THE EVOLUTION OF PREFABRICATED CONSTRUCTION IN UKRAINIAN RESIDENTIAL BUILDINGS: TECHNOLOGICAL INNOVATIONS AND CHALLENGES

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Abstract

Ukrainian housing construction has undergone significant changes, from simple brick buildings to energy-efficient prefabricated buildings. Each period has reflected the needs of society, technological advances and economic conditions. The study provides an overview of the evolution of structural systems in Ukrainian residential buildings. The aim of the paper is to analyse the chronological development of technological, typological and design solutions in housing construction in Ukraine. The discussion will point out the challenges for rehabilitating the perception of the benefits of prefabricated construction and increasing the implementation of industrialized elements in housing construction in the country.

Keywords

Prefabrication, housing, modernization, sustainability, efficiency

1 INTRODUCTION

Ukrainian housing construction has undergone significant changes since the end of the Second World War, from simple brick buildings to energy-efficient structures using a range of industrialised construction methods, the most prominent of which are prefabricated technology and, in the case of housing, mainly prefabricated construction. Each development period has reflected the needs of society, technological progress and economic conditions. While in the post-war period the development of housing construction had common features in all post-socialist countries, at present, in relation to the use of prefabricated housing construction, they are already markedly different. Prefabricated construction in the Ukraine continues to have a prominent position, which is being consolidated in the context of the current war conflict and the need for rapid construction for internally -displaced people as well as the need to rebuild conflict-damaged apartment buildings.

The aim of the study is a chronological analysis of the basic features of technological, structural and typological solutions in housing construction in Ukraine, related to the development of the floor area of the development, the size of apartments, their equipment, as well as the development of industrialized elements used to increase the performance and sustainability of construction.

The study is based on the method of chronological content analysis, primarily employing a qualitative research framework [1], [2], [3]. From the perspective of new research paradigms, the content analysis methodology is built upon the following constitutive components:

A. type of analysed content: text communiques, online scientific and professional articles and contributions
B. research sample: consistent, focused on prefabricated residential construction and sustainability in construction
C. depth of analysis: latent - revealed through the full text content with high cognitive value
D. direction of procedure: inductive – from text to findings and conclusions
E. form of research output: verbal, based on interpretative conclusions

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2 DISSCUSION

The interpretation of the results follows a chronological composition, based on a logical temporal sequence. The length of the interpreted time periods varies depending on the significance of the changes or socio-economic contexts.

The beginnings of prefabricated housing construction in Ukraine (1950–1960)

The mass construction of prefabricated houses in Ukraine began in the 1950s and was related to the need for a quick solution to the post-war housing crisis and also to the country's industrialisation policy, which directed the transfer of the population from the countryside to the cities. The first type of apartment buildings were the so-called Khrushchovka, named after the political leader Nikita Khrushchev and became the basis for the urbanisation of many Ukrainian cities [4]. Conceived as a temporary solution to bridge the housing deficit and provide basic conditions for working-class housing, the Khrushchev Houses were originally planned to last only 25 years, however, many of which are still occupied. In their early days, they were four- to five-storey buildings constructed of brick blocks and later of standardised reinforced concrete panels, with the aim to accelerate and simplify construction (Fig. 1) [5].

The main features of the Khrushchevs were small sizes of the flats, with living areas ranging from 30 to 40 m². Ceilings were only 2.5 metres high, which helped to save building materials and heating costs. The flats were equipped with small kitchens of 5-6 m², which, however, caused problems in the practical use of the space (Fig. 2) [6].

Fig. 1 Khrushchovka series 1-464 built in Kyiv

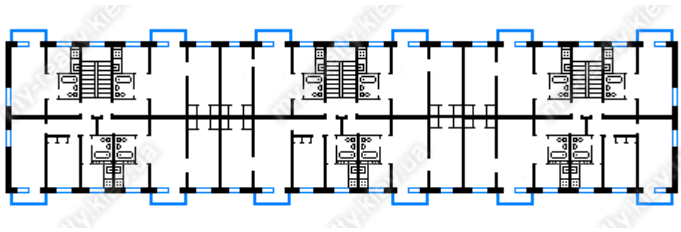

Fig. 2 Typical floor plan of Khrushchovka series 1-464

One of the most significant disadvantages of the Khrushchevs was the absence of elevators and basements, which made everyday life difficult, especially for the elderly and physically challenged residents. In addition, the buildings were characterised by a simple façade design, with an emphasis not on aesthetics but on keeping production costs as low as possible [7]. The construction materials used in the construction of the Khrushchevs varied depending on the period and technological possibilities. While in the 1950s these dwellings were predominantly built of brick, from the 1960s onwards prefabricated reinforced concrete panels began to be increasingly used, which made construction even quicker and cheaper [8].

