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CONDITION SURVEY AND RECOMMENDATIONS REGARDING THE REPAIR OF THE FACADES OF THE HISTORICAL BUILDING IN THE BESARABSKYI QUARTER IN KYIV

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Abstract

The article describes the work carried out during 2021 – 2022 on the condition survey of building facades in the so-called historical Bessarabian quarter in Kyiv. The purpose of the survey is to identify defects and damage that were acquired during the operation of the facades and can reduce their durability. The following methods were used: visual – when determining the technical condition of structures based on external features; analytical – when assessing the technical condition of the surveyed object, instrumental – when studying the physical and mechanical indicators of structures. Based on the received survey data, recommendations were formulated regarding the facade restoration technology. It is recommended to focus specifically on the method of dismantling the existing decorative layers of the facade and replacing them with new ones. This approach will maximally extend the service life of the facade of the historic building.

***Keywords**: Bessarabskyi quarter; Kyiv; Façade; Architectural monument; Visual survey; Instrumental survey, Restoration; Repair*

Introduction

The historical Besarabskyi quarter is located between Velyka Vasylkivska Street, Basseina Street and Besarabska Square and was built in 1894 – 1901 according to the project of architect A. Krauss in the style of historicism. In Soviet times, medical institutions, shops, student dormitories and apartments were located here. In 1986, the residents of the quarter were evicted due to the dilapidated condition of the buildings, and for 15 years it was in an abandoned state. As of 2001, the physical wear and tear of individual structures was up to 95%, and at that time, some walls and floors collapsed, biofouling was observed, some walls had cracks, and the foundations were jammed. The reconstruction and restoration of the buildings of the Bessarabian quarter with a change of function was carried out in 2002 – 2005 by the corporation "Ukrrestavratsiia" according to the project of the author's team under the leadership of Vadym Zhezherin Historians of modern architecture evaluate this work as "one of the most significant urban planning actions of Kyiv at the turn of the millennium", noting it as a manifestation of neo-historicism on Ukrainian soil [1]. The buildings of the quarter, which was to be reconstructed, did not have the status of architectural monuments (and during the

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reconstruction of the quarter, a significant number of them were demolished), however, it was decided to preserve part of the historical facades, in particular those facing the corner of Velyka Vasylkivska and Basseina streets. Preservation of historical facades can be considered as an action aimed at preserving the main characteristics of the formed historical environment in the central part of Kyiv, although some buildings underwent substantial reconstruction.

As a result, the old foundations were strengthened with almost 2,000 driven piles, the destroyed parts of the facades were recreated and supplemented with new ones in the same style, and metal braces were installed on the historical walls. The most difficult issue was engineering and technical equipment for modern functions. Initially, the facades of the building were made of the famous grayish-yellow Kyiv brick, but during the period of operation before the reconstruction of the Bessarabian quarter, the original surface of the brickwork was repeatedly painted, and in some places it was plastered, and the condition of the front surface of the brickwork was unsatisfactory. Therefore, it was decided that after cleaning and removing the exfoliated parts of the brickwork, it should be covered with a layer of plaster, and painted and stitched with seams, imitating brickwork.

During operation, damage appeared in the structures of the historical part of the building, in particular, in part of the facades at the corner of Velyka Vasylkivska and Basseina Streets, 1-3/2. In this regard, a survey was carried out, the purpose of which was to determine the actual technical condition of the structures of part of the facades and to develop recommendations for repair and restoration works to extend the service life.

Materials and methods

The following general scientific methods were used in the study: *visual* – when determining the technical condition of structures based on external features; *analytical* – when assessing the technical condition of the inspected object, *instrumental* – when studying the physical and mechanical indicators of structures.

Given the experimental and exploratory nature of the research, sources covering the following aspects were involved:

a) problems of the territories' revitalization – publications by *M. Dyomin et al.* [2, 3];

b) the transformation of historical buildings into public spaces, including the artistic direction (since the famous art gallery Pinchuk Art Center is located in the Bessarabskyi quarter) – articles by *A. Dmytrenko et al*. [4], *O. Ivashko* [5], *M. Orlenko and Y. Ivashko* [6], *M. Orlenko and O. Ivashko* [7];

c) problems of preservation of the historic environment – the works of *P. Spiridon et al.* [8], *L. Pujia* [9], *V.A. Nikolaenko et al.* [10].

d) питання, пов'язані з конкретними матеріалами та технологіями – articles by *P. Krivenko et al*. [11, 12, 13], *L. Luvidi et al.* [14], *M. Furtak et al.* [15], *T. Savchenko* [16].

