Engineering in modern construction

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Abstract. The article highlights the issues related to the quality assurance of products and structures manufactured by the building complex subdivisions. The problems of this type complex objects’ engineering are revealed, and an assessment of the technological production features as a sequential, interdependent process is given. The article considers the introduction effectiveness of the innovative technologies with digitalization elements in the process of manufacturing the reinforced concrete products and structural elements and the construction of buildings and structures on their basis, as well as the importance of engineering in modern construction in general. Based on the theoretical analysis, the recommendations for the use of engineering methods for reorganizing a business process with the controlled parameters technological operations and with the established quality indicators for the finished products are proposed.

Introduction

One of the most important components of a quality assurance system is improving the industrial products’ reliability. At the same time, the methods for achieving the appropriate level of reliability are specific for each stage of the life cycle for the products and structures [1, 2]. This direction is especially important when considering the operational reliability issues, which is determined by the maintenance organization and includes such categories as maintainability, reliability, preservation, safety and durability. A fairly large number of works related to various management areas, including construction, are devoted to the problems of researching operational reliability, which in modern conditions is the most developing industry. The launch of new capacities for the mechanical engineering enterprises, instrumentation, the device of new transport interchanges and an increase in the volume of housing construction is impossible without activating the work of enterprises in the construction industry.

Construction industry plays a significant role in the Russian economy. Construction ensures the reproduction of fixed assets in all economy sectors, has numerous intersectoral connections and a high multiplier effect. More than 50% of total investment in fixed assets falls on the construction of buildings (residential and non-residential) and structures. The construction industry accounts for 6% of the total gross value added (GVA) for the economy as a whole. And, at the same time, the measures aimed at ensuring safety, both during the production of work and during the operation of buildings and structures, are gaining more and more speed. These actions are aimed at implementing the requirements of the Federal Law "On Technical Regulation" [3], in terms of the safety issues reflected in the Federal Law of the Russian Federation of December 30, 2009 No. 384-FL "Technical Regulations on the Safety of
Buildings and Structures” [4].

The main provisions on the construction industry and the strategy for its development are set out in the Draft Strategy for the Development of the Construction Industry in the Russian Federation until 2030 [5]. This industry is defined as a complex of participants in urban planning activities. It includes state and municipal authorities and administrations, organizations, enterprises, individuals engaged in the creation, preservation, improvement and utilization of buildings and structures (in the form of territorial planning, urban zoning, architectural and construction design, construction, overhaul, reconstruction, technical re-equipment, renovation, demolition), and the system of interaction between them at all the life cycle stages of capital construction objects and territories to form a comfortable and safe environment for people’s life and activities [5]. The composition of the industry participants includes: citizens, developers and construction companies, contractors, design and expert organizations, engineering research organizations, financial and development institutions, government bodies that exercise regulation and supervision, self-regulatory organizations, educational and scientific organizations. The first and main principle of the Strategy is to focus on satisfying the consumers’ rights, regardless of who they are represented by.

The implementation of this principle is possible only if there is a competent strategy aimed primarily at the innovative activity and labor productivity growth in the industry, which will be ensured by the improvement of legal and technical regulation and take into account the territorial specifics and the constituent entities’ socio-economic development diversification high degree in the Russian Federation. This is impossible without expanding the information modeling technologies’ use at all stages of the capital construction facility life cycle. The transition to such regulation of all urban planning processes, the criterion of which is coherence and algorithmization, will make it possible to transfer all administrative procedures and technological processes into electronic form without exception. At the same time, in order to implement the Federal Law [3], the Federal Agency for Construction and Housing and Communal Services of Russia developed and agreed with the interested bodies a draft system of normative documents [6], which will ensure the transition to new methodological principles based on the technical regulations (TR) that find more and more widespread in the practice of building regulation and standardization of the developed countries [7].

Similar methodological principles are implemented in the process of scientific research. The level of such research work aimed at solving the scientific, technical, technological solutions and improving the quality of the source material, the level of the organizational and production process, product quality control at all stages begins with research and development work and ends with the work on implementation and transition for serial manufacturing of the products with the required quality parameters and the device based on them, durable and reliable buildings and structures [8]. For the widespread implementation of the scientific developments’ results, there is no information base that makes it possible to evaluate, implement and ensure the positive results and possible advantages of innovative methods for the materials and products’ manufacturing in the conditions of factory production and the construction of buildings and structures for various purposes on their basis. The withdrawal of the existing capacities for the production of reinforced concrete products and structures and the entire construction complex to a fundamentally new technical level is economically expedient both in time and in cost, which justifies the prospects of this direction in the construction industry development.

