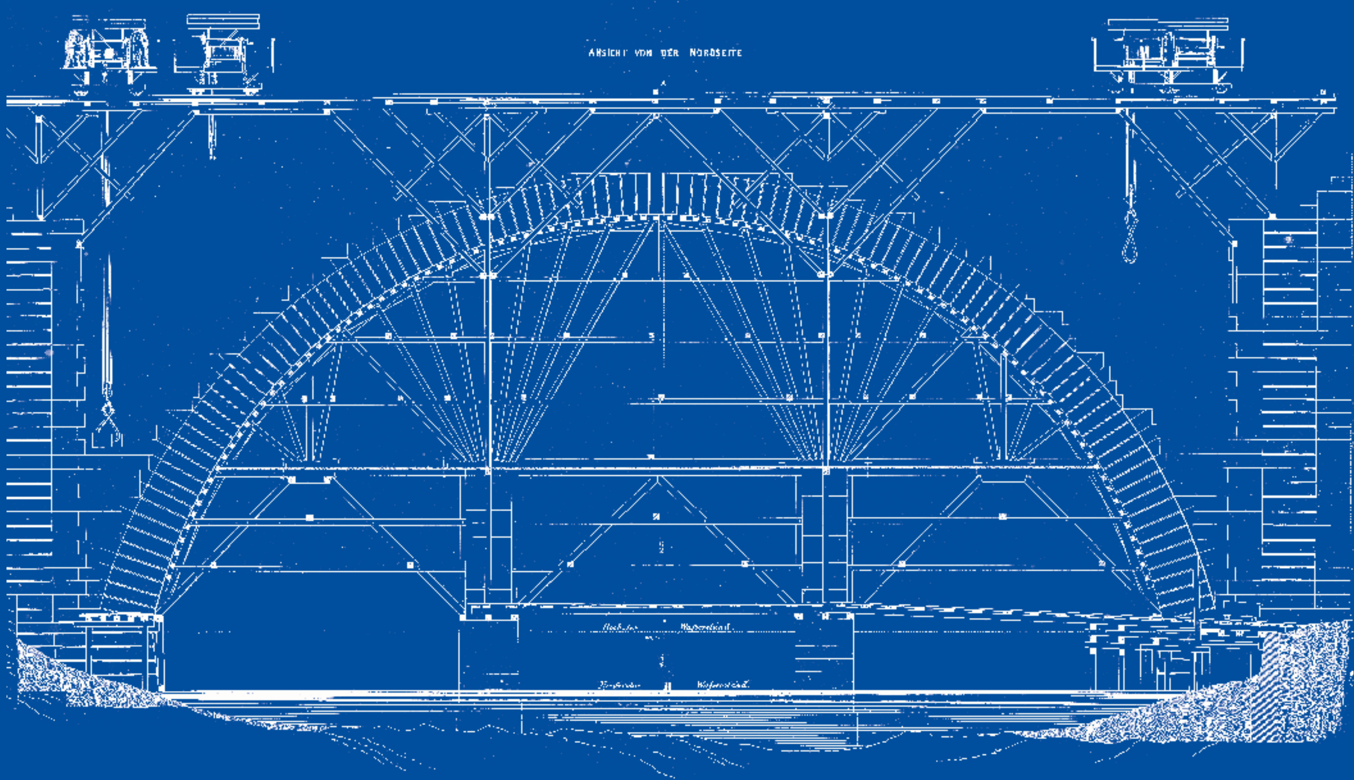
Proceedings of the 8th International Congress on Construction History

Stefan Holzer, Silke Langenberg, Clemens Knobling, Orkun Kasap (Eds.)



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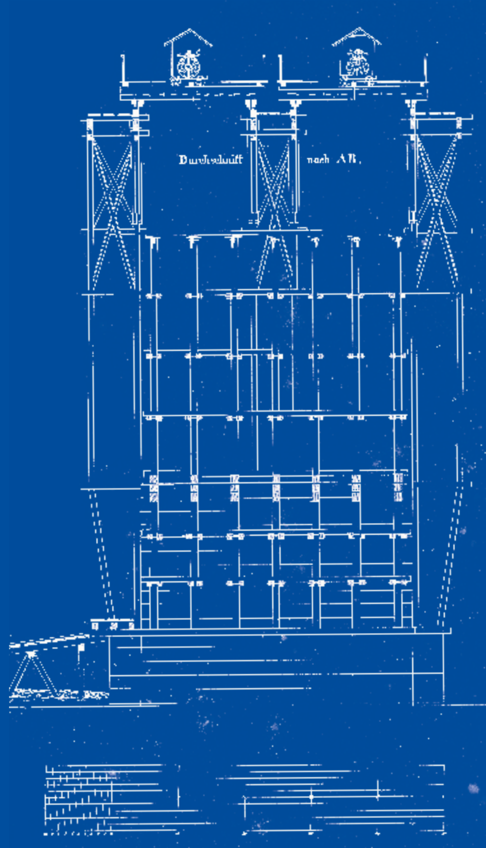