It is known that the appearance of a significant part of defects and damages, failures and accidents occurs during the construction process and the first period of operation of buildings and structures. The main factors leading to this include the following: design errors, insufficient quality of materials and products, errors in construction and assembly work, settlement of foundations, temperature and humidity changes, etc. At the same time, the greatest intensity of element failures refers to the third period – intense dilapidation, which is mainly related to the physical ageing aggression of individual building structures and the building as a whole [17].

Errors embedded in design documentation most often appear as defects already during construction or at the initial stage of operation, namely after design loading of structures.

In the initial period of building operation, the mutual beaking-in of elements in a complex single system of the building takes place. There is a decrease in mechanical indicators, strength and deterioration of operational characteristics of structures. All of these changes can be both general and local, they occur independently and in aggregate. During this period, there is a shift and detachment of the inner walls from the outer ones, shrinkage, temperature deformations of the structure, creep of materials, etc.

The period of main operation is characterized by gradual wear and tear of the load-bearing and enclosing structures of buildings and structures. During this period, sudden deformations related to the conditions of work and operation of both the object as a whole and its individual elements are possible. The causes of sudden deformations can be temporary or permanent concentrations of loads that significantly exceed the design, creep of materials, unsatisfactory operation, temperature and humidity effects, incorrect and untimely repair work.

The third period is a period of intensive wear and tear of structures, which is associated with the aging of the material and the reduction of its elastic properties. During operation, structural elements of buildings and structures under the influence of external and internal factors gradually lose their operational qualities, that is, physically (materially, technically) wear out. These factors include: atmospheric; climatic; seismic; biological; dynamic; stray currents; aggressive environment (gas, steam, water, acids); dynamic influences, etc.

The analysis of the studied sources became the theoretical basis for the argumentation of the recommendations of the survey of the facade of the building in Besarabskyi quarter.

Results and Discussions

Characteristics of the survey object

The objects of the survey conducted in 2021 – 2022 were the structures of part of the facades of the building 1 – 3/2 at the corner of Velyka Vasylkivska and Baseina Streets in Kyiv. The examined structures represent the facade part of the historical building, which was reconstructed in 2002 – 2005. The structure of the brick facade, 600 – 700mm thick, was reinforced during the reconstruction with steel beams and brackets, as well as reinforced concrete elements. In general, the object, the facades of which are subject to inspection, is a seven-story monolithic reinforced concrete building with an incomplete frame. Spatial stiffness is provided by the joint work of vertical bearing elements, overlapping disks and stiffness diaphragms. The height of the floors is from 3.2 to 4.75m. The building volume is 74,757m^3 with an area of 17,975m^2. The foundations of the building are piles, arranged by drilling injection technology, the diameter of the piles is 620 mm, the length is 24m. To unite the piles, a 1,200mm-thick grillage is arranged along their heads.

The general appearance of the surveyed building is shown in figure 1.

Survey stages

The work was carried out in the following sequence [18]:

– familiarization with the object and the source documentation;

– visual inspection of building facades using a quadrocopter and optical devices;

– 3D scanning of the building facades and processing of the received materials to obtain drawings of the facades, on which the detected defects and damage will be applied;

– instrumental survey: selective determination of the strength of stone structures by non-destructive methods;

– development of facade defect schemes;

– development of a scientific and technical report with conclusions and recommendations regarding repair and restoration works and further operation of the facade of the building.