Panel-built housing of the first generation (1960–1970)

In the 1960s, a gradual modernization of housing construction began in Ukraine, which led to the emergence of the first generation of prefabricated housing. During this period, prefabricated construction technologies improved significantly, allowing for an expansion of building capacity and an increase in the quality of housing compared to the older Khrushchevs. The result was the introduction of new five-storey prefabricated buildings, which nevertheless retained economic efficiency and standardised design. These apartment buildings were built according to standardized series, the most common being the 1-60 (Fig. 3), 2-60, and 3-60 models. Each of these series had slightly improved layouts, taking into account the needs of the growing urban population [9].

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Fig. 3 Khrushchovka series 1-60

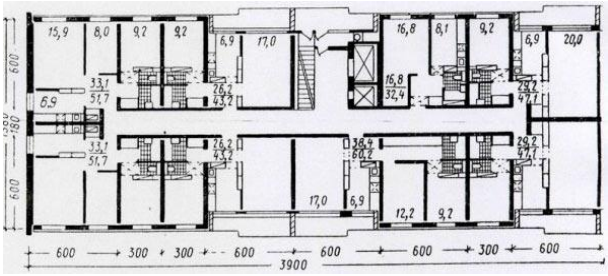

Fig. 4 Typical floor plan of Khrushchovka series 1-60

The new generation of prefabricated housing had a better interior layout (Fig. 4), while the flats were larger than in the previous Khrushchevs. The layouts included separate rooms and, in some cases, corridors, which provided more privacy and increased the comfort of living. The addition of balconies or loggias improved interior lighting and provided additional usable space. Significant improvements over previous Khrushchev designs were the larger size of the apartments and more light in the interiors due to larger windows and better oriented layouts. Although relatively small kitchens and low ceilings remained, this was a more efficient arrangement of space. Nevertheless, the buildings retained low construction costs because they still used precast reinforced concrete panels. One of the key improvements in this generation of prefabricated houses was better thermal and acoustic insulation. Although they still suffered from a lack of energy efficiency, developments in building materials allowed a slight reduction in heat loss compared to the older Khrushchevs [6].

High-rise prefabricated buildings (1970 – 1980)

In the 1970s and 1980s, Ukrainian cities experienced a significant increase in population, which created an intense demand for housing. In contrast to the five-story prefabricated buildings of the first generation, taller buildings, usually with nine to sixteen stories, began to be constructed, making more efficient use of available urban land (Fig. 5).

Fig. 5 Residential building of series K-16

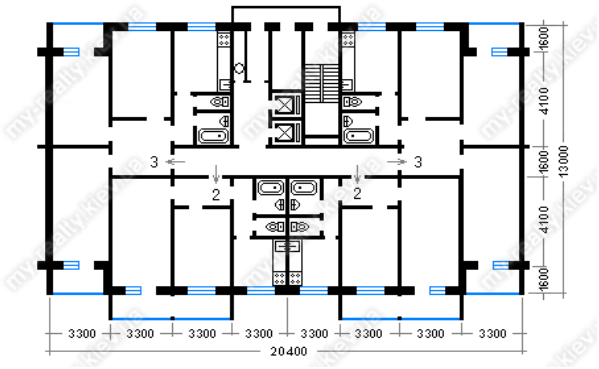

Fig. 6 Typical floor plan of residential building series K-16

This type of construction was a direct response to the need for denser urbanisation and the standardisation of building practices, with new high-rise buildings being constructed in large residential districts in the suburbs of major cities such as Kiev, Kharkiv, Dnipro, Odessa and Lviv. New prefabricated technologies allowed for improved thermal and acoustic insulation, making these buildings a more attractive alternative to older prefabricated buildings [10]. The most significant innovation of this period was the introduction of elevators, which allowed the construction of buildings higher than five storeys. Previous prefabricated buildings limited the height to a maximum of five storeys because the technical infrastructure for installing lifts was lacking. The new

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generation of high-rise prefabricated buildings already eliminated this deficiency, which significantly increased the comfort of living. Another major change was the improvement of the layout of the flats. Compared to previous models, which often used small kitchens and compact rooms, the new high-rise prefabricated buildings offered more spacious apartments with better-organised layouts. The flats contained between 1 and 4 rooms, in some cases with larger kitchens and spacious loggias (Fig. 6) [11].

