INTERNATIONAL JOURNAL OF CONSERVATION SCIENCE
ISSN: 2067-533X Volume 13, Issue 3, July-September 2022: 841-854 www.ijcs.ro

MODERN TECHNOLOGIES IN RESTORATION OF ARCHITECTURAL MONUMENTS (ON THE EXAMPLE OF ST. VOLODYMYR'S CATHEDRAL IN CHERSONESOS)

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Abstract

The article is devoted to the analysis of the use of modern materials in the restoration of architectural monuments (on the example of St. Volodymyr's Cathedral in Chersonesos (in modern Sevastopol). The article structures historical facts related to the history of the cathedral and the description of its architecture, identifies problems with the state of emergency of the cathedral before the restoration work, presents a comprehensive system of the entire list of activities and analyzes the state of restored elements in the post-restoration period. This proves that in some cases the use of modern technologies and materials in the reproduction and / or restoration of architectural monuments is rational and acceptable.

Keywords*: Restoration; St. Volodymyr's Cathedral in Chersonesos; Modern technology; Modern materials.*

Introduction

Revalorization of sacral architecture monuments is a very important group in the scope of conservators' activities. These monuments, built in different styles and periods, and often rebuilt many times, require special knowledge and skills during the revaluation [1]. This applies both to those responsible for the control of the conservation process and, perhaps above all, the conservators carrying out conservation. Today, more and more modern materials and technologies are used in the process of conservation of religious buildings, which allow to achieve the effect of authenticity while saving time and sometimes even money.

In Ukraine at different times, along with hundreds of Orthodox churches and cathedrals, churches were built that had a special sacred significance not only for Ukraine but also for all Eastern Orthodoxy. Such churches include St. Sophia Cathedral, St. Michael's Golden-Domed Cathedral, Assumption Cathedral of the Kyiv-Pechersk Lavra in Kyiv, Assumption Cathedral of the Pochaiv Lavra, as well as St. Volodymyr's Cathedral in Chersonesos (now in Sevastopol). Compared to other iconic churches, the history of which began in Kyivan Rus, and they flourished in the Ukrainian Baroque era, combining in its architecture the features of these two eras – Kyivan Rus and Ukrainian Baroque 17th – 18th centuries, the existing cathedral has external and internal view of the Historicism object of the second half of the XIX century. It is

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significant that it was built on the remains of an ancient basilica, where he was baptized in the tenth century, Prince Volodymyr – the Baptist of Kyivan Rus.

In the 19th century, the idea arose to perpetuate the event of the Baptism of St. Volodymyr by building the St. Volodymyr's Cathedral in Chersonesos. About thirty years passed from the project idea to the beginning of construction works. The project was created by Academician D.I. Grimm. The establishment of St. Volodymyr's Cathedral in the presence of members of the royal family and the Emperor Alexander II took place on August 23 (September 4 in the new style) in 1861. Construction was completed only in 1876.

St. Volodymyr's Cathedral was built of local limestone, Italian marble and other types of decorative stone were also used. The facades of the cathedral are richly decorated with stone carvings. It was a single-nave cross-shaped building with one dome on a wide light drum, three faceted apses to the east. From the west to the main volume was added a faceted vestibule with the main entrance to the first tier in the lower part. On the western, southern and northern sides, the main volume at the level of the second tier was surrounded by bypass galleries, the arches of which support paired columns of multicolored Italian marble, Romanesque capitals and bases. The second tier of the western risalit is illuminated through a cross-shaped window. The window openings were semicircular in different sizes.

Outside the walls were covered with rusted masonry of quadrae. The walls and tongs of St. Volodymyr's Cathedral were completed with developed profiled cornices with carved ornaments and mascarons in the form of lion heads.

The pediments of the cathedral were crowned with six stone crosses. The roofs are made of profiled zinc sheet, imitating Greek tiles.

Structurally, the building of St. Volodymyr's Cathedral in Chersonesos is a volume covered at the levels of the first and third tiers by combined vaults with spandrels. Along the entire perimeter of the building, two-storey galleries, a western risalit and a central apse to the east have been added to the main volume. Vaults of various configurations were used for the floors of the cathedral.