Matters

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Construction Matters

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Shaping a new building culture in Soviet Union: Soviet engineers in Italy

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Abstract: This article explores the process of technological transfer regarding structural engineering and building systems from Europe to the Soviet Union between 1954 and 1963. Travel reports held in Russian archives allow to reconstruct the strategies and the trajectories chosen by Soviet engineers to catch up with their western colleagues and enhance a building revolution in the USSR. The specialists needed to acquire knowledge in the field of concrete technology, and in particular in prestressed and precast concrete structures, fundamental for the development of industrialized construction in the USSR. Besides this, it was necessary to reform the research and administrative system: new calculation methods, research facilities, design offices and the definition of standard and regulations. An important role was played by Italian engineers, who had numerous exchanges with the Soviets and facilitated their inclusion in the international scientific community, after years of isolation during Stalinism.

Introduction

Soviet engineering, on the eve of the 1954 reforms, faced shortcomings in construction that limited ambitious programs of Nikita Khrushchev. While there were efforts in modernizing building techniques during Stalin's reconstruction campaigns, they mainly focused on monumental buildings. In the field of traditional concrete construction there were already great capabilities, as can be seen in market halls and theatre coverings (Nevzgodin 2018, Arkhipina 2018), but there was little experience with prestressing and large element prefabrication.

Khrushchev aimed for complete city renovation and mass housing, demanding millions of square meters to be built quickly. To meet these goals, they had to use prefabricated systems and reinforced concrete (See Solopova 2020, 63). Most of prefabrication methods in development in the previous years were based on block construction (krupnoblochnaja konstrukcija), that was more traditional in materials and costly. New approaches, involving prestressing and thin shells, allowed savings in material and weight, particularly in public halls and infrastructure. New Soviet urbanization demanded structures like sports facilities, cinemas, houses of culture, markets, train and bus stations, and airports, which required medium to large span structures. Concrete was chosen for its durability, fire resistance, and flexibility in embodying the new Soviet style of life.

These choices required a complete restructuration of the Soviet building culture, in just a handful of years. Mass scale prefabrication and industrialization of construction intersected all the sectors of economy, from building materials, to infrastructure, industry, to administration of public works and design offices. The atelier-centered design workflow of Stalin's years was heavily restructured and implemented with numerous engineering offices that heavily determined the final shape of the buildings. New ways of designing, calculating, producing, and building had to be adopted (Fig. 1).

Such a radical change in such a short time required the transfer of know-how from other countries.

Exchange between Soviet and Western specialists, especially European, started to be encouraged by Soviet policymakers, allowing Western technology and culture to enter the USSR during the Thaw period. This was a turning point in the Khrushchevian politics that abandoned to a large degree the terror surrounding any contact with the "cosmopolitan" world.

Soon western patents, such as the Camus prefabricated panel, were adapted for the Soviet use, and so concrete mixtures, ceramics, electrical appliances, piping, building machines, etc. (See Meuser, Zadorin, 2016, 5–20).

The exchange with the West didn't determine only the acquisition of new technologies but spurred the reform of the entire building system. Western examples became the benchmark for resetting the Soviet building organization. Soviet specialists recognized the efficiency, precision, and high level of assembly in Western engineering. They needed to study foreign experiences concerning housing districts, industries, civic-cultural centers, road types, and functional layouts.

This contribution aims to describe the process of technological transfer from the Western world to the USSR. The main sources used to expose the mechanisms of this transfer are the travel reports produced by Soviet specialists abroad. In particular, there will be a focus in the relationship with the Italian engineering community, that seems played an important role in facilitating this transfer.

