Methodological Approaches to the Formation of the Organizational and Technological Mechanism for Improving the Manufacturability of Work during the Overhaul of Buildings

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Abstract. The article is devoted to the problems of the formation of the organizational and technological mechanism for improving the manufacturability of work during the overhaul of buildings. Manufacturability is considered as a combination of properties that make it possible to manufacture them with the least labor, materials and means, using advanced technology and providing prudent project technical and economic performance indicators. It is necessary to identify existing reserves that contribute to improving the manufacturability of works during the overhaul of buildings, as well as to analyze the causes of their occurrence and ways of their use in order to increase the main parameters of manufacturability. Works, as a rule, is carried out in extremely cramped conditions, which determines the specific technology for their implementation, the use of special equipment, mechanisms, tools, devices. The duration of the overhaul cannot be reduced to the detriment of reliable and safe operation of the facility.

1. Introduction
Conducting a scheduled overhaul ensures safe operation and a comfortable living environment in buildings throughout the entire life cycle. During the overhaul of the building, the engineering systems and structural elements of the building are replaced, restored and (or) repaired to eliminate physical deterioration, maintain and improve operational properties without changing the function of the building and technical and economic indicators. The overhaul includes repairs of the roof, facade, internal house engineering systems (power supply, drainage (sewerage), gas supply, water supply (hot and cold), heat supply, repair or replacement of elevator equipment, repair of elevator shafts, basements and foundations. Each type of the listed works is carried out according to its individual technology and in a certain organizational sequence.

1.1. The scientific relevance of the issue with a brief review of the literature
Repair and construction work has its own specifics associated with technologies that provide for the use of advanced achievements in the development, primarily of building materials science, that have occurred during the period of operation of the building until the time of the overhaul.
One of the indicators of the effectiveness of construction production is the concept of manufacturability. The methodological foundations of the theory of manufacturability of the construction of buildings of various structural systems have been developed in a number of scientific labor [2 - 4, 13-20].

However, due to the peculiarities of the repair and construction industry, combining the adaptation of materials and designs of the previous and new generations, as well as combining the types of work that differ in technology and organization, the improvement of manufacturability is associated with the development of new approaches, algorithms, methods, forms and methods that together form technological mechanism.

Improving the forms and methods of carrying out major repairs of buildings is based on the results of scientific research [1, 5, 6, 15-25]. Observing the regulated time intervals for major repairs during the period of operation of buildings, the service life of real estate objects does not change. Otherwise, the residual resource of the building is reduced, which subsequently leads to an increase in the cost of its implementation. For various structural elements and engineering systems, the minimum duration of effective operation is established taking into account design solutions and purpose [7, 8, 9].

1.2. Formulation of the problem
Modern methods of carrying out works on the overhaul of buildings are based on the principles of threading and scientific methods of labor organization, developed taking into account the specifics of certain types of technologies for repair and constructional works. The following indicators are considered as the main indicators of the manufacturability of works during overhaul: labor intensity and duration of work, material consumption, cost and costs of manufacturing structures. Each of these indicators has corresponding reserves, which are identified and used to increase the manufacturability of production, both of each type of work, and in the building as a whole.

2. Materials and methods
Structurally - technological solutions during the overhaul of buildings are multi-variant. The manufacturability of works on the overhaul of buildings is considered as a set of requirements that allow them to be met with the lowest cost of labor, materials and means, using advanced technology and providing the technical and economic performance indicators stipulated by the project. The manufacturability of certain types of work during the overhaul of buildings must be assessed in conjunction with the space-planning and structural solutions of buildings, as well as taking into account the technological compatibility of repaired structural elements from obsolete and new materials.

Structural and technological solutions are considered technological, which provide the simplest, fastest and most economical production, transportation and installation, reliable and economical operation, while complying with the conditions of strength, stability, resistance to aggressive and other types of influences. Indicators of operational manufacturability take into account the planned costs of preventive maintenance and repairing works.

Quantitative indicators of manufacturability are relative parameters and are compared for similar types of work or with the basic option for material consumption, labor, duration of work and operational characteristics [10-12], [15-20].

The structure of each group of indicators is similar. It includes:
- an absolute quantitative indicator of the manufacturability of each type of work (labor intensity, duration, etc.);
- relative indicator - the ratio of each of the components to the absolute indicator;
- specific indicator characterizing the design in operational condition - the ratio of the absolute indicator to the parameter adopted as the main one.

