Design organization and construction implementation of the installation and reconstruction technology using helicopters

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Abstract. The article analyzes the helicopters’ rational flight operation issue state in the reconstruction projects’ design and implementation to replace the cover structures of single-story industrial buildings. The practical use experience of helicopters in the conditions of an existing industrial enterprise is summarized. The basic prerequisites for the use of helicopters for the structures’ dismantling and installation are described. The joint development issues of the reconstruction projects using helicopters are considered, taking into account technological and organizational aspects. The structure and relationship of the technological process organization individual elements. A scheme for organizing and implementing a rational technology for mounting and dismantling using a helicopter, professionally trained flight crews, teams of ground installers to perform mounting and dismantling work during the industrial facilities reconstruction has been developed. The possible ways of expanding the operational range when using helicopters for installation and dismantling work are shown.

1. Introduction
The need for re-profiling and reconstruction of the existing one-story industrial buildings arises primarily with the physical deterioration of structures, in connection with the main production technology improvement and in the event of an industrial enterprise ownership change.

Reconstruction is a complex set of construction and installation works and organizational and technical measures. There are three main methods of reconstruction - with stopping, partial stopping and without stopping production [1]. As a rule, preference is given to the latter option, but taking that into account, it is possible to create favorable conditions for the work to be done as soon as possible. In the context of the existing enterprises’ reconstruction, an individual approach to the organizational and technological solutions’ selection is required, taking into account the additional factors that are practically not encountered in the new facilities’ construction - special knowledge, skills and appropriate training of engineering and technical workers. In each specific case, the technological solutions’ development, in especially difficult conditions of an existing enterprise reconstruction, requires the creation of a number of alternative options, their comprehensive assessment and the selection of the most preferable for a number of performance criteria. Moreover, such decisions should take into account and comply with the real conditions for the reconstruction of a particular object.

The state of this issue is presented in previously published works [2, 3, 4].

2. Results
The main prerequisites for the helicopters’ use for installation in the current production and reconstruction of industrial facilities are:
- constrained and especially difficult conditions for the installation and dismantling work;
- work performance in the areas beyond the reach of traditional mechanisms, when cable cranes, masts on braces, which require significant costs at the preparatory and final stages of installation, become alternative methods and means;
- heterogeneity, dispersal and small volume of the work performed;
- the presence of railways in the installation area;
- access roads’ remoteness from the reconstruction zone;
- storage areas’ remoteness from the installation area.

All this necessitates a focused organization and technology study of work, as well as identifying the influence patterns of the latter on the technical and economic indicators of the construction and installation organizations’ activities during reconstruction. Currently, there are no methodological developments to create a work organization project (WOP), a work production project (WPP) using helicopter technology and taking into account the technical, technological and organizational aspects for the installation and dismantling works (IDW). Unfortunately, in most cases, the issue of using a helicopter on IDW has to be decided directly during the working period, which most often leads to large losses of time and money. As a result of this, very often, the use of a helicopter is assessed as inefficient and not economically feasible.

In the conditions of an existing industrial enterprise, there is a need for thorough, high-quality and timely development of project documentation, documentation for the organization and installation and dismantling works production. A clear work interaction and coordination of all participants in the reconstruction process is necessary - design, construction and installation organizations, customers and the aviation company. In this connection, special attention should be paid to preliminary multivariate organizational and technical design with a detailed study of all the issues at the stage of the technical task, and later in the WOP and WPP development.

At the same time, the main task of the customer, knowing the specifics of the reconstructed object’s conditions, is to choose the right design and general contracting construction organizations that could analyze the technologically possible IDW options in advance, taking into account the installation area constraint and the restrictions imposed by the existing production. And the selected design organization, still at the stage of the reference terms and the construction organization project development (WOP), to increase efficiency, as an alternative, should consider the possibility of using a helicopter at the reconstructed object [5]. For this, the specialists with knowledge and experience in the field of helicopter mounting should work in this organization.

As a rule, at present, the general contracting organization, in most cases, performs only the functions of managing the reconstruction of the facility directly at the construction site, and for the work performance it concludes contracts with one or more subcontracting organizations. When reconstructing the industrial buildings with the use of helicopters, the organization that is highly specialized in helicopter mounting should be involved (Fig. 1). Such a subcontracting organization should have its own crane modification helicopters, special technical means, own advanced helicopter mounting technologies and specially trained ground installers crews. Helicopter crews should have the skills to work with ground installers crews and perform the construction and installation works [6]. At this point in time, such organizations do not exist. However, there are the unique installation organizations with specially trained teams of installers for the joint implementation of the IDW using a helicopter. Therefore, the general contractor will have to hire at least two subcontracting organizations to carry out the work. It is quite obvious that in such a situation it is necessary to spend time and money on training the joint interaction of the crew and installers. And, as a result, these financial expenses fall on the shoulders of the customer, which means that all this can lead to a rise in price and, consequently, low efficiency of the helicopter use. It would be much simpler and cheaper to connect a specialized company with trained and employed specialists.
Often, most design organizations also have no idea about the technologically possible options for the structures’ installation, taking into account the constrained conditions of IDW by helicopter, imposed by the requirements for the production processes continuity. When designing WOP and WPP, the main one should be the correct choice of organizational and technological schemes and the IDW sequence [6]. Since the time and cost of the machine-hour of operating a helicopter is most often the determining factor in the installation and dismantling process cost, special attention should be paid to the variant design of the detailed work schedules using computer simulation.