Fig. 1. The general appearance of the surveyed building. Photo by Oleksandr Molodid, 2021

Methods of surveying building structures and elements

Digital scanning (3D) of the facade was performed using a Leica ScanStation P40 laser scanner. Digital scanning within the scope of the survey was performed due to significant complexity, namely the presence of a large number of decorative elements on the facades (pilasters, cornices, patterns, capitals, balustrade, etc.). Its purpose was to create a 3D model of the examined part of the facade, which was used as a sub-base for creating sweeps of facades on which defects and damage were applied. In addition, based on the created model, in the future, it will be possible to establish the appearance of the structures at the time of the survey, to track possible deformations or damage to the structures. Such a model can be used for further repair and restoration work, in particular at the stage of calculating estimates for establishing the scope of work, etc.

To scan facades, the scanner was moved from station to station along the perimeter of the building with a step of about 5m. In order to capture as many details of the facade as possible, the scanning stations were located at a distance of 1m from the facade, and at a distance of 5 to 10m (depending on obstacles). Thus, two passes along the perimeter of the facade were made.

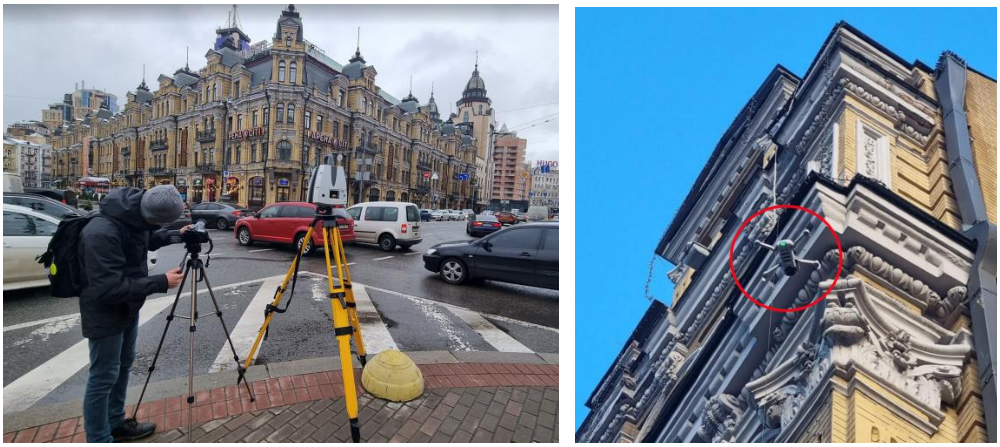
At each of the stations, the laser scanner was installed on a tripod and calibrated in the horizontal plane, the vertical and horizontal scanning angles were set, the geographic coordinates of the scanning station were determined, and actually the scanning itself was performed, which took about 15 minutes at each of the stations. In total, scanning was carried out from about 25 stations.

According to the scanning results, a cloud of points was obtained, which make up the model of part of the facade. Each point corresponds to the position of the facade surface in space and has three coordinates. In addition to spatial parameters, each point contains information about the color of the scan area. The results of the scan are shown in figure 2.

Visual inspection of building structures with the detection and fixation of existing defects and damage received during the period of operation was carried out by inspecting them**.**

Fixation of existing defects was carried out with the help of photography and sketching of defect schemes. Basically, the visual inspection was carried out by searching for defects using a monocular with 8x magnification, after which the defects were sketched and photographed using digital cameras. However, in hard-to-reach places, a visual inspection of the structures was carried out with the help of a DJI Mini 2 quadcopter, which was controlled using a remote control. For precise positioning of the drone on structural defects and damage, a smartphone display with appropriate software was used, onto which the image from the drone's camera was projected. While controlling the drone, photography was also carried out. All photographs that were taken during the survey using a camera and a drone were examined in detail after the survey for the presence of defects that could have gone unnoticed during the survey. The photofixation process is shown in figure 3.

Fig. 2. The result of 3D scanning with a laser scanner



a b

Fig. 3. The process of visual inspection of the building (photso by Oleksandr Molodid, 2021):
a – photographing the building in parallel with the creation of its 3D model; b - photographing hard-to-reach places with the involvement of a drone

Equipment used during visual inspection:
– Sigeta Mirage 8x32WP monocular;
– DJI Mavic Mini 2 quadcopter;
– Canon 60D and Sony DSC-HX50 digital cameras;
– Bosch DLE 40 laser rangefinder;
– roulette;
– a set of probes 0.05 – 1.0mm;
– crack gauge.