The determination of the level of manufacturability can be estimated by quantitative indicators, or using a generalized criterion for assessing the level of manufacturability of the production of various types of overhaul works K, which can be represented by the dependence:
\[ K = f (K_i, K_t, K_m, K_q), \]

where \( K_i \), \( K_t \), \( K_m \), \( K_q \) – indicators of the level of manufacturability, respectively, for the manufacture, transportation, installation, operational reliability, taking into account, accordingly, the rational amount of labor, the cost of manufacturing structures and products, material consumption, the use of transport, the amount of labor and machine time for work, the level of operational manufacturability characterizing the costs of maintenance and repair of buildings.

Since the above indicators have a certain dimension, using the comparative equivalent it is necessary to bring them to a dimensionless form for comparison in a generalized indicator.

To determine the assessment of the level of manufacturability of various types of overhaul works, it is necessary to compare the design proposal with the indicators of the basic structural and technological solution.

Indicators for assessing the level of manufacturability of the production of various types of major repairs are determined by the formulas:

**Material consumption of structural elements:**

\[ K_m = \frac{M_p}{M}, \]

where \( M_p \) and \( M \) – specific material consumption, respectively, of the project proposal and the base case;

**The complexity of manufacturing structural elements:**

\[ K_i = \frac{T_{i_p}}{T_i}, \]

where \( T_{i_p} \) and \( T_i \) – the specific complexity of manufacturing, respectively, the project proposal and the base case;

**The complexity of the device or installation:**

\[ K_m = \frac{T_{m_p}}{T_m}, \]

where \( T_{m_p} \) and \( T_m \) – the specific complexity of the device or installation, respectively, of the project proposal and the base case;

**Maintenance overhaul costs:**

\[ K_y = \frac{Y_p}{Y}, \]

where \( Y_p \) and \( Y \) – indicator of operating costs, respectively, of the project proposal and the base case.

In each particular case, the indicator for assessing the level of manufacturability of various types of overhaul works can have numerical values less than or greater than 1. Moreover, a coefficient whose value <1 characterizes a high level of manufacturability of a structural and technological solution, and a coefficient whose value is> 1, - low level of manufacturability.

3. **Results and discussion**

The decision algorithm for the overhaul of structural elements and engineering systems of buildings includes a number of interrelated sequentially performed actions (Fig. 1):
The identification of reserves for improving the manufacturability of work during the overhaul of buildings makes it possible to improve the use of resources as a result of improving the organization of labor, the production process and management, and the intensification of the technological process.

According to the implementation methods, design-structural, technological, and organizational-technological reserves are distinguished (Fig. 2). the use of all types of reserves means the economical use of material and labor resources, where the conditions and nature of their implementation determine the main directions of improving the manufacturability of work compared to the previously established level.

**Figure 1. Decision Algorithm for overhaul of buildings.**

- Determining the life of each of the engineering systems and structural elements of buildings
- Take into account the excess of terms in relation to the established terms of effective operation
- Assessment of technical condition based on monitoring
- The state of the systems is taken into account according to monitoring data of specialized organizations
- Using the points system in determining the priority of major repairs of buildings
- The final indicator is defined as the sum of the assessment points by the criterion of each engineering system and structural element of the house

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Figure 2. Reserves to improve the manufacturability of works during the overhaul of buildings.
Improving the manufacturability of repair and construction works also requires the elimination of other reasons related to each other by parallel and serial communication. The peculiarity of this type of work is due to the fact that each structural element in the process of its use passes through a complex and multi-link chain of various technological processes and organizational and technological processes. In this case, specific features of the best use of resources may be created. The implementation of each opportunity, both individually and in combination requires the identification of not only technical and technological, but also other reserves. In many cases, production reserves are the result of organizational and technological factors.

4. Conclusions

Scientifically-based methods for choosing rational options for organizational and technological solutions in the course of overhaul of buildings, which increase the manufacturability of works by identifying and involving various types of reserves, create the methodological basis for the formation of the organizational and technological mechanism for improving the efficiency of repair and construction works.

The feasibility of overhauling emergency buildings is determined by the cost of its implementation, subject to bringing the space-planning and structural solutions of the repaired buildings to the level of ensuring the required safety and durability of the operated buildings.

Thus, one of the effective ways to increase the manufacturability of work during the overhaul of buildings is to identify reserves and involve their production process.

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