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TECHNICAL AND ECONOMIC COMPARISON OF THE EFFICIENCY OF PRODUCTION OF EMPTY PLATES OF OVERLAPPING OF UNDERWORKING FORMING WHEN REINFORCED WITH WIRE AND ROPES

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Abstract:
The article is devoted to one of the most promising technologies for the formwork molding of reinforced concrete products. The article presents the results of a technical and economic comparison of the production efficiency of hollow-core floor slabs without formwork when reinforced with wire and ropes.

Keywords: Concrete, Reinforced Concrete Products, Formwork, Wire, Rope, Hollow Core Slabs, Production Efficiency Analysis.

In the world, the demand for the construction of buildings and structures using precast concrete products is growing rapidly. This method allows not only to minimize the specific consumption of concrete and metal, but also to significantly increase the pace of construction. Currently, high-rise buildings are mainly erected from precast concrete. For example, in the PRC in the Hunan province, prefabricated reinforced concrete was erected in 2018

5-star hotel with 30 floors in 15 days. In the future, the authorities of the PRC are planning to implement in Changsha, by the Broad Sustainable Development company, the tallest (838 m) building in the world with 220 floors [1-4].

In Uzbekistan, this world experience has not yet been properly developed. In our country, in recent years, the construction of multi-storey buildings in a monolithic design prevails. This technology, with certain positive properties, does not significantly reduce the consumption of concrete and metal, reduce the construction time and make it affordable [5, 6].

In the republic, the main part of the precast concrete factories continues to work according to the outdated costly technology for the manufacture of products and structures by molding mobile concrete mixtures in wrapped steel molds with subsequent heat treatment of products. As a result, the manufactured products have a high cost due to the increased specific consumption of cement and metal by 15-20%. Also, the unit cost increases due to significant wear and tear of expensive board equipment [7, 8].

In order to eliminate such shortcomings, many enterprises for the production of precast concrete in our country have begun the transition to a non-formwork technology for the continuous molding of reinforced concrete structures and products on long benches, which allows not only to reduce the cost of production, but also to reduce the consumption of steel and binder, as well as to increase the production culture.

The main essence of the technology is that products are molded on a heated metal floor and reinforced with pre-stressed wire or strands (ropes). It should be noted that the main criterion for determining the cost and size of products is the choice of a reinforcing element.

This article presents the results of a technical and economic comparison of the production efficiency of hollow-core floor slabs without formwork when reinforced with only wire and in a combination of ropes + wire.

Widespread use for reinforcement only with ropes is constrained by the limitations of the length of the product (Fig. 1), which can reach a maximum of 7 meters. Further increase in the length of the rope is not effective, due to the impossibility of creating the required force for pre-tensioning the reinforcement. In addition, when a rope is used as a reinforcing element, the metal consumption of the product increases, and ultimately its cost and weight increase.

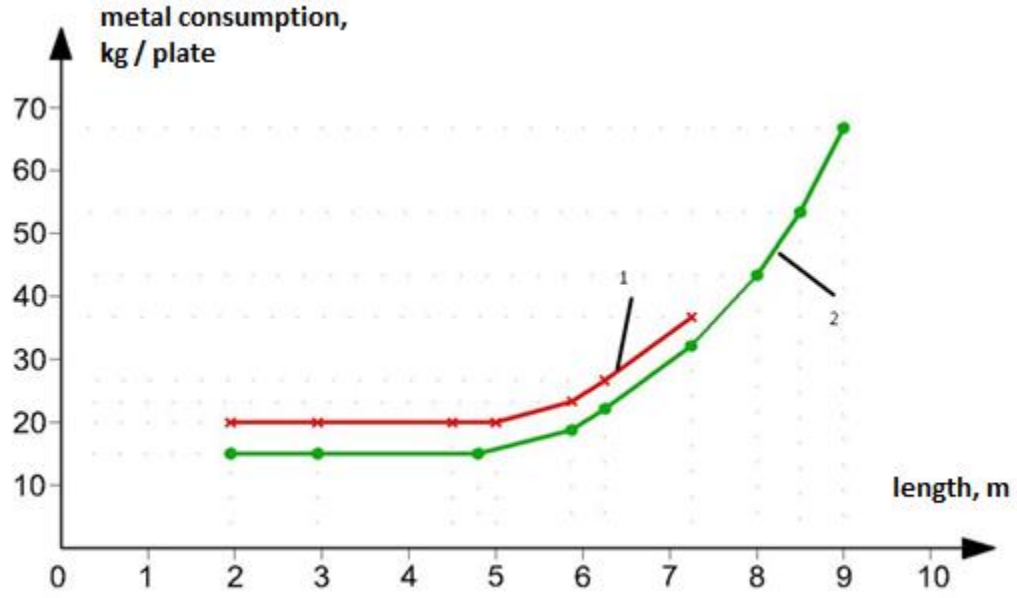

Figure 1. Graph of the dependence of the metal capacity of the PB type floor with a bearing capacity of 800 kg / m2 on the length of the product, reinforced in combination with ropes (1) ∅12.5 K-7t and wire reinforcement (2) ∅5Vr1400

In order to conduct a thorough analysis of the effectiveness of form-less molding using various types of reinforcement (wire and rope), we will consider the technology for the production of products using these types of reinforcement.

