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Cover illustration: MBM factory in Trezzano sul Naviglio (Milan), Italy.

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THE ITALIAN SOCIO-HISTORICAL FRAMEWORK OF PRECAST CONSTRUCTION IN THE SECOND HALF OF THE 20TH CENTURY

Enrico Dassori, Renata Morbiducci

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Abstract

The events that have given nearly exclusive prominence to concrete precasting techniques since the second half of the 20th century (at least in Italy) in the production of industrial buildings offer a chance to create an engaging overview of the industrialization of the construction sector. This overview cannot be separated from brief recollections of previous decades as well as a glance at contemporary developments. Unlike the housing sector, industrial precasting does not suffer from the obstructionism of complacent builders towards traditional technologies, the distrust demonstrated by many architects toward the ideologization and politicization of principles, or, ultimately, the confinement to a low-cost, low-quality building market. The survey begins in the 1920s when a strongly rational approach to building design and production processes emerged and mainly focuses on the post-World War II period, when industrial construction encouraged experimentation and developed avant-garde techniques, achieving significant results across various fields of application.

Keywords

Italian precast construction, Industrial buildings, 20th-century overview.

Enrico Dassori
DAD - Dipartimento Architettura e Design, Università degli Studi di Genova, Genova (Italy)

Renata Morbiducci*
DAD - Dipartimento Architettura e Design, Università degli Studi di Genova, Genova (Italy)

** Corresponding author:*
e-mail: renata.morbiducci@unige.it

1. INTRODUCTION

Reading and understanding the events that gave concrete precasting techniques almost exclusive prominence in the second half of the 20th century (at least in Italy) in the production of industrial buildings cannot be separated from a brief reminder of what happened in the earlier decades [1, 2]. Particularly interesting is what, starting in the 1920s, determined the affirmation of a strongly rational approach in building design and production processes; an approach that generated a substantial renewal of procedures and techniques towards a transfer to the civil sphere of the principles of industrial operation, typical above all the mechanical one (Fig. 1).

The legacies of the First World War are the acceleration of industrial development processes with regard to production capacity and technological refinement, the almost definitive transformation of society from an agricultural to an industrial one, and the introduction into the labour market of large numbers of workers made up of demobilized soldiers and the unemployed due to the sudden fall in demand in the industrial sphere.

On the socio-political level, there is a strong downsizing of the liberal bourgeoisie, while the echoes of the October Revolution foster growing awareness in the popular masses towards their rights to work, wages and

