

## *Теория и практика устойчивого экономического развития*

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### **EVALUATING THE EFFICIENCY OF RECONSTRUCTION SOLUTIONS FOR RESIDENTIAL BUILDINGS OF MASS SERIES BY VALUE INDICATORS**

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**Keywords:** housing stock; depreciation; reconstruction; estimated cost; technical and economic indicators; efficiency.

**Abstract:** Possible solutions for reconstruction of residential buildings of standard series are considered. The analysis of studies on the reconstruction of buildings in the world practice is conducted. The existing methods of technical and economic assessment of the effectiveness of the reconstruction of apartment buildings are analyzed. Using the example of the housing stock of the Tambov region, a study of the values of the technical and economic indicators of the space-planning solution of the building was carried out; the cost estimation of reconstruction with the construction of superstructures or extensions to the building was made in order to find the most optimal solution.

In modern conditions, in conditions of an increasing volume of physical and moral depreciation of the country's outdated housing stock, an urgent direction in solving the housing problem is the reconstruction of residential buildings of the first mass series. Demolition and reconstruction of "Khrushchevka apartments" is a difficult task, both due to its scale and due to the technical complexity of its solution [1].

The experience of reconstruction of the existing housing stock with the use of new technologies indicates the possibility of obtaining additional comfortable housing with lower financial costs than would require new construction [2].

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Consequently, the stage of assessing the economic efficiency of the reconstruction of residential buildings is one of the defining ones in the design of the reconstruction of a residential building. In this regard, an attempt was made to analyze possible options for the reconstruction of residential buildings for the conditions of the Tambov region from the standpoint of optimizing its cost.

The analysis of the existing methods of technical and economic assessment of the effectiveness of the reconstruction of residential buildings shows that the assessment of the effectiveness of the reconstruction of multi-apartment residential buildings of the existing stock is usually carried out on the basis of two aspects: determining the relative (comparative) effectiveness of reconstruction in comparison with new construction and the economic efficiency of the invested capital for a specific construction project. For this purpose, methods are used to determine the national economic and financial efficiency. The system of indicators of national economic efficiency allows for a comprehensive assessment of economic efficiency, taking into account the social consequences and costs associated with social measures. The system of indicators is based on determining the relative technical and economic efficiency of the reconstruction of a residential building and reflects the ratio of the entire complex of costs associated with the reconstruction, and the results that are achieved as a result of construction, installation and repair work.

The search for cost-optimal solutions in the field of reconstruction of residential buildings presupposes taking into account the modern experience of holding such events. When solving this problem, two main approaches can be distinguished: “surgical” and “therapeutic”.

The “therapeutic” approach presupposes, first of all, the restructuring of buildings (changing the number of floors, erecting “built-in” buildings, adding loggias and elevators, etc.). The “surgical” approach implies the demolition of buildings and the erection of new buildings on the vacated territory. This method of renovation can be justified only in case of dilapidated buildings or extreme high cost of land, which is relevant mainly for the capital region. An interesting experience in the reconstruction of residential buildings is in Germany in the light of the concept of increasing the comfort and prestige of the residents’ living conditions [3].

In general, an analysis of the existing experience in the field of renovation of residential buildings abroad indicates that:

- construction of standard residential buildings of mass series was carried out in more than 20 European countries;
- no country in the world has demolished typical residential buildings of industrial housing construction;
- Western European countries have accumulated extensive experience in solving organizational and technological problems of reconstruction of buildings of the first mass series;
- in foreign countries, the work is organized with residents of buildings subject to reconstruction, headquarters are created for collective discussion by citizens of the problems of reconstruction of their own homes;
- the foreign experience of the reconstruction indicates that the sources of financing for the reconstruction of residential buildings can be both the state budget and the funds of investors, and the funds of the residents of the buildings being reconstructed.

Typical buildings of the 1-447C-38 series, which are widespread in the development of the city of Tambov, were taken as the object of research to assess the cost of the reconstruction of residential buildings in the Tambov region [4]. The study was carried out on the example of a 4-floor two-section brick residential building series 1-447C-38, located in the city of Tambov at 86 Michurinskaya Street. The existing space-planning solution of a residential building only partially meets modern requirements and needs redevelopment during the reconstruction process [5, 6].