In this form, St.Volodymyr's Cathedral lasted for almost ten years, and only in 1888, on the eve of the celebration of the 900th anniversary of the baptism of Kyivan Rus, again raised the question of its completion. On July 13, 1888, the lower church was consecrated in honor of the Nativity of the Virgin. Architect M.M. Chagin was entrusted with the management of construction works. At this stage, the main attention was paid to the interior decoration of the cathedral. The interiors were decorated with exquisite ornamental and plot paintings, parapets, balustrades, on the second tier was an iconostasis of white marble. Icons were installed in the iconostasis – both original and copies from ancient times.

Preserved remains of an ancient basilica, where, according to legend, Prince Volodymyr the Great of Kyiv was baptized, were kept in the lower church.

A marble iconostasis designed by M.M. Chagin was installed in the main altar, and the icons were painted by I.A. Maikov, Ye.S. Sorokin, V.I. Neff, P.T. Riss and G.A. Molokin. M. Prokofiev painted ornamental paintings in the lower and upper churches and on the walls of stairwells and galleries, compositions in the dome drum. "The Last Supper" in the apse of the main altar of the upper temple and the image of the 12 apostles under the windows of the light drum and the evangelists on the pendants, the composition "Baptism" and "Transfiguration" on the walls in the northern and southern arms of the upper church, and icons in the iconostasis altars and chapels of St. Alexander Nevsky were executed by Academician of Painting O.I. Korzukhin. On October 17, 1891, the cathedral was finally solemnly consecrated.

After the consecration of the cathedral, in 1892 the interior work was continued by V. Koretsky. Instead of a temporary iconostasis in the lower church, a new wooden gilded one was installed, carved walnut iconostasis decorated the southern aisle of Alexander Nevsky and the northern aisle of St. Andrew the First-Called. In 1894 the finishing works were performed by J. Seppi according to the design of M.M. Chagin. Mosaic floors were arranged on the first

and second tiers, carved marble fences were installed on the soleas, two memorial stelae and a "monument" to St. Volodymyr with a reliquary with his remains in the form of the Gospel in analogy were installed in the lower church. The remains of the ancient Volodymyr's Basilica were tidied up and covered with marble slabs.

For many believers, this church has become a symbol and foundation of Orthodoxy in Kyivan Rus-Ukraine. Thematic paintings of the Lower Church of St. Volodymyr's Cathedral with the remains of an ancient basilica, made by artist P.T. Riss, confirmed the inseparable link between the two events: through the holy sacrament of baptism in Chersonesos, Prince Volodymyr the Holy received the light of the Christian faith from Byzantium, through the sacrament of baptism of Kyivans in Pochaina river, he spread the light of faith throughout Kyivan Rus. The interior of the lower church was finally decorated in early 1894.

Despite the length of its construction under the supervision of many different architects and with the participation of many different artists, St. Volodymyr's Cathedral was marked by the integrity of compositional and architectural design and became a sacred urban dominant for all of Sevastopol, which, however, was visible from different parts of the city and sea.

Before the First World War and the October Revolution of 1917, the Chersonesos Monastery flourished. However, the fate of Volodymyr Cathedral in Soviet times was tragic: after the capture of Crimea by the Bolsheviks in 1919, the Chersonesos monastery was oppressed: it housed a home for the disabled and a military unit, opened a museum in 1923, and in 1924 liturgical services stopped altogether. The cathedral was looted: iconostasis and icon cases were dismantled, church utensils were removed, crosses were removed from the walls, and the central cross was turned into a spire. A museum was opened in the upper church, and reserve funds in the lower part. Nobody cared about the condition of the building: the roof was leaking, the wall paintings were damaged, the broken windows were covered with plywood. In 1924, St. Volodymyr's Cathedral was closed, and in August 1925 the Chersonese State Historical and Archaeological Museum was established on the territory of the ancient city. After the liquidation of the monastery and the closing of St. Volodymyr's Cathedral on the first floor of the church and in the monastery building was organized an exhibition of the most valuable architectural details and exhibits. In 1942, a German cannon struck the dome of the cathedral, causing a huge hole in the south side of the light drum, and in May 1944, retreating German troops mined and blew up the cathedral on the orders of Colonel Kolb, the city's commander. As a result of the powerful explosion, the remains of the dome drum fell, the ceilings collapsed, the walls were covered with cracks, the interior decoration was destroyed, the massive blocks at the level of the third tier shifted, the seams between the masonry blocks diverged. The ancient part of the cathedral with the vault was also destroyed. Only basilica foundations and the church walls survived, but they were in a state of emergency.

