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THE INDUSTRIALIZATION OF CONSTRUCTION IN THE SECOND HALF OF THE XX CENTURY

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PREFABRICATION BETWEEN TRADITION AND INNOVATION: THE FIRST NUCLEUS OF MIRAFIORI SUD IN TURIN

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Abstract

In Italy, the start of prefabrication and building industrialization experiences took place slowly and late compared to other European countries. The debate between the main workers in the construction sector and the representatives of the economic and political world on post-war reconstruction was oriented towards a substantial reconfirmation of traditional construction methods. Added to the productive backwardness of the Italian construction industry was the difficulty of supplying materials and the opposition of much of the academic and professional culture to the experimentation and introduction of industrialized systems. The problems posed by the severe housing deficit of the post-war and following years laboriously paved the way for the first national experiments with prefabrication and building industrialization systems. Due to the need to act urgently to contain construction costs – a relevant problem given the size of the housing problem – the rules of the 1963 Gescal were explicitly addressed to the use of industrialized and prefabricated construction systems. The Gescal years allowed Italy to start large-scale experimentation and application of prefabrication. Among the public interventions of the early 1960s, the construction of the first nucleus of the Mirafiori Sud district in Turin stands out for its peculiar, almost experimental dimension between tradition and innovation.

Keywords

Mirafiori Sud, Turin, Barets system, Borini, Gescal.

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1. A LOOK AT THE FIRST EXPERIENCES OF PREFABRICATION AND BUILDING INDUSTRIALIZATION IN ITALY AFTER THE SECOND WORLD WAR

1.1. THE EARLY EXPERIENCES

To contextualize the specificity of the construction experience of the first nucleus of the Mirafiori Sud district in Turin at the beginning of the 1960s, it is necessary to briefly recall some elements of the historical context and the state of the art of reference. In Italy, as widely documented by the literature in the sector [1], the start of prefabrication and building industrialization experiences took place slowly and late compared to other European countries. For a long time, the debate between the main workers in the building sector and the representatives of the economic and political world on post-war reconstruction was oriented towards a substantial reconfirmation of traditional building methods. The introduction of prefabricated elements on-site or off-site, which characterized most Italian building production from the end of the Second World War to the beginning of the

1960s, could almost still be defined as handcrafted. [2]. The very structure and organization of the construction sector companies were predominantly characterized by a low-skilled workforce, functional to a traditional and low-tech labor market. The difficulty in finding materials then compounded the productive backwardness of the Italian building industry – also in relation to the size of the destroyed building stock to be rebuilt – and the distrust of a large part of the professional and academic culture towards experimentation and the introduction of industrialized systems [3]. An example of this was the 1945 *Consiglio Nazionale per la Ricerca* (CNR) competition promoted by Gustavo Colonnetti. In addition to having the design of houses with prefabricated systems as their object, the competition was also open to semi-prefabricated systems [4]. More significant and relevant was the construction of the experimental QT8 district within the framework of the VIII Triennale di Milano (1947), financed by the Ministry of Public Works [5]. The only theme of the VIII Triennale, the first organized after the war, was dedicated to the house, as it was – as the catalog begins – «The most real, most heartfelt, most dramatic theme, which is the object of anguish, desire, and hopes for millions of Europeans…». Moreover, the number of Italian housing problems reported in the same *Triennale* catalog spoke clearly: the national need for housing spaces in 1947 was 12 million. The event entrusted to the direction of Piero Bottoni (assisted by Franco Albini, Lodovico Belgiojoso, Angelo Bianchetti, Ernesto Nathan Rogers, Ignazio Gardella, Carlo Rusconi Clerici, Gino Pollini) took up again with greater vigor and concreteness the theme of housing and popular economic construction already partly addressed in the 1936 VI Triennale, in which the urban plan of an experimental neighborhood had been presented on the proposal of the engineers Franco-Pagano, and Bottoni-Pagano-Pucci [6]. With the QT8 district in San Siro, the construction of five four-story buildings above ground with identical floor plans was started, built with different construction systems (the *Breda-Fiorenzi* with reusable sheet iron formwork, the *Gaburri*, and the *Ciarlini*) with prefabricated modular horizontal and vertical elements, assembled without scaffolding. The experience continued beyond the horizon of the VIII Triennale. In 1954, at the opening of the X Triennale and using the funding of the Ministry of Public Works, a second batch of seven multi-story buildings was built with the experimentation of the *Eliobeton*, *Forme Fioruzzi*, *Tenax*, and *Vlamark* systems. In the same years, the *Comitato Italiano per la Produttività Edilizia* was founded and led by Giuseppe Ciribini, which, in the context of the ECSC projects (European Coal and Steel Community), implemented the first organic initiatives in the field of building experimentation in Sesto S. Giovanni, Bagnoli near Naples, Milan with the Forlanini Quarter and later, in 1962, in Piombino. In the meantime, AIP (*Associazione Italiana Prefabbricazione per l'edilizia industrializzata*) was formed in 1957. AIP significantly promoted knowledge of prefabrication techniques already widely used abroad, especially in France [7]. Despite the debate triggered by the Triennale and the first experiences of buildings' prefabrication and industrialization in some Italian areas (especially in Milan and Lombardy region), the choices made by the Italian government for the vast program of public construction for the post-war reconstruction, privileged, at least initially, traditional construction systems that allowed for the absorption of part of the mass of unemployed laborer. The choices of the *Piano INA-Casa* (1949-1963) contributed to worsening the technological gap and the backwardness of the Italian construction industry compared to other European countries. At the same time, the strong economic growth of the 1950s and 1960s and the resulting immigration and urbanization phenomena, especially in the northern industrial cities, worsened the housing deficit. Faced with this situation, public building programs, due to construction cost-effectiveness and the urgency of solving housing problems, were re-oriented towards the use of prefabrication systems. Given the delay of the sector, patents, and systems – sometimes already outdated in their countries of origin – were purchased by Italian companies abroad and adopted with small variations [8].