In this period, ceramic concrete panels began to be used en masse for construction, which improved the thermal insulation of buildings. This material was lighter than conventional concrete, but at the same time had better insulating properties, contributing to greater occupant comfort and lower energy losses.

Modernized panel-built housing (1980–2000)

The 1980s and 1990s saw significant changes in housing construction in Ukraine. These developments were driven by technological advances, increasing demands for housing quality and the need for more efficient use of urban space. Compared to the older prefabricated houses of the previous decades, the new generation was characterised by better thermal insulation, more spacious apartments and more modern technical solutions [12].

A major innovation was the introduction of a series characterised by improved thermal insulation properties and higher quality building materials. In addition, these buildings were often equipped with multiple lifts, allowing more convenient access to higher floors, as well as more modern energy and water distribution systems, which increased the overall comfort of the occupants.

This new generation of prefabricated buildings reached heights of up to 22 storeys and therefore had two to four lifts, which increased comfort and better accessibility to individual flats (Fig. 7). The apartments in these buildings had more spacious kitchens, better oriented living rooms and larger loggias or balconies. The buildings were fitted with new water, gas and electricalsystems, which improved the safety and reliability of the infrastructure (Fig. 8). The use of newer prefabricated systems made it possible to reduce energy losses, making housing more economical [6]. Compared to the older monotonous prefabricated houses, the new buildings had more interesting facades in terms of colour and materials, which blended in better with the urban environment [5].

Fig. 7 Residential building of series T-25

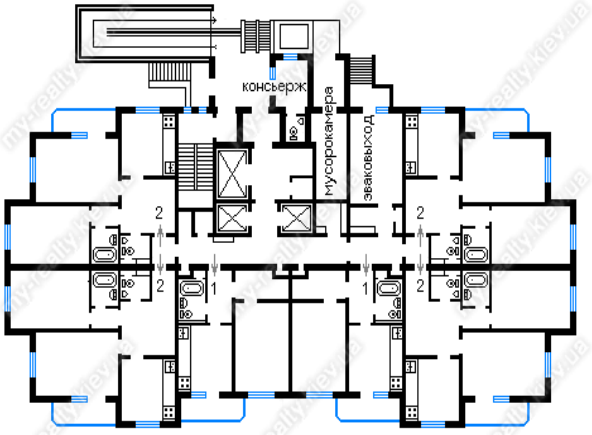

Fig. 8 Typical floor plan of residential building series K-16

In the period 1980–2000 there was a shift in housing construction from quantity to quality. While previous generations of prefabricated buildings focused on speed and mass construction, the new generation focused more on comfort and long-term sustainability. These prefabricated houses better adapted to the needs of growing cities, making more efficient use of available space and improving the living conditions of residents. Today, this generation of buildings makes up a significant part of the housing stock in Ukraine, many of which still meet current requirements or have been retrofitted to improve energy efficiency [10].

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Residential construction in the new millennium (after the year 2000)

After 2000, Ukrainian housing construction has undergone significant changes, influenced by technological advances, demands for greater comfort and a growing emphasis on energy efficiency. While previous generations of prefabricated houses focused mainly on speed and cost-effectiveness, new projects emphasised the quality of building materials, architectural diversity and ecological solutions. During this period, reinforced concrete monolithic skeleton structures began to be used, enabling the construction of taller and more spacious apartment complexes. At the same time, prefabricated panels began to be combined with traditional construction methods, creating hybrid construction models that combined the speed of prefabrication with the durability of monolithic buildings [7].