The technical condition of the building can be described as satisfactory. The building has a large time resource for the operation of the main supporting structures and is suitable for further operation after reconstruction. In accordance with the project for the reconstruction of the building, various options for changing the existing space-planning solution were envisaged, namely:

- implementation of an extension to the existing building;
- superstructure of the building volume up to five to six floors;
- redevelopment of apartments, taking into account changes in the volume of the building.

As options for the reconstruction of the building, the possibility of adding one or two floors was considered, as well as the construction of an extension with different number of floors. Combined options were also considered, providing for both the superstructure of the main part and the possibility of an extension with different number of floors. In total, eight reconstruction options were considered. The options provided for both the construction of a superstructure with a height of 1-2 floors, and the construction of an extension with different number of floors, taking into account all possible cases (see Table 1).

The economic substantiation of the choice of the option for the reconstruction of the building was made on the basis of calculating the estimated cost of the work. When carrying out calculations for the economic justification of the cost of reconstruction, the AROS-Leader 2.0 software package, version 5.3.4 (03/30/2020) was used. The calculations were carried out according to the methodology for determining the cost of construction, reconstruction, overhaul, demolition of capital construction, works to preserve

Table 1

### Characteristics of options for the reconstruction of the original building

Characteristic	Variants							
	1	2	3	4	5	6	7	8
Reconstruction of the original part	yes							
The presence of an extension	yes						no	yes
Number of floors of the extension	4	5	6	–	5	6	–	6
The presence of an extension	no			yes				
Number of floors of an extension	–			1			2	

cultural heritage objects (historical and cultural monuments) of the peoples of the Russian Federation on the territory of the Russian Federation using the base-index method for determining the estimated cost. The calculations took into account the conditions for the reconstruction in Tambov. The estimate documentation was drawn up in the FSNB-2001.

In the feasibility study of the options, the data of local estimates were used, the estimated cost of which was determined on the basis of collections of territorial unit prices for 2001 and collections of territorial estimated prices for materials, products and structures, collections of prices for equipment installation, approved by order of the Ministry of Construction of Russia dated February 28, 2017 No 361/pr.

The standards for overhead costs were adopted according to the methodological instructions of the IBC 81-33.2004, the standards for profit were adopted on the basis of the guidelines of the IBC 81-25.2001. The coefficients used in the absence of the necessary unit prices in the collections of unit rates for repair and construction work are applied: coefficient to the wages of construction workers  $K_w = 1.15$ ; to the norms of operating time of construction machines  $K_{cm} = 1.25$ ; to the wages of workers employed in the management of machines  $K_{emm} = 1.25$ ; coefficient to the norms of labor costs of workers  $K_{lc} = 1.15$ ; coefficient to the rates of labor costs of workers engaged in the management of machines  $K_{cwm} = 1.25$ . The total estimated cost of construction in current prices was determined as of the 2<sup>nd</sup> quarter of 2020 with  $K = 10.68$ .

Based on the results of calculating the estimated cost of reconstruction of the options, an analysis of costs by type of work for each reconstruction option was performed. In general, analyzing the distribution of costs by type of work for various reconstruction options, it should be noted that most of the costs (on average 20 – 25 %) are spent on insulation of the building facade [7]. This implies the need for a mandatory analysis of the constructive solution of facade systems in terms of optimizing their cost. Another possible source of cost savings is the use of cost-effective material resources when performing work on replacing window and door openings, roofing and finishing works.

To assess the economic efficiency of the considered options for the reconstruction of a residential building, an analysis of their technical and economic indicators was carried out. The main technical and economic indicators were:

- construction volume of the building,  $m^3$ ;
- total area of the building,  $m^2$ ;
- increment of the total area as a result of reconstruction,  $m^2$ ;
- estimated cost of reconstruction in current prices, thousand rubles;
- estimated cost of reconstruction in basic prices, thousand rubles;
- cost of materials in current prices, thousand rubles;
- cost of materials in basic prices, thousand rubles;
- labor intensity, man-h;
- cost of reconstruction of 1  $m^3$  of the building volume, thousand rubles;
- cost of reconstruction of 1  $m^2$  of total area, thousand rubles;
- cost of materials per 1  $m^2$  of total area, thousand rubles;
- labor intensity of reconstruction of 1  $m^2$  of total area, man-hour;
- cost of 1  $m^2$  of the incremented total area, thousand rubles.

