

## Efficiency factors in the design and construction of residential and civil buildings

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*Abstract. The article discusses the principles of design and construction of residential multi-storey buildings. The development of the construction industry based on the typification and unification of construction products, the reasons and methods leading to the improvement of various indicators of the construction process are considered: from accelerating the construction process, to a variety of variations that allow you to make standard elements of buildings. The article presents the classification of systems and production of building products, the evolution and reasons for their changes, the application and development of innovative technologies and materials that provide a new approach to the construction of buildings based on high economic indicators of reducing the cost of building residential buildings, and at the same time, improving its quality and comfort.*

*Keywords: Housing construction, typification and unification, efficiency of construction processes.*

The development of construction and design of residential buildings looks very simple - a cave, a hut, a house: wooden, stone, low-rise, high-rise, skyscraper, etc. Understanding the evolution of this development, one can note the unprecedented growth of new technologies, materials, constructive, space-planning and functional solutions in housing construction. Kazakhstan is rapidly developing housing construction, already in 2021 it is planned to build 17 million m<sup>2</sup> of housing. [1]

One of the objectives of this article was to analyze the formation of the housing industry in the Republic of Kazakhstan. The table systematizes the stages of the formation of the volume of housing construction and the factors affecting the effectiveness of this process. For the convenience of visual analysis, consider it in table 1.

Table 1 - Efficiency factors of construction production in various countries from 60 to 2000

<b>Period</b>	<b>Factors contributing to increased growth in housing construction</b>	<b>Innovation and materials</b>	<b>Characteristic signs of changes</b>
60s	Construction industry, a developed network of design and scientific organizations Full prefabricated and large-panel housing construction	Typical projects. Reducing the weight of building structures	Reducing construction time by 30-40%, reducing the cost of 1 m <sup>2</sup> of living space by 10-15%.
1961-1965	Technologies of factory production of parts and structures	Use of cassette and vibro-rolling technology	Typical projects of large-panel residential buildings of the second

			generation. Overcoming monotony and monotony.
1966-1970	Transfer of mass housing construction to the construction of multi-storey residential buildings from unified products of the unified Catalog	Modernization of reinforced concrete structures; transition from large-block to panel construction.	Convenience is increasing, engineering equipment is being improved
1970-1975	The design methodology was improved, its variant capabilities were checked	Standard designs of multi-storey large-panel houses of the third generation have been created from the products of the unified Catalog, produced by house-building factories.	
1975-1990	Complex ensemble urban development, increasing comfort and operational parameters of apartments and buildings	High manufacturing accuracy and excellent quality of products manufactured on vibro-rolling mills, more advanced assembly equipment and construction assembly technology	Use of loggias

The created production base and the extensive experience accumulated by the end of the sixties in the mass construction of large-panel residential buildings made it possible to conduct a comprehensive assessment of the achievements and shortcomings of modern housing construction.

On the basis of this analysis, a methodology for standardization and typification of industrial housing construction was developed, which allows to ensure a significant improvement in the quality of building in city blocks; effectively organize factory and construction production, as well as improve the operational and technical and economic indicators of facilities under construction. [4]

Scientific and methodological conferences of the 60s provided a large amount of material, which became the basis for the design and construction of residential and civil buildings on the basis of a single Catalog. A system of unified industrial buildings was formed.

The catalog is a systematized list (nomenclature) of building parts and equipment items, architectural and planning, technical and design parameters and solutions, on the basis of which designers have the opportunity to create projects of buildings of various storeys and architectural design from standardized elements with an optimal number of standard sizes and brands of products. spatial composition, taking into account the dynamics of the development of requirements for mass housing.

Enterprises adapted production to the range of products envisaged by the project, as a result of which they produced sets of parts and structures that did not differ much from each other, the nomenclature of products increased significantly, and the buildings themselves, in essence, did not differ from each other.

In these conditions, the creation of a unified range of building elements and parts made it possible to determine the following industry prospects:

- provide a clear order in the design,
- organize a planning process in industrial production and construction
- to determine the technical orientation of mass housing construction for the coming years and the future.

- to determine the choice of economically sound architectural and technical solutions, structural, units and schemes of residential buildings, which determine the reliability, efficiency and labor intensity of buildings.
- the minimum possible labor intensity at the plant and construction site.

The experience in the construction of large-panel buildings of increased number of storeys has shown the effectiveness of the constructive system of residential buildings with a narrow pitch of transverse load-bearing internal walls. [6] This system provides:

- general rigidity and stability of buildings,
- lower consumption of steel, concrete, cement per 1 m<sup>2</sup> of total area compared to other structural systems.

That is why for the mass construction of residential buildings from unified products of the unified Catalog, a pitch of internal transverse load-bearing walls of 3.6 m was adopted, which, in combination with a three-meter pitch and room-sized ceilings, makes it possible to erect buildings of various architectural and layout solutions with expressive facades, with different layouts and a set of apartments and to achieve low total (factory and construction) labor costs, as well as to use technological equipment proven by long-term practice.