Determining the width of the crack opening of the structures was performed using a ruler-crack gauge, probes and a ruler. The width of the crack opening was determined by alternately selecting the thickness of the probes from the thinnest (0.05mm) to the thickest

(1mm) in such a way that it could be pushed into the crack by two to three millimeters, and the probe next in thickness did not meet these requirements.

Determination of brick strength by the ultrasonic method using the UK-39 ultrasonic device

The strength of the structures was determined using the UK-39 ultrasonic concrete strength meter. The strength characteristics of the structures were measured in accordance with the instructions for the device. Places of determination of strength were cleaned of debris and dirt. Before the measurement, it was ensured that there were no sinks and air pores with a depth of more than 3mm and a diameter of more than 6mm, as well as protrusions of more than 0.5mm in the contact zone of the ultrasonic transducers with the concrete surface. At each measurement point, a series of measurements was performed 4 – 6 times. Values with a relative measurement error of the sounding base exceeding 0.5% were considered incorrect and rejected.

The process of measuring the strength of bricks is shown in figure 4.

Fig. 4. The process of measuring the strength of stone facade structures. Photo by Oleksandr Molodid, 2021

Assessment of technical condition: general conditions and results of examination

Since only the facades of the building, which are represented by stone walls, were subject to inspection, the assessment of their technical condition was performed as for a separate building stone structure. The technical condition is expressed in one of four categories:

a) "1" – normal;
b) "2" – satisfactory;
c) "3" – not suitable for normal operation;
d) "4" – emergency.

Normal technical condition is characterized by the absence of defects and damages, as well as deviations from the design.

Satisfactory technical condition is characterized by the presence of minor defects and damages that can negatively affect the service life of the object.

The condition that is not suitable for normal operation can be characterized as a condition in which there are significant deviations from the design requirements, or such defects and damages are found that significantly reduce the load-bearing capacity of the structure. However, their analysis indicates the possibility of ensuring the reliability of structures before repair, reinforcement or replacement.

An emergency state is a state in which the requirements of the limit states of the first and/or second groups are violated. With this category of technical condition, it is necessary to limit people's access to such an object and to survive urgent measures to prevent the destruction of the object.

In order to identify all possible defects that can negatively affect the life of the object in general and its construction in particular, a visual inspection was conducted, during which the detected defects were sketched and plotted on the plans and facades of the building.

Among the typical defects and damages that were detected as a result of visual inspection, the following can be distinguished:

– lack of a decorative layer (lost as a result of mechanical or climatic influences; the most common reason is alternating wetting/freezing of the facade area);

– damage/defects of the furnishing layer (lost or damaged as a result of mechanical or climatic effects; the most common reason is soaking of the facade area);

– force/sediment cracks in stone masonry (formed as a result of changes in the position of parts of the facade relative to each other, as a result of which forces arise in the stone masonry that cannot be absorbed by the masonry elements, with the formation of cracks);

– temperature-moisture cracks, a chaotic network of equipment cracks (arising as a result of temperature deformations of the equipment layers and external overlay elements of the facade);

– holes (holes in the walls through which moisture can enter the middle of the wall structure, and under the influence of negative temperatures destroy the stone structure; the equipment around the holes is subjected to an additional negative effect, in the future it can lead to its destruction);

– absence of head flashings (the head flashing is necessary for the removal of rainwater and meltwater from the horizontal elements of the facade, thereby preventing them from getting wet, the lack of a low tide can cause the destruction of the decorative layer of the facade, and subsequently can cause the destruction of the body of the structural elements of the facade);

– thawing, weathering and destruction of masonry/overlay elements (formed as a result of frequent alternating soaking/freezing of the facade area, which provokes the destruction of stone elements of the facade);

– lack of mortar for grouting the seams between stone elements (a defect characteristic of the seams of the plinth and stairs, which was formed as a result of constant soaking of the plinth, which led to the washing out of the grout of the seams between the stone elements, or as a result of a violation of the technology when grouting the seams, or in as a result of the destruction of the solution of grouting the seams as a result of the subsidence of the structural elements of the base or stairs);

– exposure of unprotected wooden elements to the facade (the defect is characteristic of coverings over dormer windows, wooden elements serve as the basis for the covering, the reason for their appearance on the facade is probably poor performance of work on the installation of equipment);