As can be seen, when searching for the best solutions to reconstruct buildings, not only cost indicators were taken into account, but also the labor intensity of work, referred to the total area of the building. It was assumed that the lower the unit labor costs, the more this option is effective from the point of view of the organization of construction production.

An attempt was made to analyze the options in terms of the increment in the total area of the building as a result of reconstruction. This indicator is significant taking into account the chosen reconstruction concept: the need for maximum compaction of buildings in the face of increased demand for housing or the creation of a comfortable living environment (the experience of East Germany). Taking into account the fact that in the domestic practice of reconstruction, the “therapeutic” approach prevails, which was previously discussed, a high increment in the total area of the building in the case of acceptable cost indicators of reconstruction is a sign of the optimality of the option.

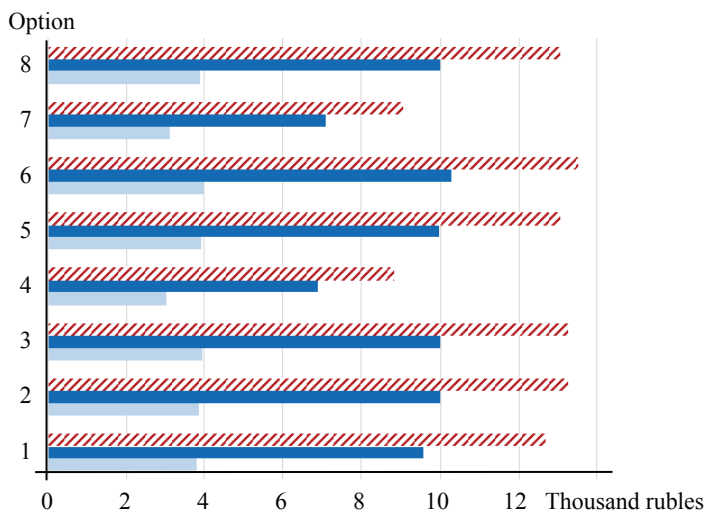
A summary of the cost of renovation options is shown in Fig. 1.

Analyzing the diagram, it can be seen that the most optimal options can be recognized as those that provide for the implementation of one or two floors above the reconstructed building (fourth and seventh options).

The reason that the options with the addition of one or two floors are the most effective is the fact that the costs do not include the costs of preparatory work, earthworks, the construction of foundations, and the installation of utilities.

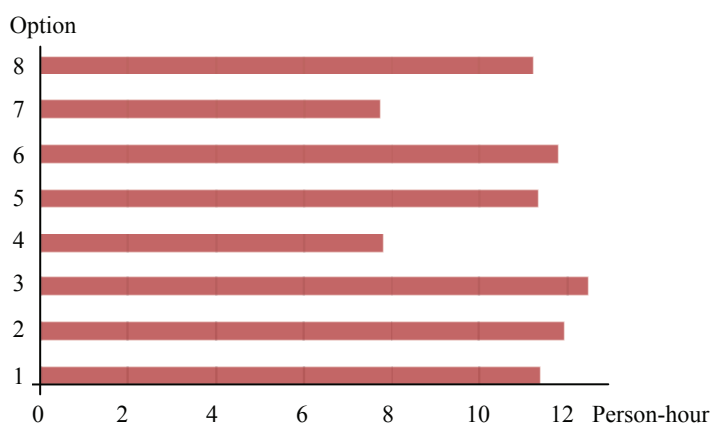
This conclusion is confirmed by the analysis of labor costs per 1 m<sup>2</sup> of total area by options (Fig. 2). However, in order to make a final judgment, it is necessary to analyze such an indicator as the increment in the total area as a result of reconstruction and its cost per 1 m<sup>2</sup> (Fig. 3, 4).

The significance of this indicator determines the goals of the reconstruction. If it is required to compact the building as much as possible, it is necessary to obtain a significant increase in the total area as a result of reconstruction.