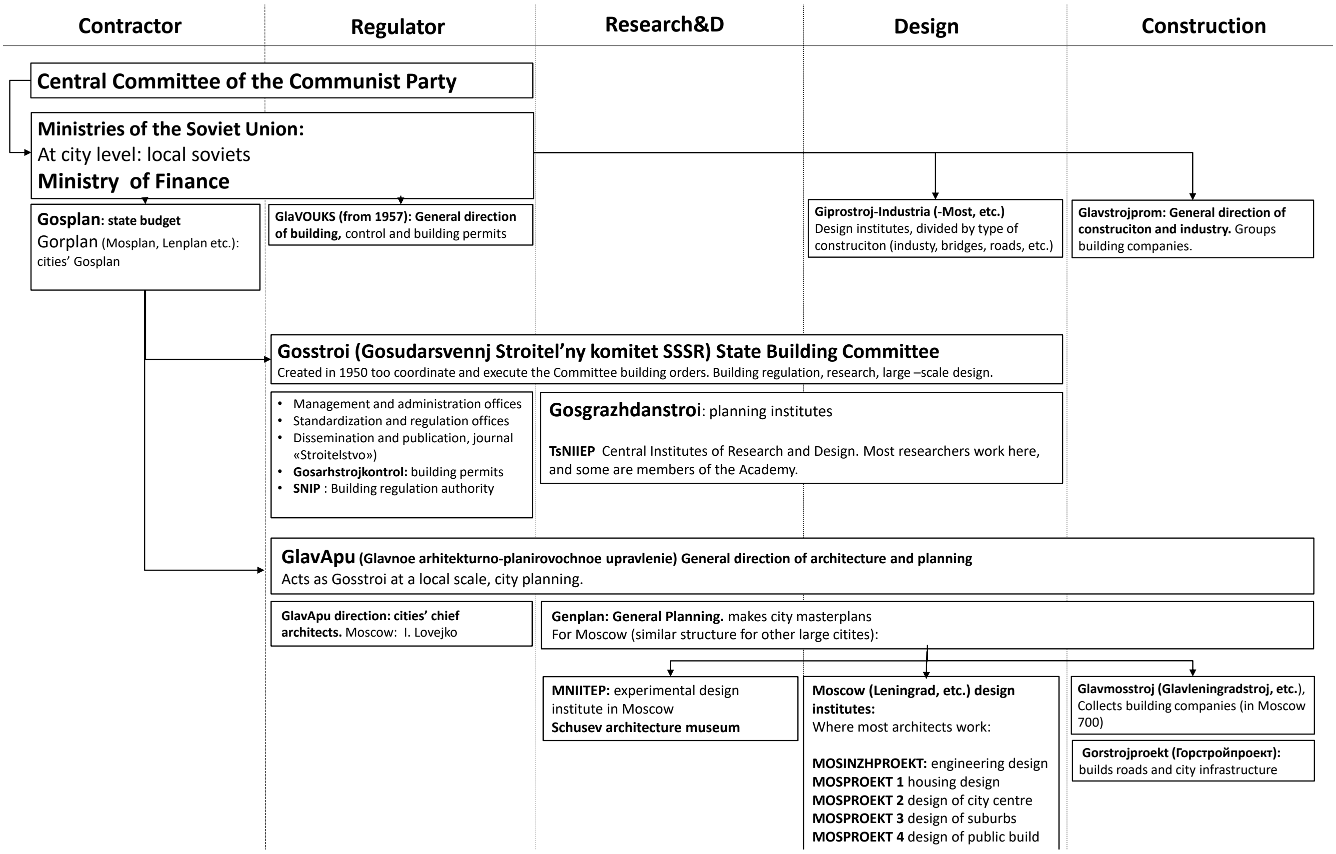

Figure 1. Overview of the structure of the Soviet scientific and technical administration after Khrushchev reforms. (by the author)

1. 1955–1956 developing relations with Italian engineers

The first steps to study Western building systems can be traced back to the 1954 expedition led by Pavel Blohin during a side event at the Geneva Conferences on housing development in Europe. The Soviet group faced initial hostility but gradually improved relations, thanks to an Italian engineer, Giuseppe Rinaldi, who provided them with publications on pre-stressed concrete and prefabrication. This may have been the first encounter with the Italian structural engineering *milieu*, that produced some of the most advanced concrete structures of the world, and counted among its members specialists such as Pierluigi Nervi, Gustavo Colonnetti, Riccardo Morandi, etc. (The so-called Italian School of Structural Engineering. See Iori, Poretti, 2014).

As soon as Soviet engineers came back, they made recommendations for future expeditions in Europe. These recommendations emphasized coordination between different disciplines in the study of foreign building systems, and suggested forming small, agile groups of specialists (RGAE f. 339 op. 2 d. 385 l. 69–74). Delegates had to act as both recipients of knowledge and propagators of Soviet influence.

The strategy of Gosstroi, the office in charge of the building sector in USSR, was to refine the tool of travelling abroad to transform it in a data collection system. Single experiences were collected and systematized, summarized, compared, elaborated and transformed in operational guidelines for the development of the Soviet building systems.

