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THE FORMS OF REINFORCED CONCRETE CONSTRUCTION: THE VELASCA TOWER, MILAN 1950–1958

FORMY KONSTRUKCJI ŻELBETOWEJ: WIEŻA VELASCA, MEDIOLAN 1950–1958

A b s t r a c t

The Velasca Tower (Milan 1950–1958) experiments with the use of reinforced concrete in one of the very first tower buildings ever erected in Italy. The issue the designers had to address was the relationship between technical and structural innovation concerning the use of this quite flexible and relatively recent material, as well as its expressive potential.

The tower's design was developed by the BBPR firm (Banfi, Belgiojoso, Peressutti, Rogers), which advocated a rational and modern approach that relied on the continuity with history and the relationship with the context as architecture's key values, and by Arturo Danusso, the father of Italian structural engineering. Their partnership and affinity of intent would achieve a particularly advantageous relationship between structural research and architectural expression. As a result of such association, the new tower would become an icon as the most recognizable symbol of the city of Milan.

Keywords: Velasca Tower, Reinforced concrete, Architectural expression, Structural engineering

S t r e s z c z e n i e

Wieża Velasca (Mediolan,1950–1958) jako jeden z pierwszych wieżowców wzniesionych we Włoszech eksperymentuje z użyciem żelazobetonu. Projektanci musieli się tu zmierzyć z problemem zależności pomiędzy techniczną i konstrukcyjną innowacją, polegającą na wykorzystaniu tego dosyć elastycznego i stosunkowo nowego materiału, jak również z jego ekspresyjnym potencjałem.

Konstrukcja wieży została opracowana przez studio BBPR (Banfi, Belgiojoso, Peressutti, Rogers), które opowiadało się za racjonalnym, ale nowoczesnym podejściem, opierającym się na ciągłości z historią i związkiem z kontekstem jako kluczowymi wartościami architektury. Przy pracy nad projektem współpracował również ojciec włoskiej inżynierii budowlanej – Arturo Danusso. Dzięki tej współpracy i zbliżonym zamierzeniom udało się wypracować wyjątkowo korzystną równowagę pomiędzy badaniami strukturalnymi a ekspresją architektoniczną. Wynikiem tej kooperacji jest wieża, która stała się swoistą ikoną jako najbardziej rozpoznawalny symbol Mediolanu.

Słowa kluczowe: Wieża Velasca, żelbet, ekspresja architektoniczna, inżynieria budowlana

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Since concrete was a new material, the issue architects faced at the beginning was what shape they should give it and, as had been the case for iron just a few years earlier, how to make it expressive so that a technical invention could fully become an element of architecture.

This issue can be particularly tricky in the case of reinforced concrete, a plastic material that, unlike wood, stone or iron, fails to provide any features or constraints that may indicate a clear and inherent principle of use. In fact, concrete is not even a material in itself – it is rather a binder that, once mixed with water and aggregates, becomes artificial stone; iron contributes to reinforced concrete with simple elements that, once folded, acquire a shape that remains invisible in the completed work. Ultimately, reinforced concrete is a purely technical invention that combines elements with opposed features which in turn become something else that resists both traction and compression, and can be shaped to acquire any shape one wishes to create.

Indeed, the key question was *which* shape?

The new material immediately revealed huge potential, and opened the way for both technical and architectural experimentation. Its static performance could be hardly predicted and just as open was the field for the exploration of its expressive potential. It was not even possible to rely on a typically rational and positivist approach to glean some suggestions from the principles of coherence, and therefore from the idea of *architectural sincerity* for a material that had a hypothetical but fleeting *inherent nature*. This is precisely the fundamental and exciting task research had to address about the application of the new building material during the twentieth century – exploring its technical and structural potential as well as the formal and expressive potential attached to its use.

As Ernesto N. Rogers would explain, technology and architecture are two conflicting elements of design that, just like utility and beauty, are bound to find an agreement and reach a synthesis. When both are open to dialogue and experimentation, the challenge of technical achievements and the pursuit of new expressive forms become all the more exciting, and the shared work of architects and engineers all the more fruitful.

In the late 1940s, when the plan for the area selected for the Velasca Tower was still in its initial phase, reinforced concrete was commonly used to build beams and pilasters, almost invariably drowned in the wall structure. The new material's technical and expressive potential was still unexplored but post-war reconstruction and the extraordinary ardour, enthusiasm and experimentalism it triggered would greatly stimulate research.