Today's apartment buildings use advanced building technologies that allow for better energy efficiency, greater comfort and flexibility in layout solutions. The new residential complexes are significantly taller than their predecessors, with 22-25 storeys, allowing for a more efficient use of urban space. The modern apartments have larger windows, high ceilings and flexible layouts. Hybrid construction technology combines the strength of reinforced concrete structures with the speed of precast panels, improving the durability of the buildings and allowing for greater interior variability. Buildings are better insulated, reducing energy consumption for heating and cooling. The use of solar panels, green roofs and modern heating systems allows for a reduced ecological footprint. The growing popularity of smart home systems makes it possible to optimise energy consumption, regulate temperature and lighting with automated systems

One of the most commonly used approaches in modern housing construction in Ukraine is the combination of prefabricated panels with reinforced concrete monolithic construction. Hybrid technology is widely used, especially in the construction of high-rise residential complexes. The main principle of this technology is the division of the building elements into two main parts (i) monolithic reinforced concrete core, which ensures the strength and stability of the whole structure, thus enabling the construction of taller buildings and increasing their seismic resistance, and (ii) prefabricated panels for walls and partitions, which ensure rapid assembly and allow standardization of construction, thus significantly reducing the time required for the completion of the construction [10]. In recent years, this technology has been increasingly used in the construction of modern residential complexes in cities such as Kiev, Kharkiv, Odessa and Lviv. Well-known projects that have used a combination of prefabrication and monolithic construction include, for example, "Art Park", "Vudstoria Residential Complex" in Kiev [7].

The combination of monolithic reinforced concrete structures with prefabricated façade panels is increasingly used in contemporary housing construction in Ukraine. The use of prefabricated façade panels has been particularly successful in high-rise residential complexes, where it is necessary to ensure quick project implementation, and at the same time achieve high quality finishes.

Prefabricated façade panels are products made of expanded clay concrete or other modern materials, which are manufactured in factories and then assembled onto the load-bearing monolithic structure of the building. This type of hybrid construction allows for aesthetic variability. Prefabricated façades can be adapted into a variety of designs, including colour variations, textures and textured surfaces. These features make prefabricated façade panels an ideal solution for modern residential complexes where functionality, efficiency and visual appeal need to be combined. In recent years, this technology has become widespread in many urban projects in Ukraine [10]. Among the most notable are the "Revutskyi Residential Complex", "Navigator 2 Residential Complex", "British Quarter Residential Complex" in Kiev.

In the current construction practice in Ukraine, modular construction is increasingly applied, which enables to accelerate the process of building construction and to optimize construction costs. One of the most advanced solutions in this regard is the use of prefabricated modular cores, which are manufactured in factories and then integrated directly into the building. This system brings significant time savings and reduces the risk of construction errors, as the modules are manufactured under controlled factory conditions [13]. Thanks to the automated production process, the risk of poor-quality construction details is reduced.

Modular cores are self-contained construction units that contain complete installations, including wiring, plumbing, ventilation and heating. These factors make modular prefabricated core systems one of the most promising technologies in modern housing construction [7]. In recent years, this concept has been applied in several major projects "Navigator 2 Residential Complex" in Kiev, "Lviv Tech City" in Lviv.

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3 CONCLUSION

Chronological analysis of the basic development features of technological, structural and typological solutions in housing construction in Ukraine confirms the close interconnection of social needs and economic contexts, which influence not only the technological and structural solutions, but also the architectural and typological solutions of apartment buildings.

The above examples of the integration of prefabricated elements into apartment building design, confirm the generally established advantages of prefabricated construction, which include not only the speed of construction, but also its efficiency. These can only be achieved via wider active use, which can be associated with mass production. The experience from Ukraine confirms that even in the case of mass production of prefabricated parts of the building, their final integration in the building itself or even in large complexes of apartment buildings does not have to lead and does not lead to uniformity, which is even nowadays, especially in Slovakia, considered to be a fundamental deficiency of prefabricated construction.