Hundreds of reports in the Gosstroi archives document the extensive effort to study the West. Gathered information was processed into detailed dossiers, with different grades of secrecy, that covered various aspects of the building sector in the West and compared them to the Soviet. These dossiers were essential for internal use and for sharing data within the building community. For example, the Dossier about the 1956 travels was divided in the following topics: General data on foreign building, Residential, Cultural, Civil building, Industrial building, Agricultural building, Construction materials, Reinforced concrete and Factory production, Research work, Training of specialists, Technical and scientific information services, Mechanization of industry. (RGAE f. 293 op. 5 d. 14, l. 54). Information was then selected, integrated with data from foreign publications, and elaborated in documents for the general professional use, such as handbooks, guidelines, etc.

In 1955, the USSR was witnessing radical changes in its building industry, marked by legislative reforms, congresses, and the appointment of new directors. By then, Soviet specialists traveling abroad became a routine endeavor rather than an exception. One of the openers of this season was Vladimir Kucherenko, who had assumed the dual role of technician and diplomat, being both an engineer and vice-president of USSR, led a high-profile delegation on a two-month journey across Europe, visiting thirty-two cities in the Netherlands, Great Britain, France, and Italy. This delegation included notable figures from various fields such as architecture, engineering, and building management. Among the participants there were Vladimir A. Kucherenko (1909–1963), President of Gosstroi, Iosif I. Lovejko (1906–1996), chief architect of Moscow from 1955 to 1960, Sergei S. Davidov (1902–1991), vice-president of the Academy of Construction and Architecture of USSR, Valentin M. Gushin, vice-minister of Building in 1954–57, Boris G. Skramtaev (1905–1966), important scholar with over 440 publications on reinforced concrete science, founder of the research institute NII Tsement, Aleksei A. Gvozdiev, member of the Academy, prominent scholar of the research institute NII Zhelezobeton (RGAE f. 293 op. 5 d. 14). This delegation, as the ones following, combined engineers-representatives that functioned as a *liason* with politics and administration (i. e. Kucherenko, Gushin), and members of the scientific community that had leading roles in research facilities in USSR (i.e. Skramtaev, Gvozdiev).

The journey commenced in Amsterdam at the II FIP Congress (Fédération Internationale de la Précontrainte), an organization dedicated to advancing concrete building techniques. It was founded as an extension of the CEB (Comité Européen du Béton) and aimed to foster collaboration among European structural engineers. In this exclusive committee, figures like Gustavo Colonnetti and Pier Luigi Nervi represented Italy. The FIP was crucial for the Soviets, as it granted access to advanced structural engineering studies, scientific literature, and expertise. Moreover, it allowed them to integrate themselves, after years of isolation, in the global community of construction sciences.

In Amsterdam, the Soviets encountered Franco Levi, an engineer who had studied under Gustavo Colonnetti, belonging to the same engineering school of Rinaldi.

Levi was prominent academic, who was well-known for having published *Fluage. Plasticité, Précontrainte* (Levi 1951), a great contribution within the Theory of Restraint formulated by his mentor. The work focused on impressed deformations and added an entire class of actions in the calculation of concrete structures. These actions had an immediate application in the understanding and development of pre-stressed structures. Moreover, he was sympathetic to communist ideals. These reasons made him an ideal contact for the Soviet engineers, that, as the Italian engineer recalls, "In Amsterdam the Russian interpreters were restless. Everything interested the new guests: the development of prestressing and of the materials, design achievements, and nonetheless, the organization between research centers, designers, and builders." (Levi, 2002, *88*).

Levi recognized that the Soviet delegation was not just interested in technology but also in the building system, focusing on the interactions between research, technology development, industries, policy makers, and design offices. The encounter was only the first of a long series.

After Amsterdam, Soviet delegates traveled through the UK, assessing urban planning, and visiting research institutes and prefabrication plants. France offered similar experiences, including visits to residential areas, industrial complexes, and meetings with high-ranking officials. In both countries, the delegation's visit often led to preliminary agreements and contracts with private companies in the building sector (Solopova, 2020, fourth chapter).

Italy was the final stop, where the delegation met with Prime Minister Antonio Segni and other officials. This visit showcased the intricate economic-diplomatic dynamics at play between the Soviets and European nations, driven by the desire to expand business opportunities and foster international relations (Fig. 2).

Kucherenko and his delegation visited numerous factories and buildings, gaining insights into construction materials and equipment. In Torino, Soviets re-encountered Franco Levi at his research laboratories. His willingness to share knowledge led to the introduction of many prominent Italian engineers, such as Riccardo Morandi, who was collaborating with Levi since 1948. This led to the publication of several Italian engineering essays in the Soviet Union, such as Morandi's *Strutture di calcestruzzo armato e di calcestruzzo precompresso*, published in Rome two years before.

