is necessarily based on the deep knowledge of the work, the original construction typologies and the vision of the designers who made it. Without prejudice to this concept, the architectural interpretation of modern construction raises certain questions. The specialization of industrial prefabrication techniques, the diversity and obsolescence of materials and construction components, are issues that require the contribution of professional figures and specific techniques of intervention on the existing modern heritage [17]. The diversity of materials and the life cycles of the assembled parts increases the problem of maintainability of the technological system, components and recovery.

They are therefore hybrid systems, generated by the continuous comparison between project and industrial production and manufactured, to obtain tailor-made solutions for the work in question. Today, however, the techniques are now standardized, to create finished products to be placed on the market. The construction process has therefore changed: whereas in previous times production was adapted to the intentions of the designer, today the technician has to choose a product already on the market based on the characteristics that satisfy the requirements of the project.

These aspects, combined with the craftsmanship of the original solutions, make the cases of intervention specific and not attributable to unique methods of restoration.

As for the recovery of the complex as a whole, finally, some ideas are suggested to improve the performance of the building, aesthetics and sustainability, reducing consumption and environmental impact. More and more widespread is the need to adapt the structures of the last century to the minimum requirements essential for a building today: the issue of eco-sustainability and the reduction of emissions of "energy-intensive skyscrapers" is more than ever relevant [18]. The following examples are based on this requirement and relate to practical approaches both from the point of view of recovery with conservation of use as offices, and the change of destination as a luxury private apartments or tourist accommodation, open to the public or mixed (e.g.: hotel, restaurant, bar, etc.).

4.1 Curtain Wall Intervention: Digital Modelling of the Existing and Technological Adaptation

The current condition of the mullion and transom, and frames of the fixtures, affected by deterioration and widespread leaching phenomena, poses operational difficulties for the recovery of the curtain wall, mainly due to the obsolescence of the original materials and production processes, requiring such high costs, the greater and the rarer the experimental constructive character adopted.

The building's constituent elements belong to a historical period in which the industrial matrix of prefabrication was mitigated by a process of progressive adaptation, which took place through the integration of more traditional construction practices [19]. This singularity gives the facade a prominent role in the eventual recovery of the complex.

The approach to recovery, however, may follow different methodologies.

In the case of the skyscraper, since there are no architectural constraints, it is suggested that partial restoration work be carried out on the columns of the facade and the cladding sheets of the external beams, while a replacement of the elements of the frames and glass plates with a product that ensures optimal performance, consulting the specifications of the manufacturers and choosing the product that satisfies the recovery needs in the best possible way. The design of the aluminium profiles, however, could be carried out through 3D modelling of the new curtain wall, inspired by the original drawings, to safeguard its architectural shape, according to the approach envisaged by the BIM. The deterioration conditions in which the curtain wall remains does not allow a complete restoration: if the oxidation of materials appears punctual and widespread outside, inside the situation worsens due to the presence of infiltrations with serious problems of sealing of the frame itself. Furthermore, the technological obsolescence typical of prefabricated elements of the last century makes the frames of the fixtures insufficient to meet characteristics such as sound insulation and thermo-hygrometric behaviour, required to the latest generation coatings, especially to given the extent of the glazed surface that surrounds the buildings. It is suggested a substitution intervention with cell modules with a motorized system of tents for the regulation of the solar contribution.

Finally, to make the building more sustainable and performing, we could adopt further measures for the design of the new facade cladding: through the study of renders of the sun's path, you could think of applying "facade systems with integrated photovoltaic elements", inserting the panels in the glass panels of the windows with greater radiation. There are semi-transparent films or gels on the market containing nanoparticles that, in the presence of light, react by producing energy and partially obscuring the surface, thus ensuring a reduction in the light component radiating in indoor environments [20].

4.2 The Design of the New Glass Staircases: A Double Skin Facade for the Central Staircases

For a complete recovery, the need for a special design of an external stairwell is advisable, upon replacement of the existing prefabricated. Also, if the width of the landings of the main staircases is suitable for common use, the minimum dimensions of the structure in the sleeve of the tower in Via Cernaia, are insufficient to meet any dangerous situations and allow the rapid evacuation of the building, being prefabricated artefacts dating back to the 60s; the further degradation makes it unfit for construction. Since it is not possible to adapt existing structures, it is therefore mandatory to include elements that ensure safe escape routes in the event of fire or risk.

An interesting proposal could be to design a structure composed of bolted steel elements, inserted in a structural glass frame: the transparency of the new element, placed in adherence to the skyscraper, would give the complex the original perception of the shape, with the indentations in the sleeve; finally, a double skin system, equipped with mobile collectors, would ensure the natural recirculation of air inside the stairwell; this same principle could be adopted for the technological adaptation of the glass tower in Via Ruffini. It is necessary to have a natural ventilation system to ensure a minimum level of environmental comfort: the compartment, due to the glass that cannot be opened, reaches high temperatures that cause overheating.

If the regulatory provisions allow, at the sleeve of Via Cernaia, you could install a panoramic lift (instead of the former fire stairs not in compliance) from which you can admire, during the climb to the floors, the view of the historic centre of Turin; the design would take up a curtain wall cell.

4.3 The Destinations: From the Offices to the Luxury Hotel, With Restaurant and Lounge Bar

The sale of the property by the RAI would open several scenarios: the problem of asbestos clearance, the final use of the skyscraper would arise from a private, by a company or a consortium of them interested in the purchase negotiation.