**The problem analysis, goals and objectives of the work**

The construction complex work is a diverse complex process aimed at meeting the consumer demand for finished products - buildings, structures, structures. For a fairly long period of time, the construction industry worked on the basis of the process ultimate goal fastest implementation principle - the construction of buildings and structures. Little attention was paid to the actual conditions, demand in the consumer market, meeting the urgent needs of the market and issues and the problem associated with the final stage - the disposal of products from the construction industry. Modern conditions of the consumer demand market have changed the very approach to this problem. More and more attention is
paid not to production itself, but to the issues related to the justification of the need for this step, the prospects for finding the consumer demand, efficiency of use, time of the main life cycle and disposal complexity. And insofar as modern living conditions dictate new requirements, it is necessary to take a new approach to the organization of construction production as a whole.

For a more complete understanding of this problem, it is proposed to consider the life cycle of the construction products manufacturing.

The life cycle is a set of interrelated processes of sequential changes in the state of a product from the formation of initial requirements for it to the end of its operation or application. The life cycle of construction products includes a number of stages:

1) marketing, search and market research;
2) design and development of technical requirements, product development;
3) material and technical supply;
4) preparation and development of production processes;
5) production;
6) control, testing and inspection;
7) installation and operation;
8) technical assistance and maintenance;
9) disposal after operational reliability loss, etc.

Research, design and development of any product is based on promising marketing research, fundamental and predictive SRW and scientific research, applied marketing research and rationing of requirements for product quality, taking into account regional characteristics [9 - 11]. This should also include the conduct of the applied research, development of technical specifications and assessment of the design and technical level of products; drawing up a business plan for the development and manufacture of the products with the required quality parameters, attracting investments; development of technical documentation and expert work, marketing and commercial testing of construction products, study, analysis and experience use in the creation and operation of similar products at all stages of its life cycle, the selection of target markets, which is carried out in parallel with the design and development of products; development of a set of marketing activities.

The stage of the product life cycle is its conditionally allocated part, which is characterized by the specifics of the work performed in this area and the final results. A conditional representation of the life cycle of construction products can be obtained from the diagram, shown in Figure 1.

![Figure 1. Stages of the construction products’ life cycle](image-url)
It is proposed to analyze some aspects of this situation from the point of view of the phased formation of problems, design and technical solutions. First of all, when designing, it is necessary to keep up with the times and provide the building complex with the products that meet the requirements of consumer demand in modern market. From the modern construction projects’ features analysis, it is obvious that this market for meeting consumer demand is dominated today by high-rise buildings, which in general is inherent in densely populated megalopolises. Evaluating modern buildings and structures, we can unequivocally say that when designing them, all modern requirements are taken into account, designed to ensure the technical safety and operational reliability of newly erected buildings and structures. However, this situation forces us to take a completely new look at the problem of forming consumer demand, the problem of meeting it and the economic feasibility of this step as a whole.

As already noted, the security requirements and the operational reliability of buildings and structures have led to the need to increase the requirements for the quality and technical properties of both materials and products, as well as the process of erecting buildings and structures using them. These requirements form other approaches to ensure compliance with the original regulatory requirements for the materials’ quality, for the preservation of quality parameters throughout the entire technological cycle, for the parameters of the technological process, as a guarantee of the operational reliability of buildings and structures erected and put into operation.

**Research part, recommendations for manufacturing enterprises**

Modern requirements for the organization of technological processes are, first of all, the introduction of individual operations’ automation, as well as the devices for operational control and non-destructive methods of the technological parameters’ quality control of the process and finished products. But first of all, we should talk about the possibility of providing the industry with high-quality raw materials. This problem is dealt with by the engineering service, which ensures the internal and external circulation of material resources.

Any production has the ability to make a decision to use finished products from other industries in its work or organize its own production, which will ensure the predicted quality of both materials and products made on their basis.

In this situation, the process of selecting suppliers is becoming increasingly important.

The main function, however, lies with the marketing services. Their main function becomes: search for the information about suppliers; request for information on prices; processing of commercial offers; holding a tender and selecting the suppliers based on tender results.

The block diagram (process diagram) is shown in Fig. 2.

In the presence of the raw materials’ reliable source, a building complex enterprise can quite effectively use the opening opportunities. This is, first of all, the provision of materials of the required quality and volume, the absence of disruptions in the supply of concrete mixtures, the ability to control the process of concrete strength gain, since all technological parameters of the concrete mixture are known and the development of hardening acceleration modes will not cause great difficulties. At the same time, it is possible to maximize the time of formwork removal by providing continuous control over the strength of concrete in the formwork and thereby not only increase the efficiency of its turnover, but also ensure that the concrete reaches the required strength, which will avoid the appearance of defects in the supporting structures. Quality control of finished products and structures, in such a situation, involves checking the geometric dimensions and shapes of products, the quality of the outer surface, the size of the protective layer, the position of reinforcement and embedded parts, which will ensure that buildings and structures comply with the requirements of the project as a whole [8, 12, 13, 14]. At the same time, a number of the related tasks of the enterprise (organization) are being solved, namely:

- increasing production efficiency by selling excess concrete mix to third parties,
- the ability to realize surplus equipment, formwork, etc. using the three-level system: construction equipment - sale of building material and sale of unused construction equipment on the one hand and a branded landing page for the organization’s construction services: rental of construction
equipment - general construction work - external and internal finishing - engineering and technical support on the other side.