The approach to the height of apartment buildings in Ukraine also offers a crucial insight. Although it is a much larger country in terms of land area than, for example, Slovakia, even with larger cities in terms of population, all large-scale housing complexes are characterised by building heights above 20 storeys, which naturally also contributes to optimising not only the procurement but also the operating costs of construction projects and their subsequent marketability. Prefabrication can naturally adapt to these socio-economic requirements, which also dispels another myth about prefabricated construction, which is the lack of flexibility. Returning to the height of apartment buildings in Slovakia, with the exception of Bratislava, and even there only in a few exceptions, apartment buildings in Slovakia are experiencing a completely opposite development trend. New apartment buildings with 5–7 storeys are not only lower than the tallest 12-storey prefabricated houses built in Slovakia before 1989, but we are also returning to the development stage of the 50-60s of the last century. One has to wonder whether for a country as small as Slovakia, but with so many problems of housing unaffordability, this is the right way to go when the zoning plans themselves create such an unnatural barrier that contributes to 'unsustainability' rather than the opposite of this global trend.

Particularly noteworthy is the use of the advantages of hybrid constructions, which are built on the principles of combining modern construction methods and take full advantage of the potential of industrialized elements and processes that reduce the laboriousness of construction procedures and thus increase the efficiency of the construction project. The combination of reinforced concrete monolithic skeleton structures or monolithic core structures with prefabricated panel or even modular prefabricated elements makes it possible to increase not only the productivity of construction but also the aforementioned building height.

It should also be noted that with the prefabrication of structural elements (walls, ceilings, façade elements) or modules (kitchen or bathroom), another added value of prefabrication is the possibility of varying the level of completion of the prefabricated element. The plumbing, finishes or even the complete furnishing in the case of modules, which are already built in at the factory, significantly reduce the workload even in the finishing phase and increase the overall productivity of the construction.

Using the example of the development of housing construction technologies in Ukraine, the above findings and recommendations confirm the advantages of prefabricated construction and its potential to continue to reflect the global challenges in the construction industry, associated with the need to adopt productivity-enhancing approaches while taking into account the principles of sustainability.

The presented chronological analysis of the development of prefabricated housing construction in Ukraine confirms that housing construction at different stages of its development was adapting to technological possibilities, economic conditions and urbanisation trends, while prefabrication has been and remains an important element of housing policy.

Significant changes have been reflected in the design solutions of apartment buildings, where there has been a gradual shift from the original five-storey panel structures with small spatial proportions of flats, to high-rise apartment blocks with a complex typological and structural structure covering the current requirements for housing quality, including energy efficiency requirements. Since the 1970s, high-rise prefabricated buildings with 9 to 16 storeys up to the current 22 storeys have been introduced. They urbanise urban environments more efficiently, increase productivity, and optimise construction costs.

In recent decades, modern industrial technologies, such as hybrid systems using modular construction or prefabricated facades, have been integrated into prefabricated construction. The current industrial technologies

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reduce costs, shorten construction time and improve the energy efficiency of buildings. Such innovations show that prefabrication can be successfully adapted to today's demands for sustainability and efficiency.

Further research will focus on the analysis of the factors of increasing the productivity and efficiency of construction through different prefabrication structures in connection with statistical indicators of the development of the number of residential buildings in Ukraine and in Central European countries. Quantitative methods will be used to investigate long-term trends in the impact of prefabrication on the state of housing infrastructure. The results of the analysis will provide a valuable piece of knowledge for urban planning and optimization of housing construction in countries that don't use its potential despite long experience with this type of construction.

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References

[1] DEVI N.B. Understanding the qualitative and quantitative methods in the context of content analysis. QQML 2009: Qualitative nad Quantitative Methods in Libraries, International Conference, Chania Crete Greece, 26-29 May 2009 [online]. [Accessed 25/03/2025]. Available at: https://www.academia.edu/1346968/UNDERSTANDING_THE_QUALITATIVE_AND_QUANTATITIVE_METHODS_IN_THE_CONTEXT_OF_CONTENT_ANALYSIS

[2] FORMAN J., DAMSCHRODER, L. Qualitative Content Analysis. In: Jacoby, L. and Siminoff, L.A. (Ed.) Empirical Methods for Bioethics: A Primer (Advances in Bioethics, Vol. 11), Emerald Group Publishing Limited, Leeds, pp. 39-62, 2007. [online]. [Accessed 25/03/2025]. Available at: https://doi.org/10.1016/S1479-3709(07)11003-7