1.2. GESCAL AND THE USE OF PREFABRICATION SYSTEMS

The *Gestione Case Lavoratori* (Gescal) and the rules to incentivize the acquisition of building areas for public

and social housing with specific area plans in municipalities with more than 50,000 inhabitants of Law No. 167 set on April 18, 1962, initiated a change in scale and methods in terms of the extension and scope of public intervention. The Gescal established by Law No. 60, February 14, 1963 [9], constituted in a chronological sense the continuation of the *Piano Fanfani* (also known as *Piano INA-Casa*); however, its primary objective was not anymore the employment of workers, but the contrast to the severe Italian housing deficit [10]. Due to the need to act urgently by containing construction costs – which were considerable given the size of the housing problem – the Gescal regulations were explicitly directed towards the use of industrialized and prefabricated building systems. In the second seven-year-period of the *Piano INA-Casa*, the technical standards issued by the *Istituto Nazionale delle Assicurazioni* (INA) had already been drafted and modulated to achieve better dimensional coordination of the building elements in order to rationalize and improve the economy of the entire building process [11]. However, it was only with the Gescal that the first organic set of technical standards for public building in Italy was drawn up. This definitively broke with the traditional "artisan" construction practice that had guided the country's reconstruction until then. The 1964 technical standards for the execution of constructions, with special reference to design [12], while taking up many of the indications contained in the *Piano INA-Casa* dossiers, introduced the use of prefabricated building components and industrialized techniques with detailed rules for the dimensional and modular coordination of building elements. The Gescal years were the occasion in Italy for the first large-scale comparison with prefabrication techniques. The initial importation of patents and systems from other European countries, in particular from France, was followed by local modifications and experiments on the same systems (such as the versions of the Tracoba system by SIMET *Società Immobiliare Edile Torino* [13] or the version of the French Barets System used by the Borini company of Turin) [14]. These mainly were minor variations of the original systems; only in the following decade, in the 1970s, were diversified and more mature, highly industrialized technical solutions adopted, with results still much debated today [15].

