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Using the prestressing method in the construction of buildings and structures from monolithic reinforced concrete

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Abstract. The article deals with the application and development prospects of the method of prestressing reinforced concrete in the construction of buildings and structures for various purposes. Structures made of concrete reinforced with artificially stressed iron are called prestressed. The prestressing method was first developed in the second half of the 20th century by Soviet scientists and became widespread in the construction industry. The main method of tensioning the reinforcement used in the USSR was the electrochemical method of tensioning the reinforcement. After the collapse of the country, the use of the electrochemical method of tensioning the reinforcement had to be abandoned due to the sharp rise in the cost of electricity. The most common method of tensioning reinforcement at present is the mechanical method, in which the concrete is compressed by pre-tensioning the reinforcement laid in the formwork, which tends to return to its original dimensions after the tensioners are removed. The use of the method of prestressing reinforcement in the construction of buildings and structures made of monolithic reinforced concrete can significantly reduce the labor intensity, energy consumption, material consumption of construction production while maintaining the high strength of structures. The prestressing method prevents the formation of cracks in the area of concrete under tension. In addition to a tangible economic effect, the use of prestressing technology can significantly increase the set of architectural and planning solutions in the design of buildings and structures by increasing the length of spans between supporting structures up to 18 m, the ability to create contours of various shapes and horizontal surfaces.

Keywords: reinforced concrete, prestressing, electrochemical tensioning of reinforcement, mechanical tensioning, strength, compression.

Today, there is a tendency towards an increase in the share of monolithic structures in the volume of construction work performed. World construction practice demonstrates that at present it is monolithic construction that is promising in terms of reliability and durability.

Unfortunately, monolithic construction also has disadvantages associated with the use of obsolete methods of building construction, incorrect design decisions and low qualifications of construction workers and line personnel, etc.

Some of the above-mentioned disadvantages of monolithic construction can be eliminated through the use of innovative methods for the construction of buildings and structures designed for the use of prestressed elements.

Reinforcement with iron prevented the destruction of concrete in the event of tensile loads, while the crack resistance of the material still did not reach high values. The crack resistance of reinforced concrete can be increased by prestressing the material at the construction stage, as a result of which the direction of the stress arising in the concrete is opposite to the stress from the load resulting from the load.

Structures made of concrete reinforced with prestressed iron have less sagging and increased resistance to cracking compared to non-stressed ones. This makes it possible to mount building structures with large spans with an equal cross-section of the horizontal beams.

The method of prestressing reinforced concrete was widely used in the second half of the 20th century in the USSR. The country's scientists have developed design methods and technologies for the construction of prestressed reinforced concrete structures. [1]

The annual volume of construction of reinforced concrete structures using the prestressing method was about 30 million cubic meters. m. Widespread in the last century, the method of prestressing reinforcement was the method of electrothermal method.

The destruction of the USSR led to the interruption of the process of widespread use of prestressed reinforced concrete, the volume of construction of structures of this kind decreased tenfold due to the rise in the cost of electricity, which made the use of the electrothermal method of stressing reinforcement unprofitable from an economic point of view.

In modern conditions, the use can find a mechanical prestressing method, the use of which is possible in the production of both prefabricated and monolithic reinforced concrete buildings and structures. When using the mechanical method of creating stress, the concrete is compressed by pre-tensioning the reinforcement embedded in the formwork, which tends to take its original dimensions after the tensioning devices are removed.

For the production of prestressed reinforced concrete, reinforcement with increased strength is used.

The prestressing of concrete delays the time of cracking, reduces the width of cracks, and increases the service life of building structures.

The use of prestressed reinforced concrete makes it possible to reduce the total weight by about 40 percent and the cost of buildings and structures by 30 percent while maintaining the high reliability of building structures.

In addition to the tangible economic effect, the use of prestressing technology can significantly increase the set of architectural and planning solutions in the design of buildings and structures in connection with the possibility of increasing the size of spans between the bearing elements and the possibility of creating contours of various shapes. [2]

Today the technology is used in the construction of residential and office buildings, industrial facilities, highways and runways in Moscow, St. Petersburg, Yaroslavl, Voronezh, Saratov.