Figure 2. Process approach to supplier selection
Summary
Analyzing the above-said, we can conclude that the business process reorganizing effective engineering methods’ introduction into production according to the operational form is possible by transferring the technological process from the category of assessing the quality of the finished product to the category of organizing production with the controlled parameters of the technological process and with the established quality parameters of the finished products. At the same time, digitalization and automation of the technological processes and product quality operational control, transfer of their management to an electronic platform, will significantly improve the production culture at enterprises, establish the causes of defects and improve the quality of products.

References
[1] Patuk I, Hasegawa H, Borodin I and Pavlyuk R 2020 Measurement of Strain Induced on a Deep Placement Fertilizer Applicator by Static load and Finite Element Simulation // IOP Conference Series: Materials Science and Engineering, 1st International Conference on Innovative Informational and Engineering Technologies (IITE-2020) 28-29 May 2020, Stavropol, Russian Federation 873 012033. doi: 10.1088/1757-899X/873/1/012033.
[2] Kravchenko I N, Tretyakov A M, Erofeev M N 2003 Mathematical description of the approximating function of the process of wear of the blades of concrete mixing machines Construction and road machines 1 36-38.
[3] Federal Law of the Russian Federation of December 27, 2002 No. 184-FL "On Technical Regulation" (November 28, 2018) [Electronic resource] // Electronic fund of legal and normative-technical documentation. Information on http://docs.cntd.ru/document/901836556 (date of access: 23.10.2020).
[4] Federal Law of the Russian Federation of 30.12.2009 No. 384-FL "Technical Regulations on the Safety of Buildings and Structures" (July 2, 2013) [Electronic resource] // Electronic Fund of Legal and Normative and Technical Documentation. Information on http://docs.cntd.ru/document/902192610 (date of access: 23.10.2020).
[5] Project from 06.12.2019. Development strategy for the construction industry of the Russian Federation until 2030. [Electronic resource]. Information on https://www.garant.ru/files/3/7/1334573/strategiya-razvitiya-stroitelnoy-otrasli-rossiyskoy-federacii-do-2030-goda.pdf (date of access: 25.10.2020).
[6] Resolution of the Government of the Russian Federation of 04.07.2020 N 985 "On approval of the list of national standards and sets of rules (parts of such standards and sets of rules), as a result of which, on a mandatory basis, compliance with the requirements of the Federal Law" Technical Regulations on the Safety of Buildings and Structures " and on recognition as invalid of some acts of the Government of the Russian Federation " [Electronic resource] // Consultant Plus: reference legal system. Information on http://www.consultant.ru/document/cons_doc_LAW_356807/ (date of access: 25.10.2020).
[7] Vodolazskaya N 2019 Types and ways of modernization in a context of the international experience Virtual Economics, London, England 2 2(1) 81–93. https://doi.org/10.34021/ve.2019.02.01(5).
[8] Romanenko E Yu, Nalimova A V 2020 The engineering of the reinforced concrete products manufacturing business process as a guarantor of the buildings and constructions’ operational reliability IOP Conf. Series: Materials Science and Engineering 913 032044. IOP Publishing doi:10.1088/1757-899X/913/3/032044.
[9] Vodolazskaya N V 2013 Problems and Prospects for Improving Regional Marketing Strategies Eastern European Journal of Advanced Technologies 1/10(61) 95 – 98.
[10] Purwanto M R, Mukharrom T, Zhilyakov D I, ect. 2019 Study the importance of Business Ethics and Ethical Marketing in Digital Era JCR 6(5) 150-154. doi: 10.22159/jcr.06.05.26
[11] Vodolazskaya N 2009 Models of network planning and management of power-consuming industries Application of new technologies in management. ANTiM 2009. Proceedings.
Banja. Serbia 2 811 – 818.

[12] Romanenko E, Ryabichenko S 2019 Construction sector enterprise product quality as a result of strategic innovation management *IOP Conf. Ser.: Mater. Sci. Eng.* 698 022074. doi: 10.1088/1757-899X/698/2/022074.

[13] Drozdov Anatoliy 2018 Improvement of assembly technique efficiency for installation of buildings and related structures in light building constructions *MATEC Web Conf.* 251 03042. doi: https://doi.org/10.1051/matecco/201825103042.

[14] Kim, Hyun Tae, et al. 2017 The Measurement of SVOC Emission Rates from Building Materials *Materials Science Forum, Trans Tech Publications, Ltd.*, Mar. 2017 893 369–374. Crossref, doi:10.4028/www.scientific.net/msf.893.369.