

Organisational and technological design improvement of reconstruction of large-paneled residential buildings of the first mass series

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Abstract. The article deals with the experience and results of the research in the field of technology and organisation of five-storey large-panel residential buildings reconstruction of 1-464A series. For this purpose, the new combined organisational and technological models for two stages of reconstruction are successfully developed and implemented. As a result of theoretical research and practical developments, the methodology of formation of rational organisational and technological solutions for reconstruction of residential buildings of the first mass series is proposed and successfully applied, on the basis of which the mandatory sections of the project of works production for reconstruction of the investigated object are designed.

1 Introduction

One of the main trends in state urban planning and housing policy in Russia for a long period of time is the implementation of measures to ensure the renewal of five-storey panel housing in cities on the basis of reconstruction, major repairs and modernisation. In modern conditions, the development and implementation of regional reconstruction programmes of residential buildings of the first mass series allow not only to maintain the panel housing stock in satisfactory technical condition, but also to provide a significant urban planning and socioeconomic effect by updating the urban environment and obtaining additional area of residential buildings in existing urban areas [1-3]. According to [4], reconstruction of a capital construction object is a change in its parameters (height, number of floors, volume, area ...), including superstructure, remodelling, expansion, as well as replacement, restoration of load-bearing building structures.

It is known that in the design of reconstruction of residential buildings of the first mass series a great experience in the development of architectural, construction and technical solutions has been accumulated [5-8]. At the same time, studies show that significant reserves of reconstruction efficiency growth lie in the field of organisational and

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technological design [3, 6, 9, 10]. At the same time, more and more attention in research is paid to the transition to the complex reconstruction of residential formations - neighbourhoods, quarters and their parts (queues, residential groups); it is justified economically, technologically and organisationally, which is repeatedly confirmed in the conditions of new construction [2, 3, 11].

The current regulatory and methodological base in construction establishes that the erection of each object is allowed to be carried out only on the basis of pre-developed organisational and technological solutions, which should be adopted in Construction Organisation Projects (COP) and Work Production Projects (WPP) [2, 3, 11-13]. However, the problem of developing rational standard organisational and technological solutions for the reconstruction of residential buildings of the first mass series, based on modern methods of construction production modelling, including optimised scheduling, has not received enough attention so far.

In the conditions of competition and the desire of contractors to meet the contractual deadlines, the application of methods of optimised scheduling based on the complex use of modern mathematical and organisational-technological modelling, adequate to the real conditions and specifics of flow production of works in the reconstruction of objects and their complexes, becomes more and more relevant.

Thus, it is relevant, timely and useful to develop, on the basis of the performed research, a methodology for the formation of optimised organisational and technological solutions for the reconstruction of five-storey large-panel residential buildings of the first mass series, based on the use of network models that are most adequate to the real construction production, which is the purpose of this work.

2 Materials and Methods

A five-storey four-section large-panel apartment block of 1-464A series, which is the most widespread residential building in the Arkhangelsk region and in many other regions, was chosen as the object of the research. The reconstruction of this object was carried out for the first time in the region, that is why special attention was paid to it. The customer was the Construction Department of the Arkhangelsk Mayor's Office, the general designer was the design firm "Architecture and Design", and the general contractor was the construction trust "Deplestroj".

The structural scheme of the building, erected in 1974 on a pile foundation with a high-pitched substructure, was designed with load-bearing transverse and longitudinal walls and floor slabs resting on the contour; the outer walls are single-layer panels of 350 mm thick shungizite concrete. The reconstruction of the object was envisaged without relocation of the tenants in two stages: the first stage involved the addition of a mansard consisting of four identical sections with two 3-room flats in each; the second stage involved insulation of the existing external walls, finishing of stairwells, replacement of carpentry, etc. The first stage involved the construction of a mansard consisting of four identical sections with two 3-room flats in each. The design documentation assumes the construction of the attic to be wooden - from wooden wall panels and trusses of full factory readiness, impregnated with fire retardants. The project provides for thermal modernisation of the building - insulation of the existing exterior walls with URSA P-30G insulation boards (130 mm) and the installation of a ventilated facade made of fibre cement boards.

For the development of the main sections of the project of works production for the investigated object new combined organisational and technological models of reconstruction (OTMr), formed according to the methodology of the department of highways and construction production of AGTU-SAFU, briefly outlined in previously published works [11, 14, etc.] were developed. These models are made for two stages of

reconstruction of the object and are designed for optimised (variant) calendar planning of works production.