Franco Levi and Riccardo Morandi were invited to the USSR in 1956, where they conducted conferences. Levi talked at the Ministry of Construction to 150 specialists, while Morandi held a lecture at the Academy of Construction and Architecture in front of 200 architects and engineers. They were guests at the Gosstroi laboratories, such as the Research Centre for Reinforced Concrete (TzNII Zhelezobeton), and the Centre for Construction Sciences (TzNIIPS). The theme of discussion was mostly prestressed concrete. They were asked tents of questions, transcribed in detail in the Gosstroi's reports (RGAE f. 339 op. 3 d. 189, and RGAE f. 339 op. 3 d. 187. See also Levi, 2002, 89). Beside theory of construction, questions where focused on the properties of steel, in particular relaxation and sensitivity to local flaws, that were at the time the main limit to the application of prestressing technology. Other related questions involved hyperstatic effects of prestressing, rheology of concrete conglomerates, systems of differential prestressing and monitoring procedures for tension and effectiveness of the coating of cables, durability issues. Furthermore, Morandi shared his own systems of pre-tensioning, and provided some economic insight on the optimal dimensions for the use in buildings and the norms that were developed in Italy.

Beside technical aspects, the engineers had the possibility to compare the Soviet and the Italian systems, especially in the relationship between research centers and building companies. Among these, a particular interest was shown towards the ISMES laboratories in Bergamo (Istituto Sperimentale di Modelli e Strutture), founded in 1951 for the calculation of concrete structures, where were tested some of


Pag. 2 — Martedì 25 ottobre 1955

IL SOGGIORNO ITALIANO DELLA DELEGAZIONE SOVIETICA

Kucerenko in visita alla città di Milano

Sopraluoghi nei più grandi complessi edilizi - Un giudizio sul grattacielo - Invito agli italiani a visitare l'U.R.S.S.

DALLA NOSTRA REDAZIONE

MILANO, 24. — La delegazione sovietica di tecnici edili, che ha già visitato Roma e altre città italiane, è giunta stamane a Milano, accompagnata dal vice presidente del governo sovietico Kucerenko. Insieme agli ospiti era anche l'ambasciatore sovietico a Roma, Bogomolov. Ha fatto gli onori di casa, nella città, il presidente della Provincia Casati.

Nel pomeriggio, alle 17, la delegazione è stata ricevuta del Sindaco, prof. Ferrari, presenti la giunta comunale, parecchi consiglieri ed altri rappresentanti cittadini. Il collegio degli ingegneri ha offerto in serata un gran ricevimento agli ospiti nei saloni [...] buono per i popoli. Importante è invece lavorare per l'amicizia fra popoli e per la pace ».

Un o.d.g. Banfi-Donini sulla scuola post-elementare

Nella seduta di sabato al Senato fu discusso un ordine del giorno presentato dai compagni Banfi, Donini, Pucci, Rosei e Salvatore Russo sul problema dell'istruzione obbligatoria. Per un errore, nel resoconto, pubblicato sul numero di domenica, apparve che tale ordine del giorno era stato preso in considerazione, mentre in realtà esso fu respinto dalla maggioranza governativa. Per documentare la importanza dell'ordine del gior[...]

considerato che la disposizione emanata dal Ministero della P.I. estendendo a tutte le province l'istituzione delle classi 6, 7 e 8, elementare pur costituendo una radicale innovazione nello ordinamento scolastico non fu sottoposta, secondo il progetto di legge, a precedente esame del Consiglio superiore;

che essa non risolve il problema della scuola dell'obbligo, anzi lo elude e lo pregiudica, contrastando allo spirito democratico del progetto costituzionale, e che d'altra parte esso danneggia l'insegnamento elementare imponendo ad esso nuovi concentramenti di classi e nuovi turni;

invita il Ministro della P.I. a sospendere l'applicazione di tale provvedimento ed affrontare, perchè sia sottoposta al giudizio [...]

La compagna [...]

Figure 2. News about the visit of Kucherenko in Milan ("L'Unità", 25 October 1955).

the most iconic structures designed by Pierluigi Nervi, such as the Pirelli skyscraper (1954) (Neri, 2014, *69–73*).

Italian engineers were asked to evaluate both the laboratories of the Academy of Construction and Architecture and the quality of the productions they were shown, and, for example, they indicate as best the concrete panels coming from the DSK n.5 factory in Leningrade.

Beside technical transfer, Italian engineers discussed with the Soviets about the connection of economic conditions and building solutions, and somehow encouraged the development of large panels. Italy had great engineers, and a good part of the iconic structures designed by Nervi and Morandi had the ambition of being types to be reproduced serially (the Sports Hall, the M patent bridges). Nevertheless, prefabrication had always a minor role in Italian building culture, and was limited to very small elements, mostly employed in industrial architecture. It may be that USSR would have been a better ground for further development of Italian experimentations.