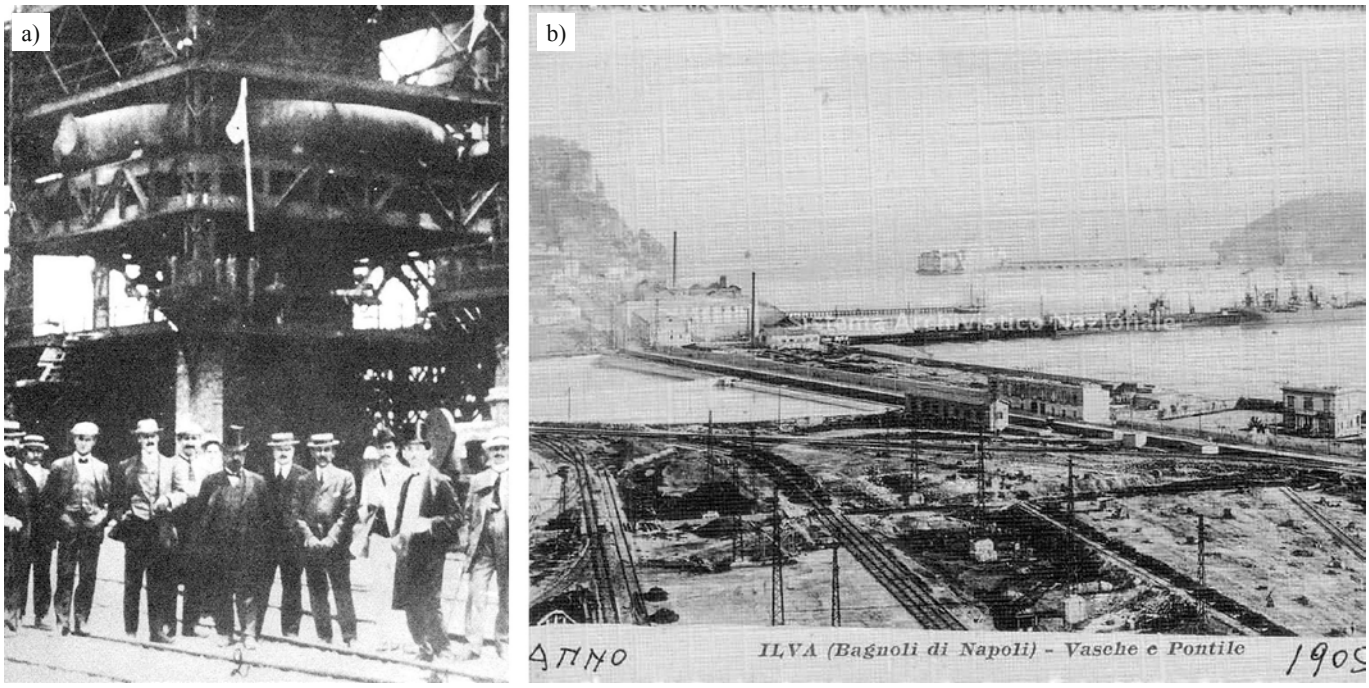

Fig. 1. *The renewal of procedures and techniques towards a transfer to the civil sphere of the principles of industrial operation, typical above all the mechanical one: (a) inauguration of Ilva at Bagnoli in 1910. Source: Rocco Lurago, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=20187415; (b) postcard of the Ilva Plant in Bagnoli in 1905. Source: unknown author, Istituto Centrale per gli Archivi, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=66858669.*

housing. In this framework, the extension of suffrage to an ever-greater number of citizens and the increasingly invasive presence of public intervention, which changes the profiles of employers, are important.

In the construction sector, the socio-economic events of this period are to be considered for the massive urban concentration, resulting in significant socio-urban problems. They demand eminently quantitative responses of new urban visions, new parameters for residential design, and new techniques and technologies capable of satisfying the demand for new buildings in a short time.

On a philosophical level, the common reasoning of intellectuals investigates a vision of technology that, after the tragedy of war, can no longer be that of unlimited power because it must set itself the goal of improving the living conditions of individuals.

In this context, the need to build many new dwellings appears to be central rather than new technical requirements to which large companies devote themselves. The need for buildings with large spans, which mainly concerns infrastructure works, is an example of these new requirements. At the turn of the 19th and 20th centuries, however, infrastructure was able to satisfy needs without significant innovations.

The collapse of the positivist-bourgeois "values" that had led to the war event is followed by a strong desire to break with the consolidated schemes; the result is the budding of new ways of thinking and seeing, true processes of clarification driven by new interests in scientific thought and logic: critical researches oriented towards drawing the balance between technical, economic and social needs and formal demands.

On the pre-war pro-rationalist experiences of Perret, Behrens, Loos, Gropius and Meyer, a renewed rational thought was grafted, a sort of neo-humanism that rediscovered the human subject and distanced itself from a technique as an end and a means, in which order and rationality proved not to exclude disorder per se.

All over Europe, the new social order was complicated by the substantial blockage of activities due to the war events; in this context, building responded with great public interventions characterized by formal simplification, unification of building types, compaction of housing blocks, and encounter between art and industry. These are years in which reinforced concrete becomes the reference construction technique for popular buildings and is no longer a subject for patents and specializations of firms.

Fig. 2. *The Frankfurt precast concrete panel system by Ernst May.*

In Italy, the process of massive urbanization would only be completed with the internal migrations of the 1950s; previously, it experienced quantitatively less relevant phenomena in housing, little affected by the war events, while the interventions aimed at modernizing the road and railway networks grew. Nevertheless, in a political framework that is certainly not favourable, *Istituti Case Popolari* and *Cooperative* (Italian public entity that promotes, builds, and manages social housing) play an important propulsive role in social and economic housing. Reinforced concrete asserts itself due to the competitiveness of its short construction times and its structural performance. Furthermore, the regime's policy in favour of the agrarian economy, the corporatist system, the crisis of 1929 and, finally, autarchy do not favour an orderly and mature development of the construction industry.