OTMr include: structure of works, matrix model of organisational and technological sequence of works and types of connections between them, as well as scale-free network model of "work-arc" type, using elements of generalised network models - connections of "no earlier" type for the possibility of typification of display of multivariant combinations of works. The peculiarity of these models, agreed with the management of the trust "Divisionstroj", is the division of full fronts of some types of works into separate parts, in accordance with the number of sections (4 pcs.) at the I stage and the number of grips (5 pcs.) at the II stage of reconstruction. In total in OTMr are allocated: 31 types of works on I stage of reconstruction and 21 - on II stage, labour costs are determined according to the estimated documentation and developed technological maps.

On the basis of OTMr different variants of work organisation were designed in terms of intensity and overlapping, the main technical and economic indicators (TEI) for two of them, determined on the basis of calculations of network models on the PC, by reconstruction stages are summarised in Table 1.

Table 1. Basic TEI by options of work organisation

Indicator name	Measurement unit	I stage		II stage	
		1 option	2 option	1 option	2 option
Total duration of work	Working days	178	165	144	106
Labour costs assumed	person/day	2848	2970	1872	1908
Average number of workers per day	person	16	18	13	18

3 Outcomes of the work project main sections' development on the facility reconstruction

As a result of the research carried out at the Department of Roads and Construction Production, and the corresponding organisational and technological design, the authors have developed a set of organisational and technological documentation, including the main documents of the design and construction process, for the stages of reconstruction of the object under consideration, described above.

Within the organisational-technological documentation the following new technological cards have been developed taking into account modern requirements [13]: for the staircase construction between the existing and attic floors, for the installation of attic structures, for the metal tile roofing (for stage I) [15]; for the ventilated facade construction (for stage II of reconstruction) [16]. In this case, the use of large construction machines is minimised due to the reconstruction without eviction of tenants, and for the supply of materials for the construction of the attic, a cargo construction lift is adopted.

As a result of comparison of the main variants of organisational and technological solutions, the final variants with the shortest (technically possible) duration of works on the stages of reconstruction (165 and 106 days, respectively), as the most satisfying the needs of the customer and the building occupants, the capabilities of the contracting company, and corresponding to the duration of the warm period of the year (especially for the II stage of reconstruction, which takes about 5 months) were adopted. On this basis, other elements of the design construction project have been developed, including:

- time-scale calendar (network) schedules;
- schedules of labour, material and technical resources requirements;
- construction master plans (for the relevant stages).

Changes in the main volume-planning parameters of the object under consideration as a result of realisation of two stages of reconstruction are shown in Table 2.

Table 2. Basic TEI of the facility before and after reconstruction

Types of flats and general indicators	Basic building parameters						Change, %
	before reconstruction			after reconstruction			
	Number of apartments, pcs	Dwelling area, m ²	Total area, m ²	Number of apartments, pcs	Dwelling area, m ²	Total area, m ²	
Studio flat	10	172.5	303.7	10	172.5	303.7	-
One - bedroom flat	40	1211.0	1801.1	40	1211.0	1801.1	-
Two-bedroom flat	9	405.2	553.0	17	744.6	1070.0	93.5
Construction volume, m ²	9449.03			12207.87			18.6
Building area, m ²	689.71			689.71			-
Dwelling area, m ²	1788.7			2128.1			
Total area, m ²	2657.8			3174.8			

The complex development is coordinated with the general contractor; it was carried out in parallel with the first experience of reconstruction of similar buildings in the city and therefore takes into account the solution of the issues arising in this case, and therefore, will find wide application in the reconstruction of similar objects; the developed methodology of formation of organisational and technological solutions on the basis of standard network

modelling is also applied by us on other objects - brick residential buildings in the cities of Arkhangelsk and Severodvinsk.

The network models developed in the process of research, timetable plans for reconstruction of objects, technological maps and other organisational and technological documentation, collected information materials are used in course and diploma design, study of special disciplines by students of the Higher Engineering School.

4 Results

Based on the above, we can conclude that the research goal has been achieved - the methodology of forming rational organisational and technological solutions for the reconstruction of residential buildings of the first mass series has been developed and successfully applied. The proposed methodology has shown sufficiently high efficiency and has good prospects for further application and improvement, including in the directions of organisational and technological design of complex reconstruction of residential quarters and in the planning of work on the implementation of the production programme of construction and installation companies. The research results are recommended for design, construction and design-building organisations and enterprises.

5 Conclusion

Thus, the results of scientific research and practical developments to improve the process of organisational and technological design of reconstruction of residential buildings of the first mass series allow us to objectively assess the possibility of effective application of the developed methodology and proposed models for real planning and management in construction production, as well as for the training of students at universities in the field of "Construction" and advanced training of specialists.

Conflict of interest

The authors confirm that the presented data do not contain a conflict of interest.

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