Improving the installation and dismantling operations’ efficiency using a helicopter can still be achieved by the coordination of technological solutions with the real conditions of the facility reconstruction. For this, it is necessary to carry out a variant design of IDW technological processes taking into account the foregoing and consider the possible solutions for the technology, organization and IDW mechanization, it is also necessary to reconcile the IDW possible solutions.

For this, it is necessary to analyze the factors affecting IDW, as well as the technological solutions for the works production on the coating elements’ replacement. This will make it possible to find among numerous options for designing building processes the optimal technological solutions for the reconstruction. As experience shows, there are a huge number of the alternative options for organizational and technological solutions, only at one reconstruction object, and this, taking into account the sequence and combination of the construction processes, means of mechanization, organization of storage sites, etc. Also, when choosing the effective organizational and technological solutions, the list and quantitative description of the space-planning decisions’ indicators and the constraint factors of the reconstruction objects, as well as the methodology for assessing the cost and complexity of reconstruction work should be adjusted.

After analyzing and summarizing the industrial buildings’ reconstruction experience, four groups of main factors affecting the IDW organizational and technological processes to replace the coating plates can be distinguished.

The first group includes the factors characterizing the facility and the amount of reconstruction work. The second group - these are the factors describing the environment of the object, everything related to the general plan. We will write down the factors affecting the capabilities of the reconstruction facility performers in the third group, and those on which the restriction on the work performance (safety, norms, rules, deadlines) depends on, will constitute the fourth group.

In future, having screened out the unsuitable options for technological reasons, at the output we will get relatively possible rational options for organizational and technological solutions.

As mentioned earlier, the important role is played by the professional training of the crew and ground crews for the IDW implementation, as well as their interaction [7]. After analyzing the current state of the Russian helicopter fleet for conducting IDW aircraft, it was revealed that most of the machines were created back in the 70s, for example, Mi-6, Mi-8T, Mi-10. Mi-26, Ka-32, Mi-8MTV, Mi-8AMT helicopters are used today for IDW operation. To improve the quality of installation technologies from the air, the use of a specialized helicopter crane with an additional cabin for an installation pilot, for example, Mi-26PK, Mi-26TM, Mi-8MTV-1K and Ka-32K, is required. Up to now many Russian airlines that have recently entered the market of aircraft construction and installation works have had very little experience in the field of helicopter installation and an outdated fleet of vehicles, but at the same time they strive to quickly gain their niche in this market [8]. So, it is possible to conclude that for the efficient and clear implementation of installation and dismantling operations using a helicopter, as well as to avoid piloting errors that could lead to an air crash, special centers should be created for training and advanced training of the specialists in the field of helicopter mounting, as well as for the design organizations’ employees. To create such a center, the Krasnodar research and production company PANH Helicopters, formed in 1964, and being currently one of the fastest growing aviation companies in Russia, may be useful [9]. The research and production company PANH has its own scientific and technical center, extensive experience in performing the unique aviation operations, highly qualified flight personnel and a large aircraft fleet. It is also possible to attract the creation of such a center to the “Aerospetsmontazh” Research Helicopter Company, located in the city of Saki. These
companies have a great reserve in technologies of performing the aviation works as well as the scientific and technical developments.
Figure 1. A model for organizing the development and implementation of a rational technology for installation and dismantling using a helicopter.

In such a center, it will be possible to work out the piloting methods when performing IDW with cargo on an external sling, as well as joint interaction with ground crews of installers. Such an approach to comprehensive training will improve the IDW quality, reduce the complexity, cost and timing of work. As a result, the project participants will gain the skills in the efficient and safe use of expensive aircraft.

Summary
After analyzing the heterogeneous and specific conditions of the reconstruction at the stage of formation and evaluation of the technological solutions during the design of installation and dismantling works, it was possible to reduce the additional costs by planning and organizing, at the stage of the technical task and developing a project for the construction organization using aircraft. Ensuring the effective use of the helicopter when performing the aircraft construction and installation works are directly dependent on the ability to competently take into account its flight performance, the organizational and technological level of the design work preparation. Therefore, the creation of a single center for training and advanced training of specialists in the field of helicopter mounting is required.

References
[1] Sokolov I 2015 Ensuring the adoption of effective organizational and technological decisions in the reconstruction of industrial buildings Construction, materials science, mechanical engineering Dnepropetrovsk 84 216–223.
[2] Balakchina O 2011 On the feasibility of improving installation and dismantling operations using helicopters Construction and industrial safety 38 29–32.
[3] Shalenny V, Balakchina O 2017 Intensification of the use of helicopters to replace the cover structures of industrial buildings Building materials, equipment, technologies of the 21st century 3–4 29–31.
[4] Shalenny V, Balakchina O 2018 Prerequisites and Substantiations of Possible Efficiency of Using Helicopters for Replacement of Roof Structures of Single-Storey Industrial Buildings Materials Science Forum 931 432–435. Information on https://doi.org/10.4028/www.scientific.net/msf.931.432
[5] Kozlovsky V, Parshentsev S, Efimov V 2008 Helicopter with cargo on external sling Moscow (Engineering - Flight) 304.
[6] Parshentsev S 2006 Priority tasks of scientific and technical support of aviation construction and installation works Construction and special works in construction 1 2–9.
[7] Parshentsev S 2003 Aerial installer. Risk can be excluded. Helicopter 3 16–19.
[8] Parshentsev S, Lobov A 2012 Methods of cargo stabilization on a bifilar external suspension of a coaxial helicopter during aircraft construction and installation works Construction and special works in construction 7 19–25.
[9] Research and Production Company “PANH” (PANH Helicopters) (Electronic resource). Information on http://panh.ru