2. THE EPISODE OF MIRAFIORI SUD DISTRICT: THE FIRST LARGE-SCALE EXPERIMENT OF PREFABRICATED HOUSING IN TURIN

The experience of building the first nucleus of the Mirafiori Sud district in Turin fits into the scenario briefly outlined above. The neighborhood located in the southern outskirts of the city, near the large FIAT Mirafiori factory complex (now Stellantis), represents an interesting example of public housing in the 1960s, both for the novelty of the almost experimental nature of the construction site, with the use for the first time in Turin of a heavy prefabrication construction system, and the large size of the public building project. The construction of the first nucleus of the neighborhood was still part of the interventions of the second seven-year period of the *Piano INA-Casa*. The construction was carried out between 1962 and 1967 on behalf of Gescal following a tender competition announced by the *Istituto Autonomo Case Popolari* (IACP) in Turin in 1962 [16]. It involved building 798 dwellings on a gross area of 550,000 m^2. The neighborhood in its definitive configuration – a total of 2,450 homes were planned for a construction volume of 1 million cubic meters – should have represented, in the intentions of the city administration, the new centrality of the urban expansion towards the south of Turin [17]. According to the tender notice, the competing companies had to provide a volumetric plan for the entire residential complex, including the subsequent construction of two more lots of approximately 800 homes plus the related services, in addition to the executive project of the first lot.

The tender's requirements left the possibility for competing companies to adopt or not prefabricated construction systems to realize the project. The company *Franco Borini, Figli & C.* won the competition with a project involving prefabrication techniques based on a system derived from the French Barets system. Jean Barets himself had previously illustrated its patent, of which Borini was the concessionaire, at the *Società degli Ingegneri e degli Architetti* in Turin [18]. The company had already used this same system to construct some school buildings [19]. The system was based on the prefabri-

Fig. 1. *Planovolumetric model of the Mirafiori Sud complex. Source: Gescal, IACP Turin, 1966.*

cation on-site of all vertical and horizontal construction elements: load-bearing wall panels, internal longitudinal bracing elements, façade panels, internal partitions, floors, stair ramps and landings, and other finishing elements. The thickness of the façade panels was 25 cm, with a height equal to the inter-story and a length varying from 3 m to 7 m. The water and electrical network plants were also integrated into the panels.

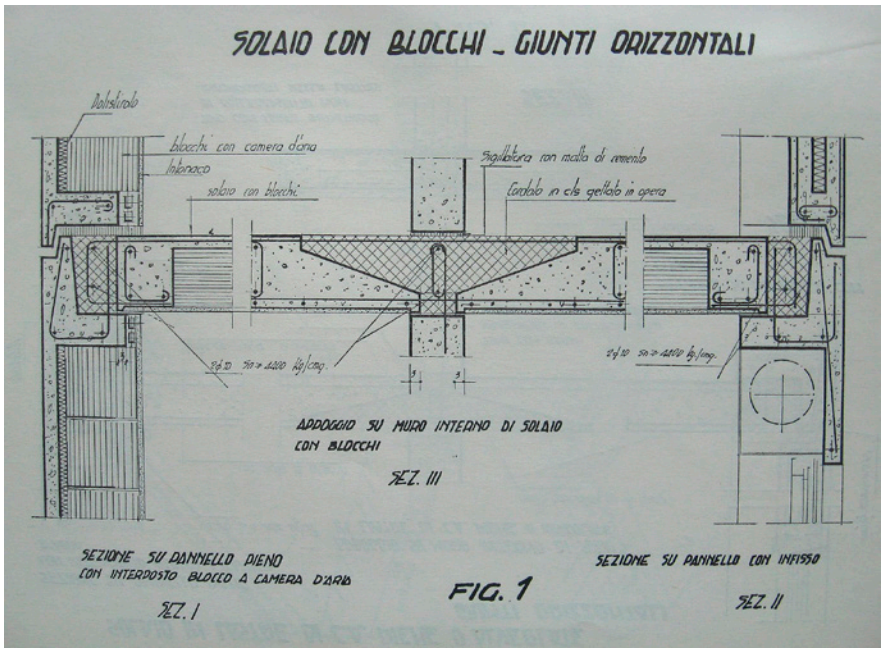

Fig. 2. *Barets system detail of slab section with horizontal joint blocks. Source: ATC archive, Turin, 1963-66.*