– cracks on the protective layer of reinforcement of balconies (such a defect is characteristic when, due to constant wetting of structures, the reinforcement located in their middle begins to corrode, which means an increase in the volume of reinforcing elements, which creates a force that acts on the protective layer of reinforcement, because of which cracks appear);

– lack of a protective layer of balcony reinforcement (the next stage of development of the previous defect. Due to excessive efforts, the cracks increase until the protective layer breaks away from the concrete body of the balcony structure);

– absence of decorative overhead elements (the defect is observed on overhead elements and stairs, which, as a result of external factors, have lost any adhesion to the base);

– subsidence of perimeter paving (the defect is present along the perimeter of the entire facade, the cause of which is the soaking of the base of the perimeter paving; the reason may also be an under-compacted base under the perimeter paving, or the lack of a cement layer);

– the junction of the plinth to the perimeter paving (the junction does not ensure the drainage of water from the building, which leads to water flowing under the paving structure);

– deformation of the cross-section of the pipe of the drainage system (due to an increase in the volume of water by 10% during the transition from a liquid state to a solid state, forces arise that change from the inside the shape of the pipe cross-section from a square to a super-ellipse form. This process is possible due to the absence of a heating system inside the drainage pipes);

– loose connection of elements of the drainage system (the reason for this was incorrect installation of the pipes of the drainage system. This defect is the cause of the destruction of both the decorative layer of the facade and the destruction of the body of the elements of the facade in the areas close to which the pipes of the drainage system pass);

– the direction of rainwater and meltwater through the pipes of the water drainage system to the building (the direction of the drainage elbows has been changed in such a way that the water flows in the parallel facade of the direction, and not from it).

As part of the instrumental survey, the strength of the brick was determined, which ranged from 4.3 to 16MPa. Since the facade of the building perceives only its own weight (it is self-supporting) due to the fact that a complete frame was integrated into the main part of the building, which was connected to the facade, such strength values are quite sufficient to perceive the load from its own weight.

The condition of the structures was determined by visual and instrumental inspection, taking into account the defects and damage (Figs. 5 and 6) that were detected during the visual inspection, as well as their quantitative and qualitative indicators, as well as the physical and mechanical characteristics of the structures under inspection. Thus, it can be stated that the examined part of the walls of the facades of building 1-3/2 at the corner of Velyka Vasylkivska and Basseina streets in Kyiv can be classified as technical condition 3 – unsuitable for normal operation.

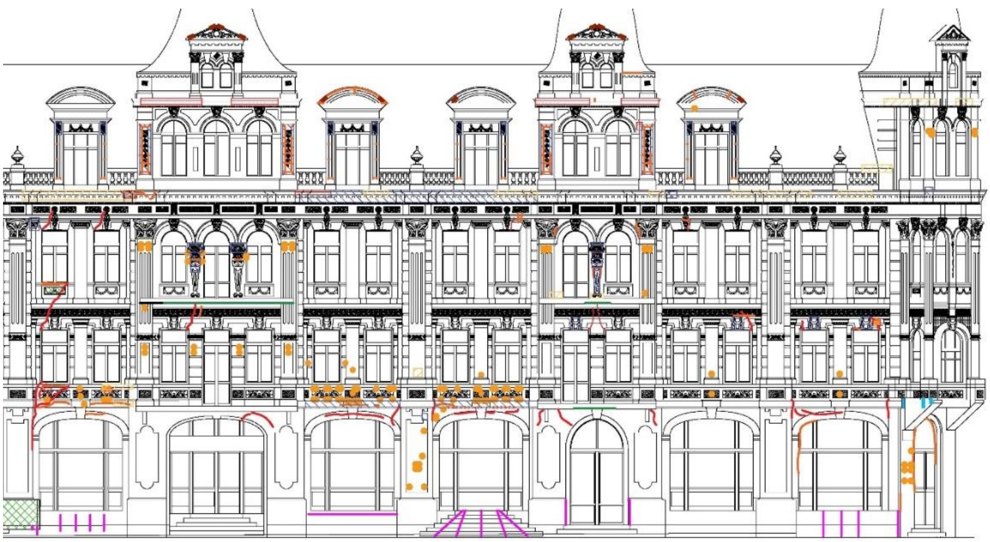


Fig. 5. A fragment of the facade of the building with applied defects and damage.