With World War Two only a few years behind, Italy, and Milan in particular, were in a delicate and important phase of their history. As one of the major theatres of the bloody clash between Allied and Fascist forces, the country was still in ruins and tending to its wounds. Hence, the priority was modernization and the creation of new infrastructure, particularly in Milan, which had been heavily bombed during World War Two, and therefore required extensive reconstruction. Economy and industry were fast resurging, the city was expanding at an impressive rate, and its cultural climate was extremely lively and stimulating. As a hothouse for ideas and experiments in all the realms of art, science and philosophy, Milan equally offered an ideal testing ground for the development of architectural theory and the experimentation of the Modern Movement's key issues as well as, at a later stage during the 1950s, for the questioning of its more time-worn tenets and therefore for its theoretical renewal.

The design for the Velasca Tower was developed in this atmosphere of exchange and cooperation that involved all the actors of physical, moral and cultural reconstruction. The design was commissioned to the BBPR firm (which spelled its architects' initials – Banfi, Belgiojoso, Peressutti, Rogers – although Banfi had died in the Gusen concentration camp just before the end of the war), and to the renowned engineer Arturo Danusso. Ernesto Nathan Rogers was the most brilliant architectural theorist of his time as well as the master of several generations of Milan School architects, and the editor in chief of *Casabella Continuità*. Arturo Danusso, a professor at the Polytechnic of Milan since 1915, was a far-sighted master who blazed the trail for an entire school of Italian structural engineers later famous for their works, viaducts, bridges, skyscrapers and huge covered spaces, and whose influence would also shape countless architects.

Since the Velasca Tower benefitted from the converging approach of architects and engineers, it would successfully reflect the identity of its city. As a passionately discussed and still debated masterpiece, the tower is the result of the highest level of cooperation between the most advanced architectural and engineering concepts. At the same time, it reflects a host of key issues for architecture and the construction of the modern city.

The Velasca Tower was one of the very first buildings to be erected in reinforced concrete in either Italy or Europe. With its 99 metres of height, it is certainly one of the best results of the mutually enriching relationship between structural research and architectural expression, and is in itself inextricable from the features of the city and from Italy's productive achievement.

The very first Italian reinforced concrete high-rise building had been erected in Brescia by Marcello Piacentini in 1932. 57 metres tall, it had also benefitted from Arturo Danusso's expertise. This building was followed by another 108-metre tall tower, again designed by Piacentini in Genoa, later called the Piacentini Tower. Later on, in 1954, Luigi Mattioni would build the Breda Tower in Milan. Other reinforced concrete buildings include the Ambassador's Palace Hotel in Naples and the 118-metre tall tower in Cesenatico (1958). In these buildings developed as column and beam frames, the key tenets of the innovative reinforced concrete construction allowed for higher buildings but failed to provide a recognizable expressive quality.

At the time, housing and office towers were new building types in terms of both their relation with the city and the construction technology they required. The only models then available were the iron frame skyscrapers built in the American cities and designed for contexts that had little in common with European cities and their foundational principles. As a result, the very first high-rises erected in Europe were inspired by the iron construction technologies and forms used for their American counterparts.

How and why did reinforced concrete emerge as an alternative option?

The very first plans for the construction of the tower on its site date back to the late 1940s, while the tower itself was completed in 1958. During its design phase, the tower would undergo several major alterations.

On the site, which had been razed to ground following war damage, the City administration wanted to develop a high-density closed lot plan based on curtain wall housing with small and dark inner courtyards. The BBPR architects, who found such option utterly inadequate, proposed instead to concentrate the entire building volume in one tower building that would rise independently and separately from the surrounding blocks with a somewhat curtailed building volume. Such solution meant that the voids between the buildings still existing on the site could be shaped and organized into a square in lieu of the *corridor street*.

Ill.1. The Velasca Tower, Milano (photo Stefano Topuntoli)

This is the first choice that would cause debate.

The tower's location, in the city centre and at walking distance from the Cathedral, was strategic. Such a tall building would be clearly disruptive because it would engage with the Madonnina – the statue of the Virgin Mary placed atop the Cathedral that, according to a Fascist era law, could be surpassed by no other building in the city. Being located at the end of some of the city's major road axes, the tower would also be visible from far away just like a mediaeval tower.