2. 1957–1960: entering the international community of structural engineers

After the first presence at FIP's conference in Amsterdam, Soviets intensified their participation at international engineering congresses. Engineers were present in 1957 at Geneva's IBCC conferences (RGAE f. 293 op. 5 d. 165 see also RGAE f. 203 op. 5 d. 58) and especially at the II Oslo FIP conference, devoted to thin shells, where the delegation was led by Gvozdiev and other prominent soviet engineers (1–3 July 1957, participants: T.K. Avdeev, V.S. Vlasov, A.A. Gvozdiev, S.S. Davidov, A.D. Efimov, O.D. Oniashvili, I. A. Rybin. RGAE f. 203 op. 5 d. 58).

At the conference they could meet with the best specialists in the world, coming from different nations, such as Arup and Esquillan, the latter being co-author with Franco Levi of the Palazzo Vela in Turin, an important application of bi-directional prestressing (see FIP 1955). Gvozdiev was able to delivery to this high-level auditory a presentation on different kinds of large and medium span thin shells already built in USSR, mostly coming from the Leningrad institute of Construction Sciences.

At the III FIP Congress, 1958, in Berlin, the main theme of discussion was construction steel, and Soviet delegates were officially accepted by president Torroja as official members of FIP. This was an important step: by statute, any member could submit a scientific question and therefore obtain any relevant documentation, published or unpublished, shared by the other members. In practice, Soviet specialists, by 1958, had direct access to scientific production by the best researchers in the world concerning reinforced concrete technology. By this point, Soviet integration in the international scientific community proceeded fast. The following FIP conference was held in the same year in Moscow: discussion was about semi-probabilistic methods, an "epochal" turning point (according to Levi's words) on methods of calculation and building regulation. Semi-probabilistc methods were developed thanks the teamwork of both western engineers (Prot, Robert, Levi, Freudenthal), and Soviet (Gvozdiev, Strelezkij).

1958 was the year when USSR actively engaged in international activities, beside FIP, Moscow hosted the International Union of Architects' Congress (UIA), involving several thousand of architects from all over the world, and participated for the first time since the end of the war at the Bruxelles Expo.

Soviet integration in the European engineering community continued in the following congresses, and after Tel-Aviv, Madrid, Johannesburg 1959, USA and Oslo 1960, at Rome's FIP congress in 1960 professor Sergei Davidov, thanks to the support of the Italians Franco Levi, Guido Oberti, Cestelli Guidi, Piero Pozzati, is admitted at the CEB, the office from where originated building regulations for the whole Europe (see FIP 1953–1994).

Italian engineers played an important role in involving the Soviets and shared other information on the most recent developments of harmonic steel and prestressing terminals.

The first important result of the CEB-FIP commissions was the publication of the *Recommendations*, after Monaco 1961 and Luxemburg 1962 meetings, that constitute the backbone of the Eurocodes that up to today are the basis of EU safety building regulations (Levi 2002, p.75).

Connection with the Soviet world can be seen in the parallel publication of the USSR's SNIP regulations, elaborated by TsNII Zhelezobeton Institute (SNIP II-B.1–62, *Betonnye i Zhelezobetonnye konstruktsii. Normi proektirovaniya*. Substituting norm SN 10–57 of 1957). The members of this institute were the same that participated at the international engineering meetings.

Both documents are divided in "General Principles", and "Rules of application". Both didn't only list requisites for structures but tried to integrate the building experience of the best engineers with recent calculation methods, so to provide a useful tool for design, and underline critical points in the design of structures and use of materials.

As the 1960s begun, ties between Italian and Soviet engineers became increasingly frequent, and the Soviets were in fact fully accepted into the scientific community. Numerous trips followed, even outside the conferences. The Soviets by now could make real contributions to construction science, as evidenced by reports of later meetings such as in Rome 1962, in which Davidov presented the latest experiments on fatigue behavior of prestressing (RGAE f. 339 op. 2 d. 782, and RGAE f. 339 op. 9 d. 214). In these years Soviet scholars also begun to occupy important positions within these institutes, joining committees, as in the case of Skramtaev who in 1964 became president of RILEM after a Czechoslovak and a Polish president. From this time on we can considered completed the phase of alignment of Soviet structural engineering, on the Western standards.

Italian engineers were instrumental in this process, especially Franco Levi, who held the chairmanship of the CEB throughout the critical decade of 1957–68 and favored in many ways the entry of the Soviets into the international circuit, at least from what emerges from the documents reviewed, on the basis of personal convictions and friendly relations, rather than pressure from political forces.