In Germany, the intellectualism of the Weissenhof and the almost obsessive serialities of Hilberseimer give way to the concreteness of the *Siedlung*. Their dimensions activate industrialized approaches to the project and the building site that also take their cue from Martin Wagner's earlier studies on the application of Taylorist theories and the industrial processes of prefabrication that Ernst May applied in the production of load-bearing reinforced concrete panels as early as 1928 (Fig. 2) [3].

In 1930, May himself gives lectures in Moscow and Leningrad, exporting to the Soviet Union those technologies that are ideal for the massive construction of planned cities, assuming political significance.

Iconic in 1930 is the Shell building in Paris, where Lucien Bechmann, returning from a trip to America to design firms and building sites, demonstrates the full metabolization of the criteria of industrialization and precast.

What emerges in the transition from the 1920s to the 1930s is the complete clarification of the two terms: industrialization is a mode that applies to processes, while prefabrication is a construction technique with its own characteristics. Although there is clearly a close reciprocity between the two, the former is not necessarily matched by the latter and vice versa.

The 1930s are compressed between the protracted crisis of 1929 and the socio-political events that prelude the Second World War. The process of industrialization of the building sector proceeds in different directions, also becoming part of the debate on the renewal of architecture. In this context, we must remember the primary role assumed by reinforced concrete, innovations in the field of cement, the development of technical regulations for calculation and standardization, and significant theoretical-practical contributions. In Italy, we recall Colonnetti's studies on states of compaction in the prestressed reinforced concrete field and innovations in site equipment.

Taking inspiration from Maillart's projects, applications in large reinforced concrete structures generate a movement of designers who legitimize the technology of industrialization and prefabrication as the inspirational source of form. In Italy, mention must be made of engineer Nervi and his *Aviorimesse*, designed from 1935 onwards.

The 1940s are inevitably marked by the world war, which, unlike the previous war, carried out large-scale destruction of cities and infrastructure. During the war, interest in the principles of industrialization is pragmatically pursued in the United States, where Konrad Wachsmann founded the General Panel Corporation with Gropius and patented the *Packaged House System* in 1942.

At the end of hostilities in 1945, the building stock throughout Europe is severely compromised. However, at least until 1950, the main theme is the survival of civilian populations wounded by the war, as demonstrated by the Marshall Plan of 1947 and the Berlin Airlift of 1948. A special mention is deserved by the Consortium of Local Authorities Special Programme (CLASP), based on metal components, which provides for the construction of school buildings from 1946 to 1957. Another element to be noted is the new political order resulting from the "East-West" conflict that was to be decisive for the events of the following decades (Fig. 3).

Fig. 3. *CLASP Block at Nottinghamshire County Hall during demolition in March 2017. Source: by Sjtaylor75 - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=57329127).*

2. NEW SOCIETY AND NEW NEEDS

The second part of the 1940s, with the birth and consolidation of the republican state, sees an Italy dominated by a formidable anxiety for reconstruction and, at times, exasperated towards oblivion and normality. It begins a path that will lead in the early 1950s to what is recognized as the "economic boom" period, represented by an average annual GDP growth of 6 percent, which will last until the mid-1960s. The state asserts its presence with the creation of more than three hundred controlled entities.

Between 1951 and 1961, the process of intense urbanization is consolidated, linked to the massive phenomenon of abandonment of the countryside, where income does not exceed subsistence level, and migration from the South to the industrialized North [4, 5].

In this context of socio-economic events, the construction industry takes on a leading role, addressing the housing crisis, rebuilding and expanding infrastructure, and constructing operational service buildings for all the booming industrial sectors. In contrast to the first conflict, where the war fronts were limited to precise geographical areas, World War II diffusely affected almost all urban areas, with extensive damage to the building stock due to the massive deployment of air forces.