Table 1 shows the general characteristics and cost of the equipment of the production workshop, and in table. 2 comparison of the main calculated indicators for the ropes + wire and wire scheme.

Table 1

General characteristics of the production workshop

The main production equipment of the molding shop, taking into account the reinforcement with ropes and wires				
	PB 60.12-8 K7T (ropes + wire)		**PB 60.12-8 Vr1400 (wire)**	
Equipment identification	**Price per unit, sum**	**Total cost**	**Price per unit, sum**	**Total cost**
Concrete mixing unit-1 PC.	1 602 429 000	1 602 429 000	1 602 429 000	1 602 429 000
Forming machine -1 pc.	512 777 280	512 777 280	512 777 280	512 777 280
Cleaning machine - 1 pc.	427 314 400	427 314 400	427 314 400	427 314 400
Wire laying trolley - 1 pc.	160 242 900	160 242 900	160 242 900	160 242 900
Tensioning machine -1 PC.	106 828 600	106 828 600	106 828 600	106 828 600
Trolley for protective cover - 1 pc.	32 048 580	32 048 580	32 048 580	32 048 580
Hydraulic jack for stress relief - 1 pc.	74 780 020	74 780 020	74 780 020	74 780 020
Cutting machine - 1 pc.	747 800 200	747 800 200	747 800 200	747 800 200
Bridge crane 10 tons - 2 pcs.	142 550 800	285 101 600	142 550 800	285 101 600
Removal trolley for SGP 20 tn - 1 pc.	35 000 000	35 000 000	35 000 000	35 000 000
Matrix of products (shaper) - 1 pc.	128 194 320	128 194 320	128 194 320	128 194 320
Total		**4 112 516 900**		**4 112 516 900**

Auxiliary equipment				
Installation for tensioning ropes - 1 pc.	227 230 920	227 230 920	-	-
Collets for gripping fittings - 10 pcs.	3 204 858	32 048 580	-	-
Total		259 279 500		**-**
Total equipment cost		**4 371 796 400**		**4 112 516 900**

From the analysis of the table. 1 it follows that the specification of the main production equipment of the molding shop of reinforced concrete products when laying with ropes and wire is the same. However, for the release of products, taking into account the reinforcement of ropes + wire, additional technical retrofitting is required, which has a significant impact on the final balance sheet value of production equipment.

Table 2

Comparison of the main calculated indicators for the ropes + wire and wire scheme

The name of indicators	**Ropes + wire**	**Wire**	**The advantage of using wire technology (+ savings)**
Product productivity per shift (units)	60	80	+20
Costs for basic materials - rolled metal (sum)	633 321	224 331	+408 990
Costs for auxiliary materials - rolled metal (sum)	33719,4	25619,4	+8100
Equipment cost without VAT (sum)	4 371 796 400	4 112 516 900	+259 279 500
Production cost (thousand soums / unit)	996 631,8	564 541,7	+432 090,1
Profitability per unit v %	15%	103%	+88%
Payback (in years) at a selling price of 1.318.045.6 soums / unit. and profitability 103%	1,6	0,3	+1,3
For reference: Payback (in years) in relation to the first calculation at a selling price of 790.709.1 soums per unit. and a profitability of 15%.	11,2	2,1	+9,1

Comparison of the manufacture of reinforced concrete products using no formwork technology with the use of wire and ropes on the one hand and the use of only wire on the other shows that it is additionally necessary to consider and solve the issues of optimizing the use of auxiliary equipment.

Thus, based on the analysis of the calculations, the following calculated and technological results were obtained when using various reinforcement schemes:

- there is an increase in the cost (996.6 thousand soums / item) in comparison with the use of just wire (564.5 thousand soums / item) almost twofold, including significant metal costs by 2.8 times;
- the duration of the production process increases due to the time spent on laying and tensioning reinforcement (ropes), which affects the productivity of products (up to 60 units of plates / shift);
- technological losses and metal waste are increasing;
- overhead costs increase;

- the return on financial costs, subject to the acquisition of technological equipment, exceeds more than 5 times.

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