St. Volodymyr's Cathedral in Chersonesos was unnecessary in the postwar years. There was no place in the list of objects for the reconstruction of the cathedral, instead it stood in ruins in the center of Sevastopol, and Carrara marble, which decorated the interior, was used to decorate administration buildings.

Materials and methods

Despite the fact that today St. Volodymyr's Cathedral has been restored to its original form, the unique work of the restorers of the Ukrrestavratsiia Corporation on its revival is still little known to the general public. That is why the authors decided to analyze and highlight the work done.

To solve these problems, the relevant source base was studied. The publications of M. Arnold [2, 3], D. Bobrovnikova [4], F. Livanov [5], devoted to the history and description of the architecture of St. Volodymyr's Cathedral and the monastery around it were analyzed. Scientometric sources of recent years have also been studied, which raise the question of the

influence of the natural environment on the image of churches in Ukraine and on architecture in general (D. Chernyshev et al. [6], Yu. Ivashko et al. [7]), the fate of churches in the totalitarian period and in post-totalitarian society and the problems of their restoration and reproduction [8], general aspects of restoration activities [9-11].

The study of practical experience of the restoration of St. Volodymyr's Cathedral in Chersonesos and scientific sources allowed to formulate the main objectives of the study:

– to structure historical facts related to the history of the cathedral and the description of its architecture;

– to determine the problems of the emergency condition of the cathedral as of the beginning of the restoration works;

– present in the form of a coherent system the entire list of activities and complement the text part of the visual series.

To solve the tasks the following methods were used: historical analysis (to analyze the history of the cathedral, its special role), system analysis (to systematize the restoration and restoration activities), photofixation method and graphoanalytical method (to supplement the text with drawings and photographs).

Results and discussion

Research and field surveys of St. Volodymyr's Cathedral

In 1961, a special commission inspected the ruins of the cathedral and concluded that it could not be rebuilt, and its ruins should be dismantled. However, the staff of the Chersonesos Museum-Reserve managed to defend the priceless monument. In 1969–1970, a project for the conservation and adaptation of St. Volodymyr's Cathedral for a museum was developed, but this project was not implemented (Fig. 1).

Fig. 1. The state of St. Volodymyr's Cathedral in 1974.
Photo from the stocks of the Ukrrestavratsiia Corporation

In 1986, the Kyiv Institute "Ukrproektrestavratsiia" commissioned by the Chersonesos Historical and Archaeological Reserve prepared its restoration project of the Volodymyr's Cathedral, which differed radically from the project of 1969 –1970 in that it provided for the restoration of the cathedral in its original form with the restoration of authentic parts with interiors with the possibility of its functioning as an Orthodox church. The revival of

St. Volodymyr's Cathedral in Chersonesos was included in a separate item together with Kyiv holy places – St. Michael's Golden-Domed Cathedral, Assumption Cathedral of the Kyiv-Pechersk Lavra and the Church of the Virgin of Pyrohoshcha in the Resolution of the Cabinet of Ministers of Ukraine Resolution of the Cabinet of Ministers of Ukraine № 567 of June 9, 1997 "On measures to prepare and celebrate in Ukraine the 2000th anniversary of the Nativity of Christ", adopted on the initiative of the President of Ukraine.

Construction history of the architectural monument of the 19th century – St. Volodymyr's Cathedral in Chersonesos is not full of any events related to the reconstruction or changes in its appearance. Up to the moment of destruction, it was preserved almost in its original form. The existing remains and, accordingly, the full number of iconographic materials contributed to the restoration design, but the transfer of the project in kind seemed a difficult task. As of 1999, the cathedral was in a dilapidated condition. The third tier was almost lost, most of the stone vaults collapsed. The general technical condition of the building was assessed as emergency.

Previous measurements of the remains of the cathedral showed significant deformations. For example, the northern risalit, the northwestern corner of the bypass gallery, the southwestern corner of the western risalit, and some other areas due to the explosion were shifted in the horizontal plane relative to the original state. The masonry of the walls and vaults of the cathedral is made of stones in lime mortar, facial facade and interior parts of the walls are composed of rectangular blocks of sawn fine-grained organogenic-detrital limestone and the inner part of the wall masonry is covered with limestone boulders of irregular shape and filled with lime mortar. The outer rectangular blocks are additionally fastened together with metal brackets.