In this period, it is interesting to divide the different types of initiatives in the construction sector:

- Private housing, dominated by private initiatives, registered a real speculative market, also favoured by easy access to bank credit, based on the differential between the low cost of agricultural land and the rapid increase in housing value.
- Public housing, on the other hand, is embodied in the Italian *Piano INA-Casa* (Fig. 4) in force between 1949 and 1963 (the so-called *Case Fanfani*) and in the programs of the Italian *Istituti Autonomi Case Popolari* (IACP). These institutions have been active since the beginning of the 20th century, with specific competences until 1977, when they were decentralized to the single Italian Regions.
- Infrastructural construction, which can also be referred to as service construction, is managed by large public contracting authorities, which become the primary examples of expenditure for the private sectors of component production and shipbuilding.
- Industrial construction is practically the exclusive domain of the private sector, representing both demand and supply in terms of the entire production chain (Fig. 5).

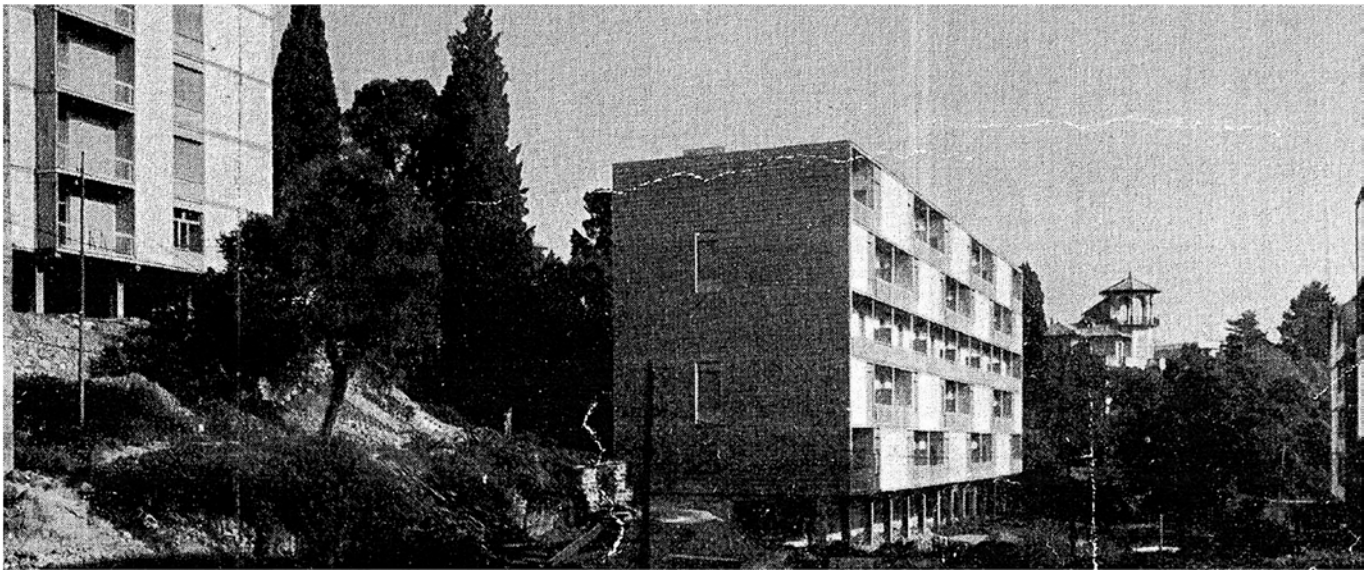

Fig. 4. *Neighbourhood* INA-Casa, *"villa" Bernabò Brea: photo of the building a few years after construction 1954. Source: https://censimentoarchitetturecontemporanee.cultura.gov.it/scheda-opera?id=662.*