The BBPR architects were aware of the exceptional role the tower would play in the city, then still comprising only low and medium height buildings. Rogers in particular had seen the high-rise buildings erected in the US by the Chicago School, and of course he was inspired by the mediaeval towers built in San Gimignano, Tuscany. All while recognizing the huge gap between American and European cities, he did not reject pre-emptively the high-rise building as a new, modern and disruptive building type for housing and offices. On the contrary, the key tenets of BBPR's theoretical research – that would distance them from a certain formalism that could be associated with the International Style – were precisely the pursuit of a relation with the context, an extremely careful approach to the *pre-existing environment* and a *continuous* and far from imitational relationship between historical city and new architectures. The relationship with the context would be precisely one of the guiding principles for the tower's architectural design.

For Rogers, *continuity* – a word he even used for the masthead of *Casabella*, the magazine he edited at the time – implied transformation and innovation. In his mind, continuity was certainly not about forms – it was about culture, the deep-seated and underlying values that survive the test of time, and the ability to address a constantly changing reality. The idea of *realism* the BBPR architects pursued was fundamentally based on a commitment to *modernity* and the continuity of tradition. *Modernity does not contradict tradition – on the contrary, it is the ultimate evolution of tradition itself. In any case, we must find the courage to impart the sign of our age, and the more modern we are capable of being, the better our connection with tradition will be and the better our works will fit into the pre-existing environment. The concept of continuity implies change within the order of a tradition* (Rogers, 1958).

Given such aspirations, they accepted the challenge to build a tower that had to accommodate "*the activities of modern life, shops, offices, apartments and terraced villas*". Such a statement may sound as contradictory as an urban relationship established on the grounds of difference, yet another *antinomy* underlying architectural design, inevitably made of issues that must be reconciled in the dialectics Rogers viewed as the necessary foundation of design.

The tower clearly creates a strong contrast with its surroundings by introducing a new element in the urban scene and a new building principle that, for BBPR, was justified precisely by the dialogue with the surrounding context and its central position in the city, and by the need to introduce new emerging elements as a new reference for the modern and larger city that was then under development within its existing structure.

Giuseppe Samonà – the other great master of Italian post-war architecture – wrote about the Velasca Tower in an article for L'Architettura in 1959. With a remarkable clarity, understanding as well as some doubts, he defined it as an "exceptional element" in the context of the city precisely for its "new constructional dimension" and for the new relationships it established with the city. On the other side, he wondered about its elements of continuity with the context, although he recognized the tower had some.

But let us proceed with order.

Based on the very early sketches, the initial concepts developed by BBPR show an iron and glass tower. The design variations reflect a unitary shape that expands in volume while rising. The very first iterations show a more gradual process that divides the tower into sections, while later solutions reflect a more dramatic shift in volume similar to the building's final image. Given its figurative and technical novelty within the Italian building tradition, an American firm was hired to review and size the iron and glass design, and to estimate its cost. Based on this estimate, RICE (Ricostruzione Comparti Edilizi S.p.A.), the company that owned the area, decided that the building was too close to its American counterparts in terms of both forms and image, and therefore that it would be too expensive, and perhaps too much of a novelty for Milan.

A decisive choice made at this point led to an entirely new course. Reinforced concrete, rather than iron and glass, was selected as the material of the new tower – a solution that would be remarkably cheaper as well as more adequate to Italy's building tradition and to the still limited scope of its construction industry. Arturo Danusso was hired to develop the structural design for the tower. A major expert in reinforced concrete construction, Danusso also shared Ernesto Nathan Rogers' and BBPR's ethical and humanistic view of architectural design, as well as a realist and experimental approach to construction that welcomed field research.

Arturo Danusso was a pioneer of reinforced concrete applied to structural design. Soon after graduating from the Polytechnic School of Turin, he was hired by the Porcheddu Enterprise, the Italian licensee of the French patent for reinforced concrete devised by Hennebique, which was famous for the bold constructions it enabled. Ever since contributing to the construction of the famous Ponte del Risorgimento in Rome – a single arch bridge erected in 1911 that would long remain the longest and slimmest depressed arch bridge built in reinforced concrete – Danusso would pursue the idea of devising a convincing scientific explanation for these great inventions, sometimes based on insight more than calculation, so that their structural performance could be adequately interpreted.

He continued the experience of the Materials Testing Laboratory at the Polytechnic in Milan and in 1951 he established the Experimental Institute for Models and Structures (Istituto Sperimentale Modelli e Strutture, or ISMES) in Bergamo, the world's largest laboratory for model-based study of structural performance. Danusso realized that the then current scientific theories failed to fully explain the behaviour of reinforced concrete, which actually seemed to be significantly sturdier than predicted. The construction of scaled models was used to verify the structural features the material seemed to offer so that designers could correctly estimate their structures by pushing their load tests until collapse.