Fig. 6. Typical facade damages. Photos by Oleksandr Molodid, 2021

To restore the operability of the building's facade and extend its service life, it is recommended to repair it.

Recommendations on methods of restoration of the historical façade

In order to extend the service life of the inspected facade, as well as to eliminate defects that negatively affect both the operability of the inspected facades and their appearance, it is recommended to repair defects and damage that the structures acquired during their operation.

Restoration of the facade is possible by three methods:

– local restoration of established defects and damages;

– hydrojet cleaning of the facade with exposure of hidden defects and subsequent restoration of all existing defects;

– dismantling of the existing decorative layers of the facade and installation of new ones instead.

Local repair of facade defects and damage is a temporary measure that can delay the completion of capital repairs of the facade for 3 – 5 years.

In the process of hydrojet cleaning, under the pressure of a jet of water, defective areas of the plaster layer and masonry will be removed. Thus, defects that would appear in the future will be exposed. In the future, existing defects and damages are repaired. It is predicted that this option will postpone the repair of the inspected facade for 7–10 years. An alternative to this method of cleaning could be sandblasting, but as a result of sandblasting, the cracks of the facade will be filled with sand, which will impair the quality of the repair and restoration work, so this method of cleaning is undesirable.

The best option, from the point of view of extending the service life of the facade structure, is to dismantle the existing decorative layers of the facade and replace them with new ones. This option can extend the service life of the facade from 15 years, depending on the materials that will be used.

Recommendations for the repair of damaged areas are provided based on repair methods and materials of TM "MAPEI" [19].

In case of local restoration of defects and damages, obvious defects and damages that can be seen visually on the facade are subject to restoration (Figs. 5 and 6).

It is recommended to repair the force cracks of the facade by "stitching" them. This is achieved by inserting high-strength steel rods into the body of the structure, perpendicular to the axis of the crack with a step of 150 – 300mm and a length of about 300mm. Another way of strengthening cracks is also possible, which is implemented by gluing the material of carbon fiber bandages on the body, perpendicular to the axis of the crack [20]. The crack itself must be glued using the classic technology of injecting polymer adhesives through packers. This approach makes it possible to stabilize the crack and connect two parts of the body of the structure separated by the crack [21].

Damaged areas of the facade decoration must be removed, after which a new decoration layer of plaster should be placed in their place. In order for the color and texture of the plaster to match the appearance of the main part of the facade, it is planned to paint the plaster with the subsequent application of imitation brickwork seams.

Restoration of a damaged or missing protective layer of concrete is provided for in the same way. For this purpose, the concrete surface is prepared (removal of unbound parts of the concrete body, impurities, etc.) and reinforcement, namely the removal of corrosion and its protection against further corrosion. After these actions are completed, the geometry of the structures is restored using cement-based repair solutions with subsequent painting of the restored areas [22-26].

As mentioned earlier, another possible option for restoring the facade is its water jet cleaning, in the process of which, with the help of a water jet under pressure, the upper layer of the facade is washed from mineral and organic pollution, in addition, thanks to the water pressure, damaged parts of the finishing are removed. The qualitative difference from the first option is that not only obvious (visually visible) defects are repaired, but also hidden ones, that is, those that are impossible or difficult to detect as a result of a visual inspection. Thus, more damage to the facade is repaired, which extends its service life. Repair of defects and damages is carried out according to the methods given above. After restoring the facade using this method, it is necessary to apply a primer to the old cleaned plaster and apply Antipluviol S hydrophobizer to the entire area of the restored facade, which will prevent excessive wetting of the furnishing layers and the body of the structures, which in turn will extend the service life of the facade, especially in the winter period, for which characteristic alternating wetting-freezing of structures.

The last possible option for restoring defects and damage to the facade structure is to completely remove the existing decorative layers and replace them with new ones. Removal of existing finishing layers must be carried out without excessive dynamic loads. This can be done using the hydrojet method, or using manual or light equipment (perforators with an impact force of up to 3.5kJ). Before installing new coatings, it is necessary to eliminate all defects and damage to the base. Repair of defects and damage is carried out according to the methods described above.