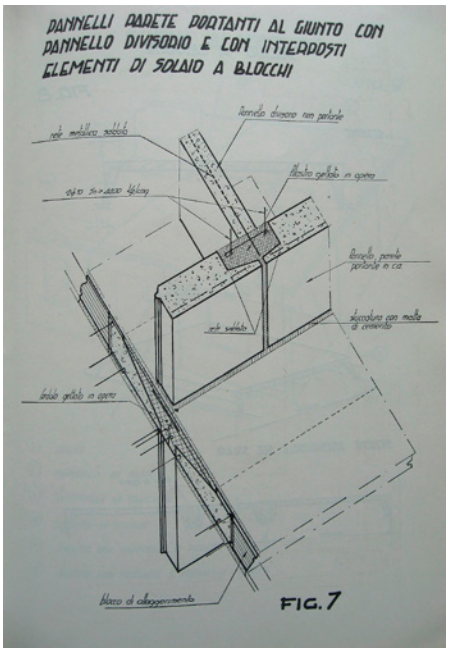

Fig. 3. *Barets system detail of the junction between the load-bearing wall panel, the dividing panel, and the floor elements. Source: ATC archive, Turin, 1963-66.*

2.1. ARCHITECTURAL AND FORMAL ASPECTS

The general and executive details of the construction of the lot were described in detail by Gescal in a small volume in 1966 [20]. A characterizing element of the architectural design, as stated by Gescal, was « that of grafting onto the structural normalization the typical elements of residential construction that were in such a relationship with each other that they could be reciprocally replaced without any prejudice, thus capable of creating a pleasant compositional variety of the façades». In essence, despite its structural rigidity, the system allowed for a certain compositional articulation by combining a few elements. This characteristic was essential for the containment of construction costs and duration. A fundamental characteristic of the system was the perfect overlap between structures and vertical supply and discharge ducts. The construction was carried out in close collaboration with the architects in charge, Mario Roggero, Ugo Mesturino, and Emilio Giay, the technicians of the prefabrication system and the company. For the construction of the 798 dwellings envisaged by the tender, 15 buildings were built, divided into three types of the same height and depth, characterized by different lengths (66.27 m, 95.29 m, 167.63 m), with seven floors above ground, plus a ground floor where the entrance halls, garages and cellars are located. The stairs were placed to serve two dwellings per floor. From an urban planning point of view, the buildings were arranged on the lot according to a comb-like pattern, with a central road axis from which secondary streets branched off at right angles. A distinctive and peculiar element was the organization of the construction site into three areas, with a single concrete mixing plant and the use of different formworks. The fifteen buildings were aligned on six parallel lines, so each part of the construction site served two lines, «since the total construction area is huge, it was more rational and convenient to place the molds near the buildings to be constructed rather than create a single prefabrication area with the need to move the large mass of prefabricated elements on-site». The concrete mixing plant was placed in a central position with respect to the three parts of the construction site. The production reported by Gescal was 28 cubic meters/hour «via double-traction dumpers with a pivoting tipper body, hydraulically controlled, with a capacity of half a cubic meter of concrete».

This layout arrangement allowed the concrete to be discharged directly into the molds without using conveyor belts, reducing costs, and rationalizing construction site operations. As regards the assembly phases, the foundations were built in the traditional manner. The first vertical panels were inserted into them, and the subsequent prefabricated vertical elements were attached. The connection was made using reinforced connecting pil-

Fig. 4. *View of the packaging and storage phases on the building site. Source: Gescal, IACP Turin, 1966.*

Fig. 5. *View of the building site during the assembly phases of the load-bearing panels. Source: Gescal, IACP Turin, 1966.*