Comparison of the results of evaluating construction indicators using conventional reinforced concrete and prestressed reinforced concrete allows us to make an unambiguous conclusion about the economic efficiency of using the latter (fig. 1).

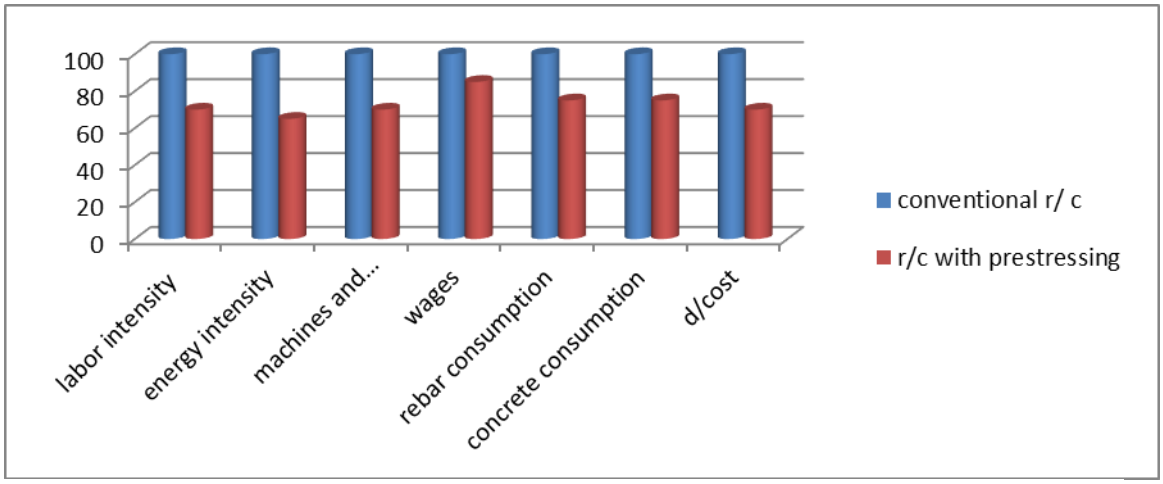

Fig. 1. Comparison of the results of assessing construction indicators using conventional monolithic reinforced concrete and prestressed monolithic reinforced concrete

Table 1 shows data confirming the economic feasibility of using structures made of prestressed reinforced concrete. The indicators were obtained by analyzing the data of design estimates. [3]

Table 1 - Values of indicators of the resource intensity of construction, per 1 square meter of floor area of monolithic reinforced concrete

Indicator	**Project**	**Purpose of the structure**		
		Apartment	**Business**	**Shopping**

		building [1]	center	center [3]
Rebar consumption	Without prestressing reinforcement and concrete	0.034 tons	0.040 tons	0.051 tons
	With prestressing reinforcement and concrete	0.016 tons	0.019 tons	0.021 tons
Concrete consumption	Without prestressing reinforcement and concrete	0.25 m^3	0.25 m^3	0.35 m^3
	With prestressing reinforcement and concrete	0.23 m^3	0.22 m^3	0.25 m^3
Labor intensity	Without prestressing reinforcement and concrete	2.5 man-hours	2.7 man-hours	3.2 man-hours
	With prestressing reinforcement and concrete	2.5 man-hours	2.3 man-hours	2.4 man-hours
Energy intensity	Without prestressing reinforcement and concrete	5300 Wh	5500 Wh	7100 Wh

Thus, significant savings in resources are evident in the construction of all categories of buildings in the case of using prestressed monolithic reinforced concrete. The use of prestressed monolithic reinforced concrete is justified from both constructive and economic points of view.

Along with saving resources, the construction of buildings and structures using prestressed structural elements can significantly increase architectural and planning solutions.

Today, the technology of prestressing reinforced concrete is used in the construction of various kinds of buildings and structures in cities such as Veliky Novgorod, Voronezh, Saratov, Yaroslavl, however, it is necessary to spread the technology of prestressed reinforced concrete throughout the territory of the RF.

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