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METHODOLOGICAL JUSTIFICATION FOR THE PROCESS OF RESTORATION WORK TO STRENGTHEN THE STRUCTURES OF ARCHITECTURAL MONUMENTS

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Abstract
This article describes the methodological justification for the process of restoration work to strengthen the structures of architectural monuments. This is a good program for researchers in this direction.

Key words: architectural monuments, construction, restoration, operation, reinforced concrete, deformation, technology, modern design.

Абстрактный
В данной статье описано методическое обоснование процесса реставрационных работ по усилению конструкций памятников архитектуры. Это хорошая программа для исследователей в этом направлении.

Ключевые слова: памятники архитектуры, строительство, реставрация, эксплуатация, железобетон, деформация, технология, современное проектирование.

The acute relevance of modern problems of restoration work, a new level of its formulation, as well as the most diverse experience of restoration urgently require a comprehensive analysis. Historical and practical material, concentrating unique examples and long-standing traditions, is the basis for a great deal of work on creating a theory of restoration. Many provisions of the fundamentals of the theory and methodology of restoration are of certain interest for modern Russian architecture.
Nowadays, the protection of cultural monuments is turning into an independent branch of the national economy. This is confirmed by the ever-increasing volumes of restoration work and the expanding network of restoration organizations. The field of restoration has acquired the character of complex actions, significantly expanded the boundaries of scientific and methodological foundations and revealed the possibility of moving from unique objects of restoration to setting tasks for the restoration of complex ensembles.
At the present time, a system of certain restoration patterns has developed in works with architectural heritage. It provides the following provisions:
complete preservation of the architectural environment;
preservation of the historical identity of each historical fragment of the city;
preservation of historical street facades;

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the possibility of setting up new buildings in the historical environment until they are fully architecturally and aesthetically linked to the old environment;
full and mandatory functional use of ancient buildings;
full provision of housing in a historical environment with modern engineering, communal and welfare conditions;
preservation of original elements (their conservation) during the restoration of individual historical objects;
the use of new building materials in the restoration and imitation of previous forms of monuments. [1].

Monuments of cultural history, including works of architecture, deserve attention and care from society due to their special historical, artistic, aesthetic and material merits. Measures of these advantages of a historical or artistic work, both during its creation and throughout the life of many generations, can serve as a category for the quality of the work - its value. Moreover, in different periods, historical quality values could change depending on the requirements placed on them. For example, at the time of creation of a structure there may have been no historical or scientific restoration value. However, under certain conditions, depending on the surrounding buildings or changes in the city's planning scheme, etc. The urban planning value of individual buildings and an entire fragment of old urban development may change.

The classification of types of conservation, repair, restoration and restoration work carried out is constantly being improved. The need for dynamic development, ensured by the scientific and technical achievements of the time, leads the restoration process to qualitative and quantitative changes.

Large restoration or repair and restoration work on outstanding objects, be it free-standing architectural monuments, architectural complexes or historical ensembles, is recommended to be preceded by the implementation of a theoretical restoration model - a general restoration project.

The theoretical restoration model is based on the qualitative values of the object. Such values for the general restoration project are: historical, urban planning, architectural, artistic and aesthetic, scientific restoration, functional.

The theoretical model is compiled on the basis of: preliminary studies completed in full; developed research design plans; the nature of the restoration production and the planned final result of the restoration. If necessary, in addition to the drawings of the general restoration project , economic data are presented that characterize the aggregated indicators of the cost of restoration work, the timing and stages of production.

The practice of restoration work and a change in attitude towards the preservation of architectural heritage have led to the need to take into account the historical , albeit non-simultaneous, environment of individual monuments. Taking into account historical buildings was required due to the need to introduce modern buildings into the historically developed architectural and spatial environment of cities. Quite naturally, many cities almost simultaneously faced the problem of constructing new buildings

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within the historical center while preserving the historical identity of the city as fully as possible. The engineering and technical capabilities of multi-storey modern buildings often create conflict situations, disrupting the architectural and urban planning organization and harmony of old cities . This naturally requires finding ways to overcome the obstacles that prevent the implementation of a positive approach to the conservation of architectural heritage.

