Reprofiling of transport infrastructure objects with monolithic reinforced concrete frame

Dmitry Topchiy¹, Alina Bolotova¹, Alexey Vorobev¹ and Alevtina Atamanenko¹

¹Moscow State University of Civil Engineering, 26, Yaroslavskoe Shosse, Moscow, 129337, Russian
E-mail: dvtopchiy0405@gmail.com

Abstract. The actual issues of improving the quality of the organization of production processes in the monolithic construction. The efficiency of the construction production is significantly affected by organizational and technological reliability. The main factors affecting the rate of organizational and technological reliability of monolithic construction. This index takes into account the statistical characteristics of efficiency and organizational risks that arise in the process of functioning of objects of monolithic construction. Revealed and substantiated the necessity of development of recommendations and methods that will allow assessment of the overall organizational and technological reliability of monolithic construction and make a rational decision on the adequacy of the selected preventive measures with correction of the calendar plan of construction in terms of technical risk. The study examined the objects of transport infrastructure

1. Introduction
An evident trend currently observed in the building industry is towards using monolithic reinforced-concrete structures in the construction of buildings and structures. It should be noted that increasing the reliability and operational efficiency of monolithic construction projects is becoming a vital research task. The following problems have been identified on the basis of analytical studies and statistical data on the level of organization of construction operations in monolithic construction projects. First, duration of construction works is frequently extended as compared with the schedule. Second, a poor quality of design solutions and construction works. Another problem is fluctuations in construction costs that include production costs and additional expenses of improving inferior products. Duration, costs and quality of a construction project are the main criteria of organizational and technological reliability of construction operations [1-3]. For this reason, the issues of increasing the organizational and technological reliability have a major impact on the efficiency of construction operations.

We assume that an operational assessment of the organizational and technological reliability of monolithic construction projects will provide solutions to the problems of operational efficiency and organizational quality of production processes. For this purpose it is required to analyze the organizational and technological reliability of construction operations and identify the main impacts on the organizational and technological solutions in production processes. Accordingly, this article aims to make a list of the most important factors that affect the production system quality, using statistical data. The findings of this exercise can be systematized and presented as a database for monolithic construction projects.
2. Methods
The following tasks will be reviewed in order to attain the stated objective:

- Analysis of operational efficiency and organizational quality of production processes in monolithic construction operations;
- Analysis of research methodology for organizational and technological reliability of monolithic construction operations;
- Factor space formation and selection of the most significant factors that have an impact on the indicator of organizational and technological reliability of monolithic construction operations.

The erection process for a building or a structure based on the monolithic technology is determined by the project life cycle and includes several stages: design, production, and operation. A certain reliability level needs to be maintained at each stage. Reliability and organizational quality of production processes in monolithic construction projects are contingent upon analysis of the system of preparation for individual types of works, establishing and maintaining the overall procedure, sequence and terms of implementation of works, and supply of all types of resources [4]. Reliability in construction is an integrated parameter that depends on the quantity and quality of constituent elements of the construction process and production units, interaction among them, propensity for failures and capacity for their rectification. The main reliability indicators in construction operations are absence of failures, durability, maintainability and persistence.

Organizational preparation of construction operations includes decision-making on the start of construction, pre-design (in particular, surveying and siting) and design works [5-8]. Construction experience shows that proper organization of construction operations is subject to availability of integrated process engineering documents, such as a construction organization plan and a work execution plan. As a general rule, several alternative plans should be developed with the most efficient one to be selected among them subsequently. Financial, time, labor, and material and technical expenses are compared and analyzed first of all. The following technical and economic indicators are reviewed:

- Cost of production (overall or that of a construction product);
- Duration of construction works;
- Labor intensity of works (overall labor costs or labor intensity per unit).

3. Results
Figure 1 outlines the concept of organizational and technological reliability of monolithic construction operations with account of its components. Organizational and technological reliability of monolithic construction operations centers around the interrelation between the development of a work execution plan and the desired reliability, technology and organization of implementation of works as scheduled and at a desired quality level, as well as quality control for materials and works at all stages of the life cycle of the construction project. Another focus of organizational and technological reliability of monolithic construction operations is substantial reduction of the project’s operating costs and maximum conformity to the designed reliability level of the production system. It should be noted that faulty organization of production processes entails a risk of a failure to complete a construction stage as scheduled, a lower quality of works, and, accordingly, reduced efficiency of monolithic construction operations.
Figure 1. Organizational and technological reliability of monolithic construction operations.