The facade surface of the walls is composed of blocks of limestone, which differ slightly in structural characteristics and shades of color (warm, slightly pink and cold greenish). This to some extent determines the "striped" appearance of the facade: strips of limestone of different structure alternate with each other on the planes and jumpers of window openings.

The facades of the cathedral are decorated with rich stone architectural decor, cross-shaped inserts of pink marbled limestone, limestone columns and tuff breccia of spotted pink and greenish colors. It should be noted that the stone masonry of the building (the outer shell is made of large blocks of limeston imitating rustic work, the inner shell – small blocks, the middle part – rubble masonry on lime-sand mortar) – is almost a monolithic structure, which is difficult in reassembling. This circumstance does not allow us to consider the production process of restoration of the cathedral as a mechanical addition to the lost parts. Significant efforts were needed to repair the ruins, which required specially designed projects for each case. Careful measurements of the "repaired" ruins were also needed to clarify the design of their tiered superstructure.

The condition of the cathedral is considered unsatisfactory, with losses of 80 percent. Shallow foundations, which are directly connected to the rock slab of natural origin.

As a result of the explosion of 1944, the epicenter of which was apparently in the second tier, vaulted roofs, ceilings and large areas of the walls of the second tier were destroyed, as well as completely destroyed the light drum, some fragments of external walls (north riser galleries), resulting in horizontal shifts – vertical deviations were in some cases up to 10 degrees.

As of the time of the engineering survey, the structures of the building had been disrupted. Since 1944, its remains have existed in an unpreserved state and were destroyed under the influence of climatic changes, which negatively affected the state of the ruins.

The walls had significant losses up to 50 percent; there were partial losses of stone mass of limestone blocks, cracks, landslides, some rows of facing peeled off from the internal rubble monolith.

Surface weathering of the front surface of stone blocks was very common, especially on the cornices and protruding elements of the facades.

In addition, many different mechanical scratches were observed on the stone blocks of the facades. The state of losses of wall decor elements ranged from 50 to 100 percent. Cracks were found both in the wall masonry and in the vaults.

Active weathering was facilitated by the almost widespread development of biodegradation of the stone surface by lichens, mosses, shrubs and small trees.

Very corroded elements of metal fittings for fastening blocks and preserved metal fillings (frames) of window openings were observed everywhere on the collapsed sections of masonry. Corrosion of the metal led to an almost complete loss of strength of the window openings fillings structure. The same can be said about the bare reinforcement of masonry walls.

The windows of the cathedral were decorated with stained glass, made of colored glass, but at the time of the survey they were lost, leaving only fragments of colored glass.

As of 1999, some of the tuff breccia and limestone columns had been lost, and the surviving ones had been severely damaged. Their surface was largely weathered, polishing was almost lost, the back side was very dirty, rusty stains were fixed. Chips, cracks and loss of stone mass were observed on many columns. The exposed metal pins were superficially corroded. The general technical condition of the surviving columns was assessed as unsatisfactory. Cross-shaped inserts of pink limestone on the facades were also subject to restoration. The roof of the cathedral at the time of the survey was completely lost. The original roof structures were made of prefabricated metal trusses and covered with zinc sheets, which were soldered with shaped elements of the same material that mimicked tiles. Their losses were almost 100 percent. With the exception of a small part of the first tier, the vaulted ceilings were completely lost. The preserved fragmentary metal has rusted and the metal structures have lost their load-bearing capacity.

The drainage system was organized with the help of zinc drainage pipes, partially hidden in the masonry, but at the time of the survey the vast majority of them were lost.

The floors in the interior of the cathedral are preserved by 10%. The inner surfaces of the walls of small blocks of limestone and before the destruction were plastered, but their losses were recorded up to 100 percent. Structural pillars and columns were missing. Some severely damaged doors and window fillings, not suitable for restoration, have been preserved. Granite stairs, sculpting, painting, interior utensils have not been preserved.

With the exception of the first tier and part of the second, all the interior architectural and decorative elements of the monument were completely destroyed. The conclusions to the inspection report noted the general unsatisfactory condition of all building structures, the need for immediate restoration and, in extreme cases, conservation works.

After a detailed examination, it was recommended to perform the following works:

– clarification of the nature and depth of the foundations of the building;

– engineering and chemical-technological research of existing violations of the wall masonry system in order to develop recommendations for their elimination;

– to determine the quality of the material of stone wall masonry in places of shifts and permanent locks.

Stages of restoration of the cathedral

All work on the restoration of the cathedral at the time of demolition was divided into two stages, which consisted of substages.