[3] MAYRING, P. Qualitative content analysis: theoretical foundation, basic procedures and software solution. 2014, 143 p. [online]. [Accessed 25/03/2025]. Available at: https://nbn-resolving.org/urn:nbn:de:0168-ssoar-395173

[4] SHEVCHENKO L. Soviet Residential Architecture: History and Future Perspectives. In: commons.com.ua [online]. Kiev: 25/06/2018 [Accessed 01/02/2025]. Available at: https://commons.com.ua/uk/sovetskoe-zhilyo-istoriya-proshloe-perspektivy/

[5] PYVOVAROV S. 67 years ago, the Khrushchevs became the standard of residential architecture. In: babel.ua ua [online]. Kiev: 31/07/2024 [Accessed 01/02/2025]. Available at: https://babel.ua/texts/67010-64-roki-tomu-hrushchovki-stali-etalonom-zhitlovoji-arhitekturi-jih-zvodili-timchasovo-do-nastannya-komunizmu-vin-ne-nastav-srsr-rozvalivsya-a-hrushchovki-zalishilisya-yak-ce-bulo-v-arhivnih-foto-kiyev

[6] SHEPELEV, Aleksandr, Galina SEVEROVA, Alexander KOLOSV, Alexander BAHMETEV, and Tamara NAREZHNAYA. Organisational and technological design improvement of reconstruction of large-paneled residential buildings of the first mass series. [online]. December 2023 E3S Web of Conferences 458, 07032 EMMFT-2023 [Accessed 15/02/2025]. Available at: https://doi.org/10.1051/e3sconf/202345807032

[7] AMIRBEKOVA, Aidana, Sholpan ABDYKARIMOVA, Olena OLIYNYK. Renovation of Residential Buildings of the First Mass Series from A Sustainable Development Point of View. Automatica [online]. May 2023 Civil Engineering and Architecture 11(4):1814-1823 [Accessed 01/02/2025]. Available at: http://www.hrpub.org

[8] KORIAHA P. I. Kyiv metro as a factor in shaping the cultural landscape of aLarge ukrainian city in the soviet period. Automatica [online]. Jun 2014 УДК [911.31:625.42] (477.-25) «1919/1991» [Accessed 25/01/2025]. ISSN 2410-3071. Available at: https://doi.org/10.32837/apfs.v0i32.1026

[9] APATENKO, Tatiana, Olena BEZLYUBCHENKO, Oleksandr ZAVALNIY. Energy Modernization of Residential Buildings as a Challenge of the Present. [online]. Scientific Journal «ScienceRise» №12(53)2018 [Accessed 01/02/2025]. Available at: https://api.semanticscholar.org/CorpusID:127810601

[10] KONYK, Solomiia. Densification of Development in Historically Formed Urban Areas (Case Study of Lviv).[online]. Lvov 2021. [Accessed 01/03/2025]. Dissertation . Lviv Polytechnic National University Available at: https://lpnu.ua/sites/default/files/2021/radaphd/14415/disertaciya-na-zdobuttya-naukovogo-stupenya-doktora-filosofii-2.pdf

[11] ZAKHAROV, Y.I, SANKOV, PM, TRIFONOV, IV, TKACH, NO, TOSHYNA, Lo. The Content and Specific Features of Reconstructing the Residential Houses of Various Configurations. [online]. Nauka innov., 2019, 15(3), 81—93 [Accessed 19/02/2025] ISSN 1815-2066. Available at: https://doi.org/10.15407/scin15.03.081

[12] YERMAKOVA-FERUZ, Mila. Prefabricated in Ukraine: structure, features and prospects of Ukrainian construction prefab In: pragmatika.media.ua [online]. Housing for IDPS 22/05/2023 [Accessed 01/02/2025]. Available at: https://pragmatika.media/en/zhytlo-dl-vpo-prefabricated-in-ukraine-struktura-osoblyvosti-ta-perspektyvy-ukrainskoho-budivelnoho-prefabu/
[13] ZADOROZHNIKOVA I., KISLYUK D., CHAPYUK O., PARFENTIEVA I., PAKHOLYUK O. Modern Building Materials, Structures, and Modular Construction Technologies. Scientia [online]. 29 May 2024; 201-4. [Accessed 01/02/2025] Available at: https://previous.scientia.report/index.php/archive/article/view/1842

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