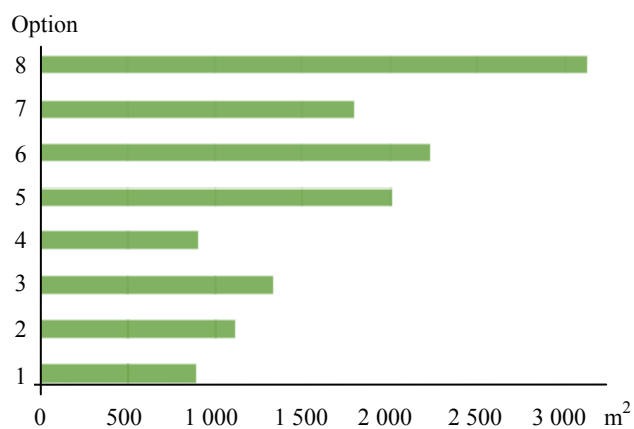


**Fig. 1. Summary of cost indicators for renovation options:**

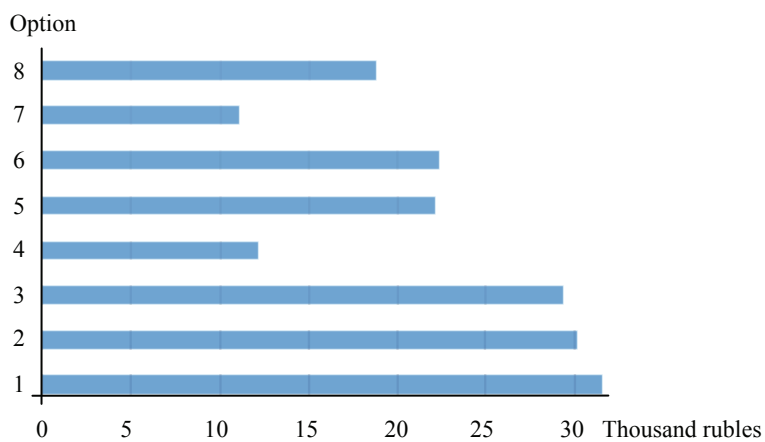
- cost of reconstruction of 1 m<sup>3</sup> of the building volume
- cost of materials per 1 m<sup>2</sup> of total area
- cost of 1 m<sup>2</sup> of the incremented total area



**Fig. 2. Complexity of reconstruction 1 m<sup>2</sup> total area**



**Fig. 3. Increase in total area as a result of reconstruction**



**Fig. 4. Cost of 1 m<sup>2</sup> incremental total area**

Since in the domestic practice of carrying out reconstruction, along with the need to eliminate the physical and moral deterioration of the reconstructed building, this is the goal, this indicator is of great importance.

The analysis of the increment in the total area as a result of reconstruction leads to the expected result – the maximum value of the increment in the total area in the eighth option, which provides, along with the superstructure of two floors, the construction of a six-floor extension. The fifth and sixth options also have good indicators, in which, along with a one-floor superstructure, five and six-floor extensions, respectively, are assumed.

The lowest indicators of the cost of 1 m<sup>2</sup> of the incremented total area have the fourth and seventh options, which is explained by the above reasons (respectively 12.173 and 11.103 thousand rubles). However, the third desirable solution in terms of the value of 1 m<sup>2</sup> of the increased total area is the eighth option, which provides for the maximum increase in the total area as a result of reconstruction. A good indicator of the cost of 1 m<sup>2</sup> of the incremented total area was revealed in the fifth option, which provides for the addition of one floor and a five-floor extension.

Thus, the optimal cost indicators are options that provide for a one-two-story superstructure of an existing building. If it is necessary to carry out compacting reconstruction of buildings, combined options are effective, providing, along with a one-two-floor building superstructure, the construction of a five-floor or six-floor floor extension.

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### **Оценка эффективности вариантов реконструкции жилых зданий массовых серий по стоимостным показателям**

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**Ключевые слова:** жилищный фонд; износ; реконструкция; сметная стоимость; технико-экономические показатели; эффективность.

**Аннотация:** Рассмотрены возможные варианты проведения реконструкции для жилого здания типовой серии. Выполнен анализ работ по реконструкции застройки в мировой практике. Проанализированы существующие методы технико-экономической оценки эффективности реконструкции многоквартирных домов. На примере жилого фонда Тамбовской области проведено исследование значений технико-экономических показателей объемно-планировочного решения здания и стоимостных показателей затрат на проведение реконструкции с возведением надстроек или пристроек к зданию в целях установления наиболее оптимального варианта.

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