In all projects of residential buildings with a height of 9, 12, 16 and 22 floors, created on the basis of a single Catalog, an improved layout of apartments is provided:

- increased areas of residential and utility rooms,
- the dimensions of the sanitary facilities were increased.
- the arrangement of living quarters and ancillary premises is made taking into account the requirements of the household regime of families.
- reserved places for the installation of sectional kitchen equipment and cabinets at the request of the new settlers.
- apartment types are duplicated, i.e. an apartment with the same number of rooms can have different living and usable area.
- well thought out conditions for study, rest, more amenities that facilitate housekeeping

The residential buildings designed and built according to the unified Catalog were distinguished by significantly higher urban planning, architectural planning and technical and economic properties in comparison with the previously used series of houses. [4]

The unified products of the unified Catalog ensured: while maintaining the necessary stability of the construction industry enterprises and with the effective use of technological equipment and tooling, a variety of residential buildings, the replacement of some types of buildings with others. Nowadays, the technological process of factory production of parts and structures should be such that it would be possible to produce not a narrow, constant range of products for a long time, but rather quickly and efficiently be reorganized for the production of new products. This restructuring was carried out on the basis of a wide standardization of products. This made it possible to build up residential quarters with a variety of beautiful and comfortable buildings and ensure the manufacturability of constructions.

The object of typing was not the house, but the industrial products themselves. The previous design-to-product principle is being replaced by a new product-to-design principle, resulting in increased cost-effectiveness.

The second important step in increasing the efficiency of construction was the tendency of successive enlargement of the used prefabricated parts and structures, external wall panels - by two spans, floors - per room, floors of loggias and staircases - by two constructive steps. The volumetric-monolithic structures of balconies, articulated in the conditions of the plant with external wall panels, were also tested. An analysis of the development of the construction industry in European countries showed that it had a number of specific features that were fundamentally different both from the socialist system and from each other. [5]

The competitive struggle of numerous construction and machine-building firms, financing of construction by private customers, a large proportion of individual construction - these and other

factors contributed to the fact that many of the methods used in construction practice are characteristic only for the territorial conditions of these countries. At the same time, foreign experience makes it possible to note a number of technical solutions that were of certain interest for domestic construction.

We have proposed our own classification of these innovations:

- monolithic reinforced concrete structures,
- erection of buildings and structures using prefabricated elements,
- widespread use of metal.
- the use of mixed designs.
- erection of pure metal frames with prefabricated or monolithic floors.
- fabrication of prefabricated structures directly at the construction site.
- use of lightweight concrete with pumice aggregate, shale rocks with a bulk density of 1700-1800 kgf/m<sup>2</sup>. This has significantly reduced not only the weight, but the cost of the products.
- the use of panels with a wooden and combined frame

Both in Europe and in the USA they are also striving for maximum unification and, in accordance with production requirements, they use grids of columns 6x6 m and 9x9 m, and the height of the floors - in accordance with production requirements. Experts from foreign countries attached great importance to typification and unification for the development of industrialization of construction and for reducing its cost.

For the construction of buildings in monolithic reinforced concrete in foreign construction, modern and advanced instrumental methods of work are used. The manufacture of inventory formwork, reinforcing cages and nets is carried out at specialized highly mechanized enterprises. Parts in wooden formwork systems are not connected with nails, but with high-strength adhesives or dowels, pressed in with automatic machines.

The development of building materials is also interesting in the development of the construction industry in the 60-90s. Innovation and research in the field of economically sound solutions lead Western countries to discoveries in this area. The example of formwork processing in various European countries gives a clear idea of the breadth of the approach to this problem. (table 2)

Table 2 International experience

<b>№</b>	<b>Country</b>	<b>Product</b>	<b>Processing methods</b>
	Scandinavian countries, England and the USA	Formwork	Waterproof plywood or wood board based on epoxy resin
	England and FRG		Wooden formwork covered with synthetic varnishes and films to protect against moisture
	USA		To protect the formwork, a nylon and Relin coating is used.
	Germany		Steel and aluminum from stamped and bent profiles, metal sectional formwork
	Russia		Trough-shaped shields with one or more stiffeners for welding
	2000's USA		Formwork made of plastic, and in some cases - "dead" or "permanent" formwork in the form of cladding panels made of waterproof cardboard
<p><b>Conclusion:</b> The use of the presented formwork technologies allows work at different external temperatures, the labor productivity of the formworkers increases by 3-5 times, the prevailing wear resistance. The level of organization and technology for performing concrete, reinforcement and formwork works in foreign countries provides structures made of monolithic reinforced concrete with good technical and economic indicators.</p>			

The development of the construction industry involves the development not only in the field of unification and typification of construction industries to increase the efficiency and speed of construction of various objects, but also in the field of innovative technologies and materials, the development of construction machinery and equipment, all together this should ensure the safety and reliability of not only individual structures, but the entire building as a whole.

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