In 1965, at Bellagio, Gvozdiev was welcomed by the Italians as a long-time acquaintance, and information sharing took place on a two-way basis. Soviet regulations were compared with Italian ones, and the differences and advantages of one and the other openly discussed. Gvozdiev, as guest at the Milan Polytechnic, noted how the experiments conducted on steels were similar to theirs, just as certain prestressed structures, such as the thin vaults of Cinecittà, were very similar to the vaults designed by the Institute of Structures in Kiev. What Soviets considered innovative and interesting, such as the study of stresses on plexiglass models using photographic optical apparatus, got immediately absorbed and replicated. The organizational structure of Italian research, as Gvozdiev pointed out in his reports, was replicated as well, with a new prestress study program involving all major institutes (TsNII Zhelesobeton, TsNII SK etc.) (RGAE f. 339 op. 3 d. 213).

3. Italian journeys

Beside international engineering associations, Soviets travelled often in Italy. In 1956, engineer I. A. Levin led a Soviet delegation to Italy following Vladimir Kucherenko's 1955 journey. Levin's team, primarily composed of engineers, focused on electrification, and reinforced concrete technology. Their journey spanned two weeks (RGAE f. 339 op. 9 d. 14).

The primary objective was to attend the XX Bologna Fair, featuring over 800 Italian and European companies in energy and construction sectors. The fair showcased the latest Italian electrical industry advancements, including engines, cables, transformers, and concrete precast elements. The Soviets likely explored ENI's exhibit, crucial for forming economic ties with the USSR.

Post-fair, the delegation visited various Italian factories, possibly arranged during the event. They explored SCAC, known for centrifugated precast elements, and equipment manufacturers like Sabiem, Ceat, Savigliano, Brown Boveri, and Aturia.

A pivotal moment was the visit to Genova's Ansaldo-San Giorgio factory, a major player in electrical and mechanical industries. They received valuable information on production processes, equipment, and costs, creating a "shopping wish-list" of Italian industrial products.

These expeditions laid the groundwork for the trading of know-how for large orders between the USSR and Italy, a pattern that gained prominence in the mid-1960s. These journeys also helped establish a network of exchanges between the USSR and Italian companies, with the tacit consent of the Italian government.

Additionally, Soviet engineers gathered data relevant to builders, visiting INA houses, bridges, and railways. They also explored the ISMES research center in Bergamo, that was, as seen, a point of interest. The visit to ISMES provided insights into physical model preparation for testing, influencing later Soviet engineering practices.

In the years following Levin's 1956 expedition, the exchange of knowledge between Italy and the Soviet Union through high-level delegations became increasingly common. Italy remained a preferred destination, hosting multiple major delegations each year.

During 1960, Khrushchev's reforms and the New Seven-Year Plan were transforming the Soviet Union, with a focus on large-scale industrialization, particularly in construction. Iconic projects such as the Brussels Expo Pavillion, the Palace of Congresses in the Kremlin, and the Palace of Pioneers in Moscow were either completed or underway. International relations between the USSR and the western world were improving, as evident in various cultural exchanges and exhibitions.

Figure 3. Thin shell coverings of the PRECEM laboratories in Italy, from Promyslov's travel report (RGAE f. 339 op. 9 d. 14).

The USSR's relationship with Italy was particularly positive, culminating in the signing of the first Italy-USSR cultural agreement in 1960. This agreement facilitated institutionalized knowledge exchange in various fields. Additionally, as seen, the fourth FIP congress in Rome saw Soviet engineer Sergei Davidov admitted to the CEB.

In 1960, Vladimir Promyslov led a significant Soviet delegation, marking a pivotal moment in these exchanges and offering insights into the Italy-USSR technological transfer.

Promyslov's high-level delegation included prominent figures like Pavel Krasilnikov and Viktor Abramenko (RGAE f. 339 op. 9 d. 133). Their journey commenced with a visit to Riccardo Morandi and Cestelli Guidi in Rome. Morandi, well known to them, generously shared information on bridge projects, including the Maracaibo bridge and the Catanzaro-Sant'Eufemia overpass. The Soviets also explored other types of structures less known in Italy at the time, like the Santa Barbara electric station and the 3000-seat cinema Maestoso.

Despite initial refusal by Pierluigi Nervi to meet them, the engineers visited his Palazzo dello Sport in Rome and examined it in detail. Later, they met with Franco Levi in Turin, who offered insights into his own projects, including the Palazzo Vela and the Palazzo del Lavoro. The delegation also visited Piero Locatelli in Milan to explore a bridge constructed with prestressed beams on the river Po.

In Naples, the Soviet engineers were guests of professors Luigi Cosenza, Elio Giangreco, and Michel Pagano. While they were not impressed by some of the recent buildings, they were enthusiastic about the Olivetti factory in Pozzuoli, designed by Cosenza. This factory served as an example of innovative industrial building design.