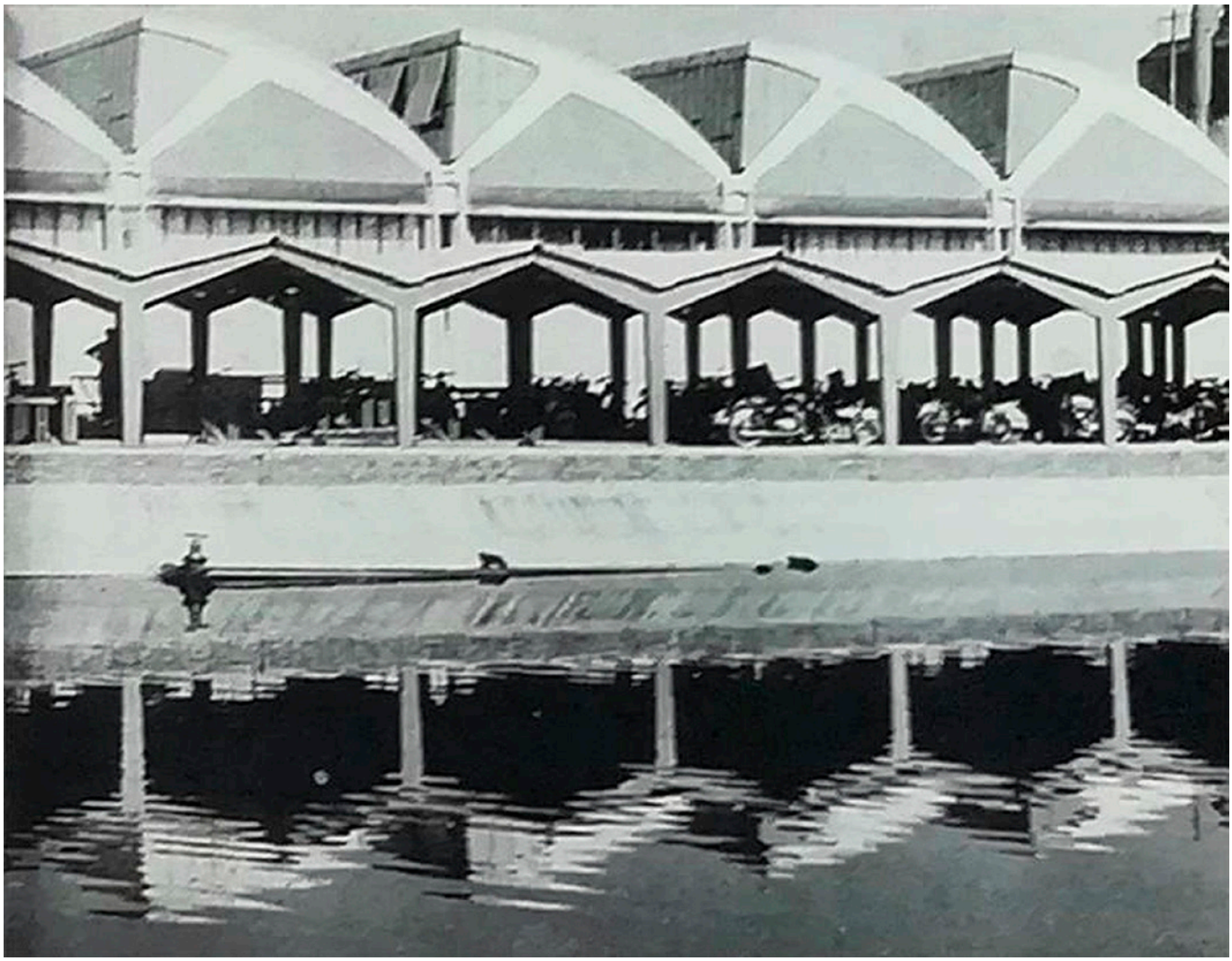

Fig. 5. *Olivetti factory, carpentry-St. Bernard district: the west front of the carpentry. Source: https://censimentoarchitetturecontemporanee.cultura.gov.it/scheda-opera?id=2342.*

3. TECHNIQUES AND TECHNOLOGIES

In the post-war reconstruction phase, the reference technique for all uses is the reinforced concrete, mostly for housing, in the form of the multi-level structure with hollow brick slabs and open-plan.

Starting from pre-war experiences, companies equipped themselves with advanced construction machinery; structural designers became familiar with calculations thanks also to the spread of manuals and the first computational supports; and the architectural project found in the malleability of the overall form, in the dialectic of infill and cladding materials, and the freedom of plan, the tools to articulate an anxious language to give aesthetic pretension to the dominant type of apartment building. There was no interest in the issues of seismic safety and energy behaviour of buildings, which, due to external events, would only appear in the 1970s.

To talk about the other building categories, infrastructure and industrial construction, it is necessary to refer to prestressed reinforced concrete (PRC) technology, which, theoretically, was developed in the 1940s. This is demonstrated by the publications of Levi, Mattiazzo and Cestelli Guidi [6] in 1940 and, especially, in 1947, the publication of the first edition of the text *Cemento Armato Precompresso* by Cestelli Guidi, which opens with the definition of the compulsion state given in 1921 by Colonnetti. In 1948, the ANICAP (*Associazione Nazionale Italiana Cemento Armato Precompresso* - Italian Association for Prestressed Reinforced Concrete) was founded in Italy with the aim of spreading the new technology.