The typical and constant feature of his approach would be precisely the prevalence of *insight* over calculus, a view he shared with Pier Luigi Nervi. Scientific laws are merely diminished interpretations of reality that fail to explain the phenomena they describe. As a resource even for structural design, Danusso relied on insight based on knowledge to bridge the gap between the richness of reality, life and nature, and the abstract schematism of the scientific laws that claimed to explain it. The construction of models relies on experience to verify the insights of design – for this reason, insight is a necessary element for the advancement of research and to provide architectural design with life and quality.

During the post-war years, the focus of model-based research was the construction of the large dams built across the national territory – huge reinforced concrete works that were studied by simulating the stresses they would be subjected to, and that provided the test bed for reinforced concrete studies in general. The same experimental model-based verification process would be carried out for the equally new and bold design of the Velasca Tower.

Which were the designers' choices and process?

Ernesto Rogers strongly advocated the material and technical aspect in architecture; *In order to be really concrete, building works should be embodied in matter, and therefore in a particular material that provides them with style and constructive character, in other words according to a precise technique. Style and technique participate in a two-way relation the value of which depends on the character* (Rogers, 1958). He argued that construction is the expressive tool of architecture, the essential instrument of its formal definition. Structure has a physical reality of its own that must be made visible and manifest – this is the most powerful instrument architects can rely on to make their architectures expressive. *The value of an architecture entirely depends on the forms of its building elements*, Rogers said in relation with Auguste Perret.

Rogers greatly admired Perret's work about which he wrote an insightful little book, and was so inspired by his approach that he used it to support a concept of construction sincerity as the ethical and rational foundation of architecture. Ethics and architecture is yet another combination that Rogers would strongly support as a foundation for any kind of action in a vision he shared with Danusso – both were strong advocates of ethics as the moral guide for any kind of human action, as well as coherence and sincerity, clarity of action and its necessary expression.

Rogers recognized Perret as an unconventional voice amid twentieth century architects because he considered construction as one of architectural design's essential tools and even more because he clarified the relationship between architecture and engineering: *Perret was the first architect to use reinforced concrete as an expressive material, or in ways that were peculiarly its own. […] He taught us once more that construction is the architect's mother tongue. An architect is a poet who thinks and talks in construction*. By retracing his thought, he underlines that architects should *build with sincerity*, but, even more, "*turn necessity into virtue*". Such statement once more projects the unavoidable coexistence of *utility* and *beauty*: it means that the forms of construction should become poetry and, in order to do so, should submit to an interpretation, a transformation. Through an explicit expression of their role, they should address architecture's ultimate goal – the ethical and moral, as well as purely artistic goal of representing the building's overall character: the forms of construction should enliven the building they create.

This interpretation of the relationship between technical and architectural forms is shared by Arturo Danusso who, in describing his work as an engineer, places ethical responsibility at the top of the list, and recognizes the supremacy of the richness of life over technique. Reinforced concrete structures should equally aspire to reflect the meaning of buildings – for this reason he insists on insight over the dryness of calculus, which will never fully capture and reproduce the deep secret of life.

According to Rogers, life should be read through *decorative expression*, *decorative energy* – a formal quality of construction that derives from its enhancing, its fully and *expressively intensifying construction reality by underlining its elements* with the goal of *integrating and amplifying* the meaning of buildings by heightening *the object in its reality* (Rogers, 1958).

How did this process come about in the Velasca Tower?

Several technical inventions contributed to the achievement of the Tower. One of these is the central rigid core that contains staircases and lifts and effectively performs a wind-bracing role – a solution that has become commonplace in any reinforced concrete high-rise building ever since. But the most remarkable feature of the tower is certainly the development of its construction and the role each part plays in concurring to this achievement.

The designers' first key choice was the decision to externalize the vertical bearing elements that support the entire building, thereby creating a contrast between their slim structure and the sheer fullness of the volume they support. As a result, the braces are represented as continuous ribs, large shaped pilasters of changing section that continuously embrace the heavily walled but delicately pinkish volume through its entire length so that, like a giant Doric capital, they emphatically represent the supreme effort of supporting the huge overhang of the tower's top section. By playing against the fullness of the wall pierced by fenestration, the uninterrupted continuity of the ribbing reflects the idea of height as successfully as Sullivan's skyscrapers.