Preventive work is important in the protection of architectural monuments and provides an intermediate link in the field of technical measures that are designed to delay the threat to the condition of the building caused by certain reasons and to help increase its durability.

Timely and correctly carried out preventive measures lead to an improvement in the condition of the building, prevent the development of destruction processes and create more favorable conditions for carrying out a set of conservation and restoration works, decisively influencing the volume of work and financial costs of restoration in the future.

During the process of monument protection, various issues may arise. From a technical point of view, they can be divided into three main areas:

preventive work associated with the use of various means to prevent the destruction of an object from the effects of precipitation, discharges, etc. (moisture, fires, fungi, parasites), preventing mechanical and chemical damage to those elements of the building that are associated with its external or internal finishing and operational comfort;

work related to maintaining strength and covering measures for temporary strengthening of the building structure and its individual elements. In this case, the volume and nature of the work are determined by the technical condition of the structures and the degree of possible threat;

protection of the territory on which the object is located. Its violation or neglect is fraught with dangerous consequences in the future. Here the main task is to prevent the consequences of movements and vibrations of the foundation, imbalances in soil masses, turbulent action of water, growth of vegetation, etc.

The effectiveness of monument protection work is closely related to systematic monitoring of the condition of the building and timely identification of dangerous areas of destruction.

From a technological point of view, protection measures can be temporary or permanent. In both cases, the means used are closely related to the program of work to protect the monument. [1].

Restoration practice has a variety of methods and methods of temporary and permanent protection, and these problems become more complex the more ruined the object is.

Restoration and strengthening of damaged or dilapidated load-bearing structures of a building is part of a general program of restoration work, closely related to the issues of stabilization and consolidation of the structural organism. Most often, these works represent one of the most significant activities in the conservation of the monument.

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The purpose of restoration and strengthening is to return structural systems to the ability to perform certain operational functions, to increase their strength, stability and resistance to various destructive processes.

The specified work is usually preceded by a study of the structural features of the building, including the design features of the damaged elements, the technical condition of the building, the nature and extent of damage and destruction, as well as their causes. Restoration and strengthening measures should be carried out in such a sequence as to first of all eliminate the causes of deformation and destruction of the main supporting system; then the parts of the building buried in the ground and those elements on which its strength and stability depend are subject to reinforcement. Even the most careful work in the above-ground parts of the building will not be able to prevent their further destruction, unless the deformation of the base is first stabilized and the possibility of developing sources of damage in the future is not eliminated . [2].

From a technical point of view, restoration and enhancement methods are characterized by great diversity. Reinforcement and restoration work usually begins with foundations and other supporting structures associated with them. As a rule, they cover small fragments of walls and individual elements of stone structures, and the restoration criteria applied to them can be divided into two groups: restoration and strengthening of the underground parts of the building and restoration and strengthening of the above-ground parts.

In the first case, decisions regarding the choice of means and methods of reinforcement can be made with sufficient freedom; this applies to both the types of materials used and the technology of work. It should not be forgotten that old structures and their elements must be protected in such a way that access to them is always provided and the necessary conditions are created for carrying out research in the future.

Restoration and strengthening of elements and structures of the above-ground parts of buildings play a huge role in the technical field of monument protection. This type of restoration work is most consistent with the principles of protection and conservation of monuments, since preventing the destruction of masonry and other elements, their restoration and strengthening are the most necessary measures aimed at maintaining and preserving the condition of the monument. It is quite clear that the higher the quality of the work, the longer the monument will be preserved. This leads to other requirements - when performing reinforcing and restoration work, you cannot use materials that are easily destroyed or can cause destruction.

Quite often there is a need to strengthen parts of a building buried in the ground, especially foundations and underground masonry. The future fate of the monument largely depends on these works.

The need to strengthen the underground parts of the building can be dictated by the following considerations:

a) the structure of masonry elements is characterized by serious weakening in the form of cracks, voids, leaching of mortar, disruption of ligation, etc.;

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b) a change in the purpose of the building, new conditions for its operation, including increased loads that require an increase in the load-bearing capacity of the structural elements under consideration;

c) defects in the design of foundations and the actual conditions of their operation, requiring strengthening, expansion, deepening or superstructure of foundations.