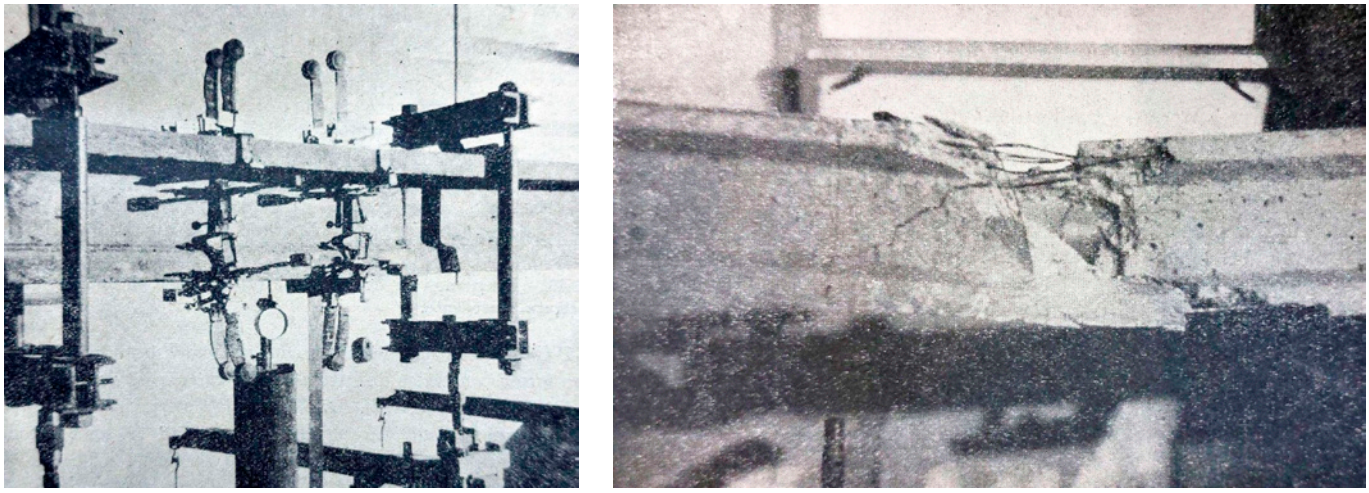

Fig. 6. *Example of experiment on ptototype prestressed beams. Source: Cestelli Guidi C (1947). Il Conglomerato precompresso: teoria, esperienze, applicazioni. Edizioni della Bussola, Roma.*

From 1943 to 1954, interesting experiments were carried out on prototype prestressed beams to test the effects of slow deformations on structural efficiency [4, 7] (Fig. 6).

What links prestressed concrete technology to infrastructure and industrial structures is the use of large spans. Conventionally, the optimal field of application of prestressing covers spans from 8-10 m, which is quite unusual for residential construction, which, as is well known, develops over ideal spans of 4-6 m. Prestressing technology, on the other hand, approaches prefabrication techniques, finding applications in "industrialized" construction for new "social districts" designed outside "historic" perimeters [8].

Precasting for housing has a tormented development which, on a political-economic level, saw the new industrial sector, in 1956, the *Associazione Nazionale Produttori Manufatti in Cemento* (Assobeton since the 1980s) is set up, clash with that of the so-called "traditional" construction companies, which managed almost all private building sites. The first companies producing precast components are incorporated into the ancient activity of a few brickmakers, who are already practising embryonic forms of industrial organization in their factories. The contrast between the two worlds is evident if one observes the different approach between the IACP programmes, aimed at maximizing the volume built with massive use of precasting in a minimum time, and the *Piano INA-Casa*, which Fanfani had conceived with the parallel aim of maximizing employment, thus favouring the use of traditional low-productivity techniques.