The slim ribs change section and increasingly taper to the top according to the static principle of uniform resistance. Such principle means that, given an equal stress on the bearing section, the section of the pilaster varies in relation to the applicable loads: the pilaster has a square section at the bottom, then tapers into a tee section so that it combines rigidity and formal expression in the play of light and shadow projected on the wall. In formal terms, such varying section reflects the stress on the tall supports as they bear the huge load.

In order to enhance the contrast between ribs and wall continuity, the floors' horizontal beams are hidden in the perimeter wall, and barely visible in the rhythm of the cladding panels. As a result, the load bearing structure is not fully manifest and fails to pragmatically show how it works. The frame is hidden so that the contrast between two very different elements can be properly expressed. The result is a compact wall mass divided into layered volumes of different size. These geometric, unified volumes are supported by and caged into the ribs. This expressive solution concisely describes a construction principle without detailing all of its components, thereby showing the dramatic contrast between slim supporting elements and heavy supported mass.

Such distinction between wall mass and ribs, placed at an interval of about 8 metres, 6 metres on the long sides and 4 metres on the short sides, also transpires from other elements such as the ribs that double at the corners in order to make the volumes apparent, the independence of the principal rafter's anchorage point from the overhang, or the deep shadow line that separates the two opposing volumes at the recessed 18th floor.

This masonry feature that connects the tower to the surrounding built fabric is precisely what Samonà indicates as the element of continuity with the context that dilutes the exceptional character of the tower within its surroundings, along with the presence of the smaller scale introduced by other elements that give the large tower its rhythm and reframe it within the domesticity of the house.

The section of the pilasters, the 10-metre wide beams of the floors, strengthened in order to perform their traction force at the 17th floor where the overhang beams are anchored, and doubled in order to resist compressive forces at the 14th floor where the inclined rafters discharge, were carefully tested and verified at the modelling laboratory in Bergamo in order to optimize the structure's reactions to stress, almost as a way of penetrating the secret of the material's life – a piece of wood turned into a puppet – that in this way acquires form and life while always following an ethical principle of construction sincerity that, however, deliberately decides which elements to enhance and how to make them speak for the sake of expressive power.

This sincerity, this way of turning technical precision into formal elegance, is typical of a certain work ethic, an approach that was shared by BBPR and Danusso. It can be equally found in the hidden elements, as demonstrated by the stunning design of the skeletons in the overhanging floor that, while not visible, correspond to the stress the structural elements are subjected to.

At the bottom of the tower, a glazed jutting section defines the scale of the plaza in relation to the surrounding buildings. This two-storey volume provides access to the elevators that separately serve the office floors placed in the building's narrower section and the apartments in the overhanging seven floors as well as the duplex villas at the top two floors. The recessed 18th floor that separates the two volumes contains small living units for the service staff along with mechanical equipment. Even the tower's multifunctional program, as well as its technical equipment – from the air conditioning system that relies on the temperature of groundwater to forced ventilation in the windowless bathrooms – reflect the most advanced and modern technologies then available on the market.

The two volumes are clad with variously finished pinkish cement grit panels that clearly evoke the warm colour of brick, although in a softer shade perhaps due to the tower's huge size. Like any large building, the tower includes variously sized offices and apartments that are designed to allow for alteration if required over time. This purely functional feature, interpreted as yet another inevitable character of the building's life, is revealed by the irregularity and variation of fenestration. Interestingly, unlike what many architects would probably do nowadays, BBPR tried to achieve a certain order in the elevation *in spite of* its necessary irregularities, even though they chose not to hide the variety of life unfolding within. A system of small pilaster strips that support the infill panels and the window frames articulates the outer wall by dividing the span between the ribs in regular 3- or 4-pitch sections. Such distribution creates a sort of second order, a minor rhythm that articulates and measures the elevation and makes it light and vibrant. The openings are freely placed within this second order – from the windows to the deep recesses of the small, beautiful loggias of the apartments that look out onto the Cathedral, the Ca' Granda building and, in days of fine weather, even the mountains that surround the Po Valley.

As a giant house that rises in the centre of Milan "like a huge tree" (Samonà, 1959) to show the city its civic face, the tower is topped by a four pitched cover that evokes a roof, a truncated cone volume clad in copper that mediates the overhanging volume's transition towards the sky and accommodates the remarkable amount of very modern technical systems the tower boasts.

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