The arrangement of the internal compartments, as well as their use, would therefore depend on the will of these subjects. The use of office space that RAI has made for more than 40 years, would be difficult to imagine today: for the total volume of the complex, the value of the coverings of the entrance hall and floors 16 and 17, the layout of the corridors of the levels of the skyscraper and the general services placed inside the low bodies of the ways, is plausible a future reconversion to accommodation. The tower could host a hotel, with the former executive floors used as luxury suites. The low structures, on the other hand, would constitute the common areas: the canteen, the restaurant, the bar, etc…

The surrounding urban context, with the presence of the Intesa Sanpaolo skyscraper and the Porta Susa station, would favour this use as a form of investment by buyers.

5. "Green" Design for Sustainable Recovery

The recovery of the skyscraper has so far been analysed from an architectural-engineering point of view, suggesting solutions for the restoration of certain elements, the technological adaptation of others and the techniques of intervention on the interior environments.

However, it cannot be today a recovery issue of the modern without paying attention to sustainable design. In the field of construction, the designers of structures are called to provide forms of environmental sustainability both for new buildings and, above all, in the recovery of existing, paying more attention to "green" solutions including the exploitation of renewable forms of energy, the introduction of vegetation as an architectural element and attention to the use of new materials that contribute to improving the quality of life of users. Below, we suggest some ideas for the design of the recovery "green" of the skyscraper under consideration.

5.1 The Gardens: The Roof Garden, The Green Roofs and the Living Wall

An effective approach to solving the problem of poor urban liveability is the green roof. The advantages of this type of solution are many: in addition to purifying the air from pollutants and also improve the psychological perception of users who live many hours in an indoor space, affects the building improving its hygrometric characteristics, the thermal insulation of the roof and the regulation of humidity in the air [21].

The recovery of the surfaces would begin from the green design: from the disposal of the oxidized pipes of the old plant, you could get a surface to be used as a roof garden, while the flat roof of the building in Via Ruffini and the open area of the former canteen, would be used as a roof garden, with a careful design to detail. For the first area, we suggest the construction of an extensive green garden (not usable), which requires less maintenance, the presence of small plants and the use of flower boxes with climbing plants and perforated panels, which allow the development in height of the vegetation to cover the size of the plants in sight. For the execution of the roof garden, instead, it proposes the intensive greening, usable as a real garden that as such needs maintenance; the thickness of stratification required by this technique is between 20 and 150 cm, with a weight between 20 and 2000 kg/m2. It is, therefore, necessary to appropriate checks before applying this solution.

A further "green" proposal concerns the reinforced concrete tower located between the streets Ruffini and Guicciardini. This structure covered in stone tends to deteriorate due to the action of atmospheric agents. A sustainable proposal considers the installation of a vertical green wall, the living wall, in modular blocks to be placed with continuity, according to the most suitable geometry.

5.2 Floor 18: The Panoramic Terrace With a Biodynamic Concrete Roof

The top floor of the skyscraper is located on level 18, where you enter an open space with a perimeter delimited by the final cells of the curtain wall and the pedestals of the rail for the glasswasher. The highest level is occupied by the steel roof, supported by cantilevered beams placed in continuity with the skeleton of the skyscraper.

The area of the top floor was mainly used to dispose of the technical compartments of the elevators and the freight elevator.

The residual surface could be recovered for the realization of a panoramic terrace, taking advantage of the accesses of the two stairs and the possible lift in the sleeve of Via Cernaia. The interventions, in this case, would mainly concern the restoration of the pavement, the restoration of the roof and the installation of grids for the climbing vegetation around the steel pillars of the same; The vertical surfaces of the lift shafts could be used as supports for vertical urban gardens, not completely exposed to the weather thanks to the presence of the roof.

If for climbing vegetation the same interventions are applied as previously seen, the sustainable recovery of the roof of the skyscraper has innovative and interesting aspects. The proposal is to model biodynamic concrete panels, with geometries specially designed and illuminated by a suitable LED light design system, to be applied to the lower surface of the roof.

This material, produced by Italcementi for Expo Milano 2015 [22], has countless qualities; among these, the ability to absorb pollutants, transforming them into inert, would ensure better air quality, behaving like a natural purifier. Just this last intervention on the structure could return the dignity improperly lost with the nickname of "asbestos skyscraper". It would be a symptom of rebirth, as a gesture of respect, due to this building.

The recovery of the RAI skyscraper would automatically fall under the category LEED for Existing Buildings, for existing buildings that have undergone renovation. The proposed application would also be advisable as a result of the many sustainable recovery measures mentioned above.

6. Conclusions

This paper illustrated the hypothesis of a methodological approach that combines the intervention tools for the renovation of a building, constituting an overall criterion of careful approach to the recovery itself. Any contribution to recovery must be based on an extremely complete knowledge of the structure, in order to avoid measures that disfigure the history or the architectural sign. The next step is to apply the methodologies to the cases under consideration, tracing a path of operations related to the type of built.

Nevertheless, the focus on sustainability, which is needed today, must lead to the application of real, shared and rapid solutions to marginalise at least the problem.

With the increase in the need for resources by the world population to the detriment of our planet, we are increasing instead of reducing our environmental impact: the need to take a reverse direction must be clear to everyone; designers, in their field, can therefore contribute to the recovery of abandoned buildings and degraded urban contexts, through small solutions with great benefits.

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