After the first interventions carried out successfully by the IACP between 1960 and 1964, using the in-line type with transversal or longitudinal load-bearing panel systems and floor slabs, the process came to a stop mainly due to the lack of continuity in the job orders that put the companies in difficulty, causing their closure in many cases. However, in 1964, the AIP (*Associazione Italiana per la Prefabbricazione* - Italian Association for Prefabrication) was founded with the aim of keeping alive a technical knowledge that was nevertheless acquired. The impossibility of proceeding with the industrial criteria, subordinated to the series production, brings traditional companies back to the housing market share, which at most accept to engage for a short period with the industrialization systems of castings in the "banche-table" and "tunnel" variants, imported from France. The designers, fearful of losing control of the project, quickly start to criticize the extreme rigidity of the modular design, which translated into the invasive presence of load-bearing partitions and the objective poverty of the formal solutions [5].

It is no coincidence, given the pre-war precedents, that so-called "heavy" precasting finds widespread application in France, where the policy of the Grands ensembles began in the 1950s and where the CSTB (*Centre Scientifique et Technique du Batiment*) and the CERIB (*Centre d'Études et de Recherches de l'Industrie du Béton*) have been operating since 1947 and 1967, and in the countries of the Communist bloc, where construction models, often of French derivation, are imposed by the regimes.

Reservations about architectural and technological quality, combined with the ideal approach of precasting to the economies of the other side of the Alps, mean that precasting, except in negligible cases, has no place in private residential construction. In 1969, the MLLPP (Ministry of Public Works) issues Ministerial Circular No. 6090 on the calculation, execution and testing of precast large-panel buildings. The document is late in coming but manages to capture the return of precasting in the transition to the 1970s when the strong increase in labour costs challenges traditional techniques. The industry is trying to overcome the criticism of designers by introducing framework systems and relatively versatile three-dimensional systems.

The Law No. 64 of 1974 and the Ministerial Decree of 3 March 1975, with prescriptions for seismic zones, profoundly affect construction techniques with regard, for example, to chaining, while Law No. 373 of 1976, an indirect consequence of the Kippur War of 1973, imposes attention to the thermal insulation of buildings. Law No. 313 of 1976 regulates the operation of industrial vehicles and is of particular importance for the dimensional adjustment of precast building shapes.

In 1974, the need for an advanced technical-scientific approach leads to the founding of the CTE (College of Construction Industrialisation Technicians), which brings together materials and construction manufacturers, academics and industry professionals. A significant contribution in this period is made by Peppino De Lettera, founder of the ITEC editor, dedicated to the sector which, among other things, publishes the magazine *La Prefabbricazione* (The Precasting) alongside the other "historical" magazine, *Prefabricare Edilizia in Evoluzione* (Precast Construction in Evolution).

After a few years in which precasting, broken down into small operations, still showed a certain vitality, not without greater attention to the solution of construction details, it can be said that at the end of the 1980s, the season of residential precasting came to an end, as its convenience compared to traditional solutions in this area also diminished [9, 10].

Completely different from residential is the use of precast construction for industry, which, as we have said, makes great spans the paradigm that eliminates at the root the comparison with traditional cast-in-place systems. Even in this sphere, which must be extended to the so-called operational buildings and infrastructural works, the Italian tradition makes reinforced concrete the unique protagonist, deriving mainly from the availability of raw materials (Fig. 7).

Fig. 7. *Example of precast construction for industry of the 1960s-1970s. Source: https://censimentoarchitetturecontemporanee.cultura.gov.it/scheda-opera?id=2275.*

4. CONCLUSIONS

In Italy, as we have seen, industrial prefabs are a deep-rooted and concrete reality that has played a central role in the country's industrial development since the years of post-war reconstruction. Unlike the housing sector, it has suffered neither from the obstructionism operated by complacent builders towards traditional technologies nor from the diffidence manifested by a large part of architects towards an ideologization and politicization of principles that should have remained predominantly in the instrumental sphere, nor, finally, from confinement to a low-cost, low-quality building market.

During the period examined, even if at times functional choices have mortified technological and formal research, industrial construction has promoted experimentation and developed avant-garde techniques, achieving significant results in various fields of application, not least, more recently, those of quality management systems, products and sustainability.

From here on, it is necessary to delve into the purely technical aspects that have given rise to another "story", that of the technological evolution of precast reinforced concrete construction elements; they are the main protagonists of three post-war requirements in industrial construction, high spans, controllable costs and times, but this is another story.

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