The method of strengthening stone structures and elements buried in the ground - depends on their functional and structural purpose, as well as on signs of damage. Therefore, first of all, you should pay attention to foundations and foundation walls, and depending on the nature of the technological operations, three main issues can be distinguished here—strengthening the foundation, strengthening the masonry structure and strengthening the entire structural system. [3].

Strengthening the masonry structure. Foundation walls, as well as strip and pillar foundations, laid out of brick or stone with mortar, characterized by weakening of the structure due to the action of the above factors, can be effectively strengthened using injections.

Sometimes the type of materials used in the construction of a building and the work technique exclude the possibility of reinforcement using injections, for example in the case of stone foundations loosely bound with clay, gypsum or lime mortar with impurities that enter into chemical reactions with the cement mortar. In this case, a reinforced concrete cage can be used for reinforcement.

The shape of the reinforced concrete frame depends on the shape and size of the foundation. This method of reinforcement is advisable to use for pillar foundations for various columns and racks. At the same time, the cage counteracts the transverse deformations of the masonry located inside it, increases the overall rigidity and load-bearing capacity of the structure, and also ensures a more uniform transfer of load to the ground.

Strengthening the structural system. Strengthening the structural system of foundations depends on their operating conditions and, to a large extent, on the quality of the foundation. Among the main techniques one can highlight strengthening by widening the base, by laying new foundations (with greater depth), as well as by adding foundations, which, however, is not related to bearing capacity, but to functional considerations. In special cases, reinforcement is carried out using piles, manholes and other structures.

Widening of foundation walls. If there is high-quality soil under the foundation and the structure of the foundation masonry does not cause concern, then the foundation can be strengthened by expanding it on both sides. Such reinforcement is carried out when it is necessary to reduce pressure on the ground, and laying the foundation base provides access to it from both sides. quality of the base. Among the main techniques, one can highlight strengthening by widening the base, by laying new foundations (with greater depth), as well as by adding foundations, which, however, is not related to bearing capacity, but to functional considerations. In special cases, reinforcement is carried out using piles, manholes and other structures.

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Widening the foundation can also be done by placing a reinforced concrete slab or precast concrete elements under the old foundation. In this case, strengthening work is carried out in sections of length 1 - 1,5 м, i.e., exactly the same as when installing horizontal waterproofing. Excavation of the foundation in a neighboring area can only be done after the completed area has acquired the ability to bear the load. And in this case it is necessary that the new parts are firmly connected to the old ones. To do this, the exposed parts of the base should be cleared of soil and washed with water so that the new parts of the foundation fit snugly against the base of the old one.

Deepening the foundations. The need to increase the depth of foundations may arise when, due to soil erosion or partial cutting, it turns out to be less than the depth of soil freezing or if the soil under the foundation is too weak to safely bear the corresponding loads. In this case, it becomes necessary to support the foundation on stronger layers of soil, if, of course, they do not lie too deep. A similar need may arise when soil is washed out from under the base or in the case when wooden piles underneath have rotted, and hydrological conditions allow the foundation to be deepened to the underlying load-bearing layers.

a new building is planned to be erected in the vicinity of the monument, the depth of the foundation of which exceeds the depth of the foundation of an ancient building, or if there is a need to deepen the existing underground premises in the building to a level below the existing foundations .

An increase in the depth of the building can be carried out under the entire building or under its individual parts . The laying of foundations should begin with the most weakened parts and be carried out in sections of length 1 - 1,5 мin compliance with the following principles.

If the foundation masonry is cracked and weakened, then its structure should first be strengthened. Especially old foundations that are destroyed and unsuitable for technical reasons for strengthening are recommended to be dismantled and re-laid, or removed altogether and replaced with a new foundation with the required depth.