The first stage included recreation the physical volume of the building with the restoration and reproduction of lost monumental architectural details in the exterior and part of the interior (Fig. 2). It is planned to restore the covered roof, window and door fillings, floor

constructions, put in order the remains of the ancient church in the lower church, the initial interior decoration with plaster, installation of lightning protection.

Fig. 2. The beginning of the cathedral walls restoration.
Photo from the stocks of the Ukrrestavratsiia Corporation

The second stage included the reproduction of the artistic and decorative design of the interior of the cathedral with monumental details of the interior. The works of the second stage directly depended on the specific adaptation of the cathedral building and provided for a set of special works. The works of the second stage involved decorative and artistic interior decoration.

The structural scheme of the building was such that it was possible to reproduce the physical volume of the cathedral in a parallel way. That is, the transfer of deformed parts of the building could be performed in parallel with the construction of the inner cross-shaped volume, followed by the addition of the volume of the light drum (Fig. 3).

Fig. 3. The recreation the physical volume of the cathedral.
Photo from the stocks of the Ukrrestavratsiia Corporation

During the works, the stone facing of the basement was completely lost, so it was proposed to restore it with blocks of fine-grained and medium-grained diorite on cement-lime mortar. To prevent efflorescence on the cladding surface, the joints between the blocks after cladding work were proposed to be widened and cleaned from the masonry mortar to a depth of 10–15mm and the joints sealed with weather-resistant colorless silicone sealant for stone surfaces.

The climbers dismantled and numbered the boulders and eaves so that the restorers could put them back in place. Everything was put together on the construction site and sorted.

Limestone stones from local Crimean deposits (treated with shallow rust white Inkerman stone) were undermined in such a way that not even a knife could enter between them. The blocks were laid practically without mortar, "dry", with individual adjustment directly on the site of their installation, as was done a hundred years ago during the construction of St. Volodymyr's Cathedral.

The scope of restoration and restoration works envisaged by the project included partial dismantling of emergency sections of stone wall masonry that lost their load-bearing capacity, as well as strengthening and repair of non-emergency fragments (Fig. 2). It was planned to restore the walls of the central cross-shaped volume at the level of the third tier with the execution of artistic carvings on limestone.

The disassembled sections of walls and vaults were rebuilded in accordance with the folded cartograms with the same limestone blocks from which they were originally composed, or similar new ones. In addition to limestone in the surrounding blocks, we have added a well-known special technology: for the addition of large losses with an area of more than 1–2 dm^2 and a layer of more than 2–3cm, inserts were added, similar by the composition to the original material; smaller losses were added with putty. The composition of the mass for the addition was selected closest to the composition of limestone masonry and corresponded to its physical and mechanical characteristics, color and texture. To supplement the losses, if possible, fragments of dismantled blocks of masonry of the cathedral were used. Masses based on natural or synthetic binders using limestone flour filler similar in composition to the cathedral limestone were also proposed to supplement the losses. The supplement consisted of lime dough, white Portland cement, filler – trifractional ground carbonate sand from limestone flour,

limestone sand and shell rock with the addition, if necessary, of yellow ocher, water and acrylic emulsion.

The site for future additions was cleaned of destructed mass residues and abundantly moistened with water and additionally impregnated with 10% acrylic dispersion solution. After the drip moisture was absorbed, it was sprayed with a solution of liquid sour cream consistency, and for better adhesion, the stone surface was impregnated with a solution of acrylic or PVA dispersion before spraying, and after 1–2 hours applied a layer of soil and compacted it: partially hardened soil was scratched, moistened with water, and then applied a cover layer.

The sprayed plaster base and ground had a composition similar to the cover, but a thinner consistency. The strength of the additive mortar should not exceed the strength of the limestone masonry material; otherwise, the mortar could tear off the base material.

Ready-made mixtures based on lime, cement and mineral fillers to imitate natural stone could be used to supplement limestone losses. Modern composite materials based on acrylic and other synthetic compounds for facades, which imitate natural stone of different texture and color, are resistant to ultraviolet rays and weathering, good adhesive properties and durability, were also offered for additions and cover layer.

The addition of losses of considerable thickness was performed in layers: the thickness of each layer did not exceed 5–7mm, each subsequent layer was applied after hardening of the previous one. In order to normalize the material crystallization, the addition was moistened with water for 6–8 days.

The order of addition of places of losses was carried out in such sequence.