It is evident from this illustration that each life cycle stage of a project has an impact on the reliability of monolithic construction operations. During its life cycle the project may be in any of several states (good, poor, operating, non-operating, limit, protective, hazardous). The project passes from one state to another in the event of a defect, damage or failure, or following rehabilitation or repair. A defect is an occurrence of disruption of operability of the project. Damage is a defect that causes a poor condition of the project, but the project is nevertheless capable of performing its prescribed functions. A failure is an occurrence of disruption in the good working condition of the project [4-5, 9]. For the construction project to be in a good working condition with all parameters conforming to the requirements of regulations and specifications, it is vital to rectify in a prompt manner all defects, damage and failures of the production system. Performance analysis of construction processes may reveal deviation of actual parameters from those established in the technological chart, work schedule or another document of the work execution plan. Such deviation constitutes a technological failure. Different kinds of causes of deviations taken together may lead to a complete or partial failure of the production system. Identification of root causes of failures of production systems requires a quantitative assessment of their impacts on the organizational and technological reliability of monolithic construction operations. Using the construction reliability indicators, the main types of defects and failures of a production system can be classified by degree of impact on the working condition of the project. The main factors that determine the probabilistic nature of the production process in monolithic construction operations can be described using a cause-and-effect Ishikawa diagram. A scheme of variations in the production process of concreting works in monolithic construction operations at buildings and structures is given in Figure 2. An Ishikawa diagram can be drawn up using statistics of quality monitoring in monolithic construction projects, rules and regulations, and statistical digest data [10-12, 15].
As can be seen from the above, deviations in production processes are affected by the following groups of factors: technological, technical, organizational, climatic, and social. Internal and external random factors act to divert production processes from the predesigned direction. Organizational and technological reliability of monolithic construction operations is determined using the reliability theory methods based on distribution analysis of sets of random values, i.e. reliabilities of individual elements of the complex.

The control system should periodically develop (В) and implement (Р) activities that neutralize negative deviations and ensure the attainment of the intended result by the project. Probability \( p \) of performance of these actions by the control system at the given management level \( U \) determines the functioning reliability of this system \( p(U) \):

\[
p(U) = p(B, P) = xpB(P)
\]

where \( p(B) \) is the probability of development by the system of solutions that ensure the attainment of its specified objective; \( pB(P) \) is the probability of implementation by the system of the developed solutions focused on the attainment of its specified objective. Accordingly, the reliability problem should be tackled by way of development and implementation of activities (plans, organizational and managerial decisions) that ensure the attainment of the specified result by the object of management. It also appears from this formula that the probability of development of solutions and the probability of implementation thereof can be considered separately. This conclusion determines two approaches to the reliability problem: consideration of reliability of decision-making and ensuring functioning reliability of the system in the process of implementation of decisions [7-8, 13].
4. Conclusions
There is currently under way an extensive study of the problem of ensuring reliability of organizational and technological models of construction projects that include calendar plans of construction and installation works. Calendar plans are used as the basis for determining the need for manpower, construction machinery, material, technical and energy resources, means of transportation, and temporary buildings and structures. A calendar plan establishes the deadlines for and sequence of supply of technological equipment and components, development of design specifications and estimates, time distribution of investment, and the scope of construction and installation works [14]. However, analysis shows that a critically weak point of existing control systems for production processes of monolithic construction operations is the problem of developing efficient solutions with a sufficient degree of responsiveness that would meet the current requirements of intensification of construction operations and could be used for prevention of deviations.

Study and analysis of functional efficiency of monolithic construction operations suggest that faulty organization of production processes creates the risk of noncompletion of a construction stage as scheduled, deterioration of the quality of works, and, consequently, a reduced structural reliability of the monolithic construction project.

There is a need for research into scientifically substantiated recommendations, and the development of methods that would enable an assessment of the overall organizational and technological reliability of monolithic construction operations and efficient decision-making on sufficiency of the selected proactive measures accompanied by calendar plan adjustments against the background of engineering risks.

References
[1] Gusakov A A, Ginzburg A V, Veremeenk S A 1994 Organizational and technological reliability of construction operations (SvR-Argus)
[2] Gnedenko B V, Belyaev Yu K, Kovalenko I N 1966 Mathematical issues of the reliability theory. Scientific Findings. Probability Theory Series. Math. stat. Cybernetics theory (VINITI)
[3] Ginzburg A V, Gusakov A A 2002 Organizational and technological reliability of construction operations. System techniques (New Millennium Foundation)
[4] Lapidus A A 2014 Herald of the Moscow State University of Civil Engineering 1
[5] Bolotova A S, Ginzburg A V 2016 Economics and Entrepreneurship 10
[6] Bolotova A S, Treskina G E 2015 Construction – formation of a living environment: a collection of reports of the 18th international applied research conference
[7] Bolotova A S, Kiryukhin S A 2016 Construction – formation of a living environment: a collection of reports of the 19th international applied research conference
[8] Bolotova A S 2015 Construction – formation of a living environment: a collection of reports of the 18th international applied research conference
[9] Lapidus A, Abramov I 2018 E3S Web of Conferences 33
[10] Topchiy D, Skakalov V, Yurgaitis A 2018 International Journal of Civil Engineering & Technology (IJCIET) 9
[11] Abramov I, Poznakhirko T, Sergeev A 2016 MATEC WebConf 86 ()
[12] Topchiy D, Kochurina E 2018 System technologies 1(26)
[13] Topchiy D, Skakalov V 2017 Prospects of science 10(97)
[14] Topchiy D V, Kochurina E O 2018 MATEC Web Conf 193
[15] Topchiy D, Tokarskiy A 2018 MATEC Web Conf 196