In addition, a number of recommendations were given regarding the following repair and restoration works: corroded metal elements, destruction of the body of elements of stone/superimposed structures, lack of mortar for grouting seams (on the stairs), exposure of unprotected wooden elements to the facade, cracks in the protective layer of balconies, installation of a protective covering of balcony slabs, absence of overhead elements, absence of window drains, subsidence of paving, damage to drainage pipes, dumping of water on perimeter paving.

At the same time, it is recommended to monitor the dynamics of the change in the width of the opening of existing cracks in the facade, as well as the detection of its possible movement in space, which includes:

– selective installation of beacons-crack gauges on force cracks;

– geodetic monitoring of movements of building facades in three planes with determination of possible tilts from the plane of the facade. The installation of crack-measuring beacons will make it possible to objectively assess whether the increase in crack opening width continues, and geodetic monitoring will make it possible to establish whether there are no movements of the facade in any of the directions. These works are recommended to be carried out within 1 year, in order to take into account the thermal expansion of construction materials, which are cyclical throughout the year, in the results.

After performing the monitoring work, it will be possible to give the most accurate conclusions about the causes of the formation of cracks.

Currently, after analyzing the results of a complex visual-instrumental survey and the available part of the documentation for the object, it can be assumed that the force/sediment cracks were formed due to minor deformations of the facade after the reconstruction of the building, and after that, the change in the width of the opening occurs already within the limits of natural fluctuations air temperature together with temperature deformations of the façade brickwork.

Steel and reinforced concrete elements reliably connect the parts of the facade to each other, and transplanting the building, including the facade, onto piles significantly reduces the likelihood of any subsidence of the building, despite the constant wetting of the outer part.

Conclusions

The survey of part of the facades of the complex of buildings in the Besarabskyi quarter generally confirmed the success of such a means of preserving the historical environment as the preservation of the historic facade with the complete replacement of all other structural elements of the building (in fact, the construction of a new building behind the preserved historic facade). The load-bearing capacity of the facade remains quite sufficient to perform enclosing functions (the load-bearing function is performed by the hidden reinforced concrete frame of the building), no significant cracks were found that would threaten complete destruction. The detected damage concerns primarily the furnishing layer, and is mainly caused by excessive wetting of parts of the facade as a result of improperly organized drainage from the roof, lack of window head flashings, poor-quality conducting of the abutment of the paving to the base of the building etc.

According to the recommendations, repair and restoration work on the facade can be carried out using one of three possible methods:

– local restoration of established defects and damages;

– hydrojet cleaning of the facade with exposure of hidden defects and subsequent restoration of all existing defects;

– dismantling of the existing decorative layers of the facade and installation of new ones instead.

At the same time, the effectiveness of each method was evaluated. In particular, it is stated that the local restoration is a temporary measure, which will allow to postpone the repair for 3–5 years.

The hydrojet method of cleaning and exposing hidden damage will allow you to postpone major repairs for a much longer period, namely for 7–10 years,

The most effective method is the complete dismantling of the existing decorative layers of the facade and installation of new ones instead, which will extend the service life, compared to the method of local restoration, more than twice, up to 15–20 years, depending on the materials used. Based on the analysis of the survey data conducted in various ways, it was recommended to focus specifically on the method of dismantling the existing finishing layers of the facade, which will allow to achieve a much higher quality of the arranged coatings in combination with the greatest durability. Given that the finishing layers on the historic brickwork were applied in 2002 – 2005, the complete replacement of the finishing layer will not lead to the loss of authentic historical elements.

It is necessary to dwell separately on the methods of conducting the survey, especially noting the 3D scanning for the creation of a computer model of the facade. The presence of such a model performs a role similar to a scientific restoration report during restoration and allows for constant monitoring of the state of the facade (not subject to its strength and stability), as well as for further ongoing repairs while preserving the historical image of the building, without conducting additional searches.

This method of facade inspection can be recommended for conducting preliminary inspections before carrying out conservation and/or restoration works on architectural monuments.

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