To strengthen the old foundation or install a new monolithic or prefabricated reinforced concrete foundation on a given pit with a depth of up to the load-bearing layer. Digging of an old foundation should be done with great care, using appropriate protective equipment. The new foundation must be located on soil with an undisturbed structure. Typically, the soil under a new foundation is compacted by driving gravel or crushed stone into it with a particle size of up to 5 см.

After placing a new foundation under the base of the existing one, both structures should be securely connected to each other. If the new foundation is made of monolithic concrete or reinforced concrete, then such a connection is made after it hardens, and in the case of a new foundation made of brick, stone or concrete blocks - after the wall reaches the appropriate strength. When connecting the base of an existing foundation with a new one, steel wedges are driven into the gap between them and a cement mortar (1:3) is supplied, which is thoroughly compacted. Upon completion of work on the next section, you can move on to the next one in accordance with the work plan.

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Strengthening foundations by digging or supporting them on piles or sinkholes is difficult and expensive. Particularly significant difficulties arise when work involves digging out deep foundation pits and combining existing foundations with a new reinforcing system. Any work related to the installation of additional and auxiliary structures is always fraught with danger. Therefore, before deciding to strengthen foundations by increasing their depth, one should consider the possibility of strengthening the ground part of the building to absorb tensile stresses caused by abnormal behavior of the foundation. This concerns mainly the strengthening of walls and ceilings and ensuring the minimum required spatial rigidity of the building so that it itself can withstand increased stresses.

Traditional methods of strengthening should also include all work related to the reconstruction and relocation of destroyed structural elements. In this case, depending on the nature of the deformations and the scale of destruction, it is possible to envisage either partial filling of the missing parts with new masonry, or dismantling and removal of destroyed structures or parts thereof and replacing them with similar structural forms when using modern masonry systems (for example, the use of masonry with longitudinal or transverse reinforcement from old bricks or suitably hewn stone on external surfaces).

The use of traditional stone working technologies for restoration work in many cases seems to be the only way to proceed.

Prestressing creates great opportunities for eliminating cracks, strengthening and stabilizing separated parts of a building. The idea of prestressing has been known for a long time. It comes down to artificially creating a stressed state in a brittle material that would effectively resist the action of external forces and increase the load-bearing capacity or overall rigidity of the structure. Nowadays, prestressing is successfully used in concrete structures and can also be used to strengthen masonry structures. In this case, the task comes down to laying prestressed reinforcement in the crack development zone, securing it in the corners of the building and stressing it to such a value that causes the appearance of compressive forces in the masonry corresponding to its strength capabilities. [1].

Among the various deformations of ancient buildings, their deviation from the vertical axis is especially alarming. Most often, such deviations are noticeable in end walls, fortress walls, towers , and minarets. The reasons for these deformations can be different; in particular, they can develop due to uneven settlement of foundations, structural defects, etc. Deviation from the vertical is usually accompanied by vertical cracks and disruption of spatial connections. As a result of the deviation, the center of gravity of the building shifts in the direction of the tilt, which causes an increase in stress under the base of the foundation or in the horizontal plane of rotation. Even in well-bonded walls, horizontal cracks appear on the side opposite the slope due to the action of the bending moment. An increase in this moment can cause the building to collapse.

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The initial measure to stop the rotation should be the installation of an auxiliary structure that prevents further deviation and ensures stabilization of the element or building before work begins directly on its straightening.

If the wall deviates in the absence of emergency signs, it can be straightened in a well-known way using steel cables wound on winches or screw jacks. The straightening process is preceded by preparatory work, including determining the axis of rotation and installing wedge-shaped grooves or grooves along this axis on the side opposite to the slope to a depth sufficient to establish the center of gravity of the wall exactly above the center of gravity of the foundation. Before straightening, the bending moment due to the wall's own weight should be checked and protective measures should be taken to ensure that no damage occurs in the upper parts during straightening. After returning the wall to a vertical position, further construction and restoration work is carried out.

In the process of straightening towers and other buildings, methods based on the principle of uneven lowering on the opposite side of the slope, or on the principle of uneven tilting on the inclined side, can also be used. Restoration of architectural objects also includes the preservation of elements of functional and artistic decoration of facades and interiors.

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