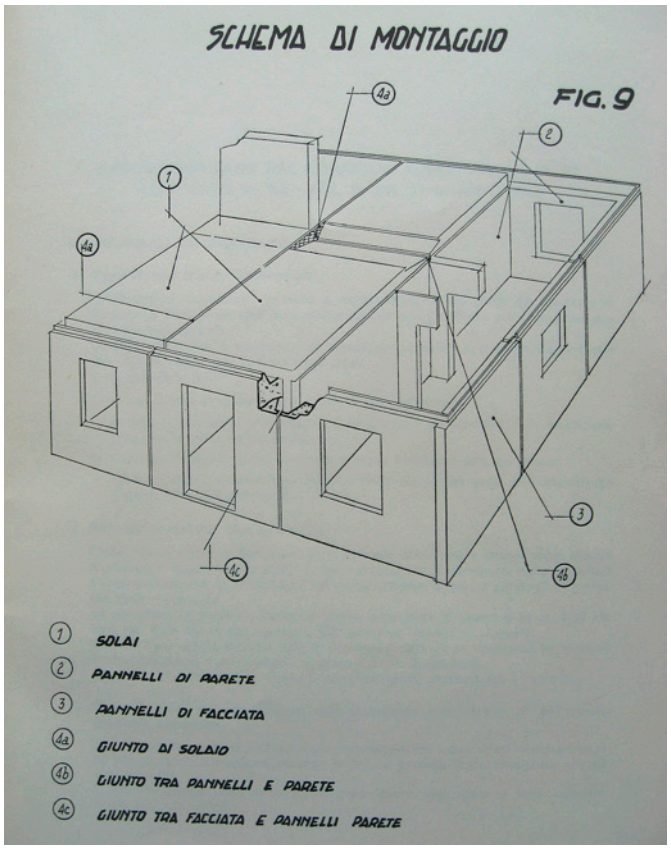

Fig. 6. *Barets system, general assembly scheme of the elements. Source: Gescal, IACP Turin, 1966.*

lars cast in situ inside special shapes in the panels themselves. A hot-applied gasket then protected the bottom of the joint between the panels. This was followed by the in situ plastering phase, which allowed the vertical connection to be closed. The partially prefabricated horizontal floors were laid on this structure, and the electrical plant, water, and sanitary system were installed. As for the finishes, a certain amount of care was given not only to the internal distribution and hygiene aspects of the apartments and common spaces but also to the formal ones, in the chromatic and material combinations: red stoneware for the stairs and landings, Botticino marble for the entrance halls. These elements still characterize the buildings almost sixty years after their construction. As for the external façades of the buildings, the use of prefabricated techniques influenced the choice of materials; instead of brick, traditionally typical of the Piemonte region, cement *granigliato* was preferred. The entrances were covered by reinforced concrete shelters, carefully designed and completed by small, boxed iron doors. The Mirafiori Sud complex was completed with the subsequent construction of two other nuclei, built with prefabricated construction systems between the end of 1966 and 1971 [21]. Alongside Borini, the second lot was awarded to *Compagnia Imprese di Prefabbricazione* (Co.Im.Pre), which used the *Costamagna-Skarne* system, and the third lot to *Società Immobiliare Edile Torino* (SIMET), and *Costruzioni Generali Ing. Recchi* (from now on Recchi), which adopted the industrialized Tracoba system. The system adopted by Co.Im.Pre was based on on-site prefabrication similar to the Barets system, which was improved from the point of view of finishing operations and some peculiarities of the assembly system. The Tracoba system adopted by Recchi marked the end of the experimental phase of these systems, perfecting the industrialization, seriality, and automation of the various construction site phases and operations.

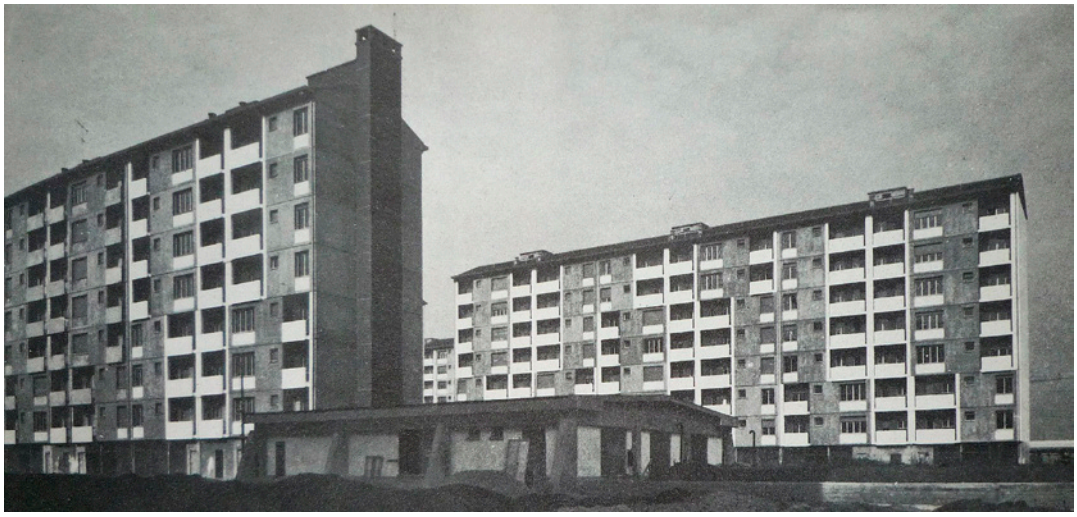

Fig. 7. *North-east view, thermal power station and buildings under completion. Source: Gescal, IACP Turin, 1966.*