First, a rectangular or other regular-shaped area was cut and removed around the limestone loss site, which was to be supplemented with new limestone.

The depth of clearing and extraction of material in this area should be as close as possible to the depth of loss. From the limestone-addition an insert was cut similar in shape, but slightly narrower and thinner than the lost area.

Then the insert was mounted in the place of loss on the mortar (lime-cement mortar of lime dough, Portland cement, fine sand and acrylic dispersion) or on a special glue. After gluing the inserts at the places of loss, the seams were plastered with a material that mimicked the front surface of the stone blocks. Stainless steel, copper, and brass cramps were used to couple large and deep limestone losses.

Many individual limestone blocks in the masonry were cut with narrow cracks, and mortars were used to inject these cracks, which in physical and mechanical properties in the hardened state corresponded to the mortar of the fixed masonry. These narrow cracks were injected using special electric pumps.

Disassembly of the destroyed masonry was performed according to cartograms developed in the process of field research of the condition of materials and structures. During the disassembly, the following organizational and production operations were performed:

a) marking of limestone blocks to be dismantled;

b) removal of herbaceous and shrubby vegetation;

c) installation of supporting formwork;

d) disassembly and storage of marked blocks.

Cleaning of the front surface of the preserved masonry, as well as dismantled blocks was performed to remove contaminants: gunpowder and dirt, moss and lichen, rust stains, tar stains.

Conservation of the dismantled masonry was performed by coating its surface with a lime-sandy solution of 1:3. After plastering, the masonry surface was covered with a layer of roofing material to protect against precipitation. Dismantled sections of walls and vaults were rebuilt according to cartograms of the same limestone blocks from which they were composed, or similar new ones.

Losses of limestone mass in separate blocks were added according to special technology.

To eliminate the remnants of biodegradation products, fungal spores and prevent their further development, it was necessary to perform antiseptic treatment of facade surfaces with special drugs in one or two stages.

Further, it was planned to strengthen the weakened front surface of the stone so that after these measures there would be no significant changes in texture and color. Solutions of synthetic adhesives with resistance to atmospheric weathering and ultraviolet rays and high penetrating properties were recommended to strengthen the surface. Hydrophobic protective treatment of the stone surface was also carried out in order to protect against moisture and, consequently, from the main cause of biodamage.

Cracks in the masonry of the walls and vaults were injected with a complex lime-cement mortar using a special injector.

Separate restoration of columns from Italian marble gallery of the second tier. Here, out of 54 columns, 8 were lost, and the remaining columns were in an unsatisfactory condition: the corners of the bases and capitals were broken off, there were many through cracks, the carving pattern of the capitals was fragmentarily preserved, the marble face was destroyed, the bases and bases were to be replaced. All fusts had through sloping cracks, potholes, 19 columns were broken into 2–3 parts, the surface of all columns was severely destroyed.

Given that the surveyed columns of the second tier are structurally load-bearing, taking into account the important aesthetic functions, the commission concluded that all existing columns should be replaced with new ones, as well as restore lost ones. The columns on the facades of the cathedral are made of cherry-colored tuff breccia and limestone, similar to masonry limestone, and decorated with capitals of white marble. All these materials had losses, chips and small cracks in some places, some columns were lost altogether, and the front surface of the surviving ones lost its luster and partially weathered.

Thus, the restoration of the columns included the installation of the lost, the addition of partial losses on the surviving columns, as well as the restoration of the original appearance of their surface. The following technologies were offered for restoration:

1) making inserts of similar material in places of losses;

2) addition of losses with special mortars prepared on site;

3) addition of losses with special mortars ready for use;

4) addition of losses with mortar with subsequent finishing of the surface with imitation of natural stone.

Materials similar to the original ones (limestone, white marble for capitals) were used to make the inserts. Losses of limestone columns were added according to the same technological scheme as losses in limestone blocks of the front surface. The losses of the columns were supplemented by a specially prepared mixture on site using the technology of making artificial marble.

Ready-made masses that mimic natural stone, based on natural or synthetic binders designed to mimic natural stone on facades, could also be used to supplement the loss of columns. Restoration of the front surface of the columns included clearing, strengthening the surface, restoring the polish.

In the XIX century the ceilings of the cathedral were made of artificial stone. Now all the ceilings are made of reinforced concrete. Simultaneously with the construction of the walls throughout the upper tier of the cathedral, wooden formwork was prepared for filling reinforced concrete. Light vaults were to be much stronger than artificial stone ones. This also strengthened the seismic resistance of a large structure.