Like previous Soviet expeditions to Italy, these visits to professionals alternated with tours of related companies and production facilities. The engineers explored various northern Italian companies, such as PRECEM in Verona (fig. 3), which produced thin curved prestressed concrete slabs, and SACAIM in Venice, which showcased its projects and products. They were shown finished products but not always allowed to view the production process.

This journey revealed a shift in the attitude of Soviet engineers toward Western and Italian building culture. They became more selective, critical, and engaged in challenging discussions. The interactions were no longer superficial, and the information collected was more detailed.

The Soviets increasingly focused on specific problem-solving details. They sought an independent path and practical operational guidelines based on Italian engineering experiences.

In Italy there has been a Standards Commission since 1955, while in USSR since 1957–56. Standards developed in parallel, but in the USSR, being more recent, innovations were integrated earlier. In fact, in 1960 in the USSR semi-probabilistic limit state methods were already used, while in Italy prevailed still allowable stresses and load at failure. USSR regulations were very assertive on construction and design methods, while Italian were less prescriptive, following the different degree of freedom of the engineer's practice. The close comparison of standards resulted in some cases in tests, in which the same designs were designed and calculated according to both Italian and Soviet standards, in order to understand the implications and advantages.

The 1960 travel report concluded with a seventeen-point recommendation list, condensing the Italian engineering experiences into a usable form for the Gosstroi (RGAE f. 339 op. 9 d. 133 l. 56–59).

They deal with construction elements, vaults, beams, cements, asphalts, but also with knowledge: methods of simulation with physical scaled models, calculation methods, books to be translated, firms to visit and people to meet. From the conclusions of the report, we understand the way different research and design institutes in Gosstroi were coordinated. Development of new technologies were assigned to existing laboratories or new ones to be created. Innovation in technologies was encouraged through standards that changed the ways materials were used. For example, it was suggested to forbid steel in small and medium spanned structures, so that engineers and companies would have been forced to learn how to use prestressed concrete: i.e. attempts were made to artificially re-propose those conditions that favored the development of this material technology in Italy.

4. Conclusions

Expeditions in Italy between 1955 and 1962 played a significant role in knowledge exchanges between Soviet and Western engineering, fostering a deeper understanding of Italian engineering practices and inspiring reflection on the future of Soviet construction.

Continual comparisons made during the journeys, between materials, regulations, structural types, production processes, construction techniques, research, draw a map of references for the development of USSR's systems. The Soviets gained experience at international congresses, thoroughly understood the Italian organizational and administrative system, and translated their observations in operational guidelines that could be applied in the Soviet environment. They also discussed with the Italians why prefabrication wasn't developed in Italy. This highlighted the difference of technical-economic conditions and allowed criticism of the Italian capitalist model.

Figure 4. Experimental prefabricated bottom-up concrete shells 40x40 m span, 5 cm thickness. Developed by the LISI laboratories in Leningrad. (Davidov 1958).

At the same time, the comparison with Italian builders underlined the issues of the total prefabrication system, which was taking its final shape in the USSR by the beginning 1960s. With construction industry well underway, many Soviet engineers and architects began to raise questions about the possibility of effective technological advancement and improvement of buildings, and above all, about their architectural quality. The conflict and series of compromises that developed between the seriality of construction and the individuality of designs underlie Soviet architectural dialectic from the beginning of the Khruschev era (1954) to the end of the Soviet economic system in the 1990s.

While prefabrication was the norm for residential and serial construction, mixed or monolithic solutions was sought for as a solution for buildings of special importance, for multiple reasons, among which the fact that they often involved large and medium spans, which were considered uneconomical to factory produce. And it was precisely on these medium to large spans that Italian engineers and architects had found solutions, which garnered admiration among the Soviets and worldwide.

The structural form of prestressed concrete became a building element that carried communicative purposes beyond simple technical requirements. The Soviets' admiration for Italian ingenuity reflected an attempt on the Soviet side to seek a new architectural-constructive concept in which concrete was to become the symbolic material of realized socialism. In a period that came to be called the "golden age" of the search for structural forms, the Soviets wanted to show themselves at the forefront (De Magistris 2013). Following these journeys, research laboratories developed advanced concrete structures (Fig. 4). The publication of updated SNIP regulations in 1962 ended a phase of orientation and research by Soviet engineers and ushered in the grandiose construction season that would lead, in the following decade, to the construction of such symbolic structures as the Kalinin Prospect (now New Arbat), the Kremlin Congress Palace, the Ostankino Tower, and many other achievements, which would define the characters of the relationship between concrete structure and architecture and which would remain unchanged in fundamentals until the early 1990s.

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