3. METHODOLOGICAL AND FINAL CONSIDERATIONS

Some considerations led to the choice of identifying, through archival reading (ATC - *Agenzia Territoriale per la Casa* of Turin and Gescal IACP - *Istituto Autonomo Case Popolari*, archive of Turin, ASCT - *Archivio Storico della Città di Torino*, historical archive of the city of Turin), documentary materials and a single episode – albeit peculiar in size and aspects of the construction site – useful elements to enrich a general framework of the specificities of the Italian experience in the field of industrialization and building prefabrication in the post-war period.

The first one concerns the large size of this public building project and the change in the direction of policies and methods of public intervention in affordable housing in Turin, in addition to the impact it had on the urban layout and development of the city [22]. The social pressure caused by the massive immigration of laborers needed by the rapidly expanding manufacturing industry made it urgent to launch a social housing program that could provide a concrete response to the severe housing deficit, with sustainable costs for the public administration, already grappling with the still unresolved problems of reconstruction. Similar issues were also present in other large productive areas of the country, especially in the north. In nearby Milan, in particular, the IACPM (*Istituto Autonomo Case Popolari di Milano*) to meet the objectives of building social housing in a short time, stipulated, in 1962, an agreement with some construction companies (Mbm Meregaglia, Sicop, Fintech, Sepi, Romagnoli), concessionaires of French patents of heavy prefabrication, for the construction of new districts of low-cost and social housing [23]. In 1963, the Municipality of Milan, in implementation of Law No. 167 April 18, 1962, launched the *Piano per l'Edilizia Economica e Popolare* (PEEP), which defined the location of sixteen public building projects in peripheral areas of the city, including the Sant'Ambrogio district, the Gallaratese, the Gratosoglio, the Missaglia, the Olmi district and the Quarto Cagnino district [24]. Despite the similarity in the processes, the urban, historical, and socioeconomic characteristics of Turin were profoundly different from those of Milan. The orthogonal grid of axes that had guided and characterized the city's development from the Baroque period onwards was dismantled entirely in the 1950-1970 twenty-year period, by the location choices of the public building plans, with the creation of self-sufficient peripheral neighborhoods. The process had started with the first projects of *Piano INA-Casa*, in particular the Falchera neighborhood, on the northern outskirts of the city and the Vallette to the west, but it was the Gescal plans and buildings that caused a total break with the past in the settlement network and the typological and formal characteristics of the city's buildings. The doubling of the spatial and demographic dimensions of the city during the economic boom period occurred mainly through the new peripheral neighborhoods and in the subsequent welding between these areas and the historical buildings, in a condition of substantial deregulation caused by the lengthy approval times of the post-war master plan (which was approved only in 1959) and by the speculation dynamics [25]. It should be noted that Turin's building heritage had been largely destroyed (about 40% of the existing one) by the bombings of the Second World War. More than 50,000 people and families had been left homeless, and to these were added the evacuees and refugees, mainly from Istria, who had taken refuge in the city. The rapid economic recovery of the early 1950s, favored by the Marshall Plan from which FIAT benefited, significantly aggravated the problem of Turin's housing deficit due to the massive wave of immigration of workers arriving from all over Italy [26]. It is worth remembering that in 1971, at the end of the twenty-year economic boom, approximately 75% of those employed in the metalworking sector in Italy lived in Turin. The choice made at the central government level with the *Piano INA-Casa* to use traditional construction systems to start the great program of building reconstruction in Italy quickly became inadequate in the face of the worsening housing problem, especially in a city like Turin. The Mirafiori Sud residential complex, located next to the large FIAT factory (which doubled in size between 1961 and 1963, becoming one of the largest in Europe), arose in just a few years on mainly agricultural land, 14 km from the city center, also symbolically marking the break with the historic city and the spatial and economic transformation of the city.

Fig. 8. *The complex, east side, view from the surrounding agricultural fields. Source: Gescal, IACP Turin, 1966.*

The change in FIAT's production and dimensional scale strongly influenced the city's development, to which public urban planning and planning choices had to conform [27]. Gescal's interventions were, therefore, decisive in guiding the completion of public social housing programs using industrialized systems. The ambiguity and distrust of the professional and academic world towards the prefabrication and industrialization of buildings in the post-war period was overcome during the 1960s by a radical transformation of urban and technical concepts of social housing and by the methods and dimensions of public intervention, the results of which, in the various Italian realities, are still a matter of discussion today.

A second consideration concerns the technological aspect. Mirafiori Sud, the first nucleus of the neighborhood, factually testifies to the passage, the difficulties, and the uncertainties of design, techniques, and management between a traditional way of constructing based on a large use of workforce to an industrial and technological one with reduced use of personnel. Until then, prefabrication techniques had been used in Turin and Piedmont only for single buildings. The most innovative element was not only the design method, tied to the modularity and dimensional coordination of the panels and the rigidity imposed by the system but the organization of the construction site similar to that of industrial assembly lines and profoundly different from the traditional one. Traditional construction sites from which the workers and designers came. The Mirafiori Sud construction site clearly shows the difficulty of moving from the traditional way of designing and building to the industrialized one. Enlightening in this regard are the words pronounced by J. Barets in his aforementioned speech at the *Società degli Ingegneri e degli Architetti* in Turin: «prefabrication (of the Barets system) consists of manufacturing on site all the elements that are part of the building under construction. For this reason, we have created an organization that requires relatively limited resources from each individual company, but that allows companies to have access to common technical services, which, by the simple fact that they intervene in a group, are competent, qualified, and effective to the extent of the importance of the group itself and in the function of the experience acquired, which is constantly enriched. Our organization is not a company; it is an organization that plans and gives the company the indispensable coordination so that, in the spirit of prefabrication, the construction is carried out in perfect and total cohesion». In this specific case, as

well documented by the 1966 Gescal report on the construction of the lot, the general project had to respond to the requirements of simplicity and linearity to reduce the number of formworks used to create the prefabricated elements and, therefore, contain costs. It was up to the architectural project to try to obtain a compositional and plastic variety of the fronts within a system that was necessarily rigid and constrained by modular coordination needs. The difficulty of managing the compositional and architectural work, the distribution variants, the tight construction times, the intermittent financing, and the lack of experience in organizing the industrialized process is documented not only by the subsequent testimonies of the professionals commissioned by the Borini firm, Mario Roggero, Ugo Mesturino and Emilio Giay but can also be glimpsed between the lines of the Gescal publications and make evident the lack of experience and adequate knowledge of these systems among the players in the Italian building sector of those years. Despite this, almost sixty years after its construction, the result of this experience – unlike the subsequent construction episodes that completed the construction of the neighborhood (in particular, the eight Towers of Via Artom built between 1965-66 with the Tracoba system by Recchi), highly controversial for their poor construction and urban quality and which contributed to worsening the phenomena of marginalization and social degradation of Mirafiori Sud – has been a product of overall good construction quality. The choice of materials, the attention to design and composition, despite the obvious constraints imposed by the system, the origin of the workers and of the company itself from the good rules of the art of traditional construction, have created a complex that is appreciable from the formal and living point of view, without severe phenomena of deterioration and degradation of the materials and buildings. The main limitations of the intervention are to be found not so much in the construction aspects but rather in the rigid planimetric system and the urban and logistical choices underlying the neighborhood's location. Mirafiori Sud is still spatially distant from the city center, and the provision of social and commercial services has been delayed and implemented with difficulty. Furthermore, the proximity to the large automobile plant, which has been progressively decommissioned for some time, poses further problems for the urban redevelopment of the area and its environmental regeneration. Mirafiori Sud is currently the city district with the greatest problems of thermo-hygrometric comfort due to heat islands caused by the largely asphalted and waterproofed ground surfaces. From a construction point of view, the main problem today is the need to intervene to improve the energy performance of buildings built in years when the abundant availability of fossil fuels made the energy problem negligible. How to intervene to safeguard the peculiar characteristics of the complex and its undoubted value as a historical and technical testimony while improving its performance and comfort is a very current issue.

Fig. 9. *View of the buildings of the I core of Mirafiori Sud, Turin. Source: author's photo, 2024.*

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