The roof of the cathedral was made of copper tiles as a weatherproof material that does not require additional protection (Fig. 4). The technology of gilding works has also been developed.

Fig. 4. The state of the cathedral after the completion of the first stage of restoration (July 25, 2001). Photo from the stocks of the Ukrrestavratsiia Corporation

Reconstruction of the interiors of St. Volodymyr's Cathedral

The more difficult problem of restoring St. Volodymyr's Cathedral, compared to the building volume restoration, concerned its interiors, where there were significant losses. There is little left in the interior of the cathedral: the remains of mosaic floors and some ornamental paintings of the altars of the lower church, the contours of the paintings. Easel paintings (icons and paintings) are lost, partially disappeared in museums and private collections. The problem was further complicated by the fact that many of them were performed by little-known artists at the time. More information was about the creative heritage of Academician Karazin. It is known that the cartoons made according to his sketches were stored in the funds of the Chersonese Museum before the war, where they where they were destroyed. The problem of sketches of iconostasis taken by Bescarini to Italy, where they were used to make working cartoons, and the problem of restoring architectural and decorative elements of the interior: capitals of columns, lining of wall panels, balustrades, lamps were similar.

The photographic fragments of the interior, which were at the disposal of the restorers, despite their documentary nature, conveyed a distorted and monochrome nature, which made it difficult to use them for basic samples.

Artistic mosaic floors have been restored and the interiors of the cathedral have been restored with marble parapets, balustrades, patterned chandeliers and other architectural details. The existing wall paintings were restored in accordance with the restoration methods, and the places of losses were sunk, the wall paintings were restored according to archival materials. In total, more than 1,500m^2 inside cathedral were painted, using modern paints, gold and platinum. Many works, including stone carving, were done by hand.

Ornamental paintings on the walls, in the light drum and under the vault of the dome, in the apses were painted just by plastering. The basis was ornaments, which in the XIX century painted with wax paints by Sevastopol painting teacher Prokofiev. Now Kyiv artists painted with modern paints using the technology of the German company "Keim" and decorated the ornaments with gold leaf and platinum. Murals in the apses were painted with oil paints on canvas and glued in place to the walls.

In St. Volodymyr's Cathedral, many decorations are made of metal. Master restorers made extremely complex net fences, lattices, lamps and chandeliers (Fig. 5).

Fig. 5. Metal decorative elements in the interior of the cathedral.
Photo from the stocks of the Ukrrestavratsiia Corporation

In the 19th century, paintings for St. Volodymyr's Cathedral were made by famous professors and academics of St. Petersburg Academy of Arts. Plot compositions and portraits were painted on canvas with oil paints. The difficulty for the artists-restorers was also not to disturb the compositional and color harmony and integrity of the cathedral's paintings: both those painted directly on the walls and those that the artists painted in their workshops. Icons for the iconostasis of the upper and lower tiers of the cathedral were also painted. In the spring of 2004, when the paintings were finished, they were pasted on the walls of the cathedral.

Fig. 6. Marble iconostasis on the lower level of the cathedral.
Photo from the stocks of the Ukrrestavratsiia Corporation

Fig.7. Marble iconostasis on the upper level of the cathedral.
Photo from the stocks of the Ukrrestavratsiia Corporation

The architectural forms of the cathedral and the ornamental and monumental interior design form a whole, organically complementing each other. To enrich the color scheme, the ornaments were inlaid with gold and silver. In the interior decoration we have a great example of a system of paintings in the "Byzantine" style with exceptional knowledge of the ornamental motifs of Byzantium, mathematical accuracy and subtle artistic sense. The interior ornaments of the lower church of St. Volodymyr's Cathedral in Chersonesos were traced from the surface of the painting, corrected or reconstructed and painted in life size. During the execution of color samples of ornaments, the ornaments of the lost vault were refined in graphic form and their graphic image in color samples corresponds more to the type of author's ornament (archival photo) than their graphic image in the catalog and cartograms of the general form of the vault.

Modern performers of the marble iconostasis in the Byzantine style made it using new technologies. Details of the iconostasis, which were made on machines with a digital program of stone processing, were delivered from Italy, all manual processing and stone carving was carried out by Ukrainian stonemasons-restorers on site (Figs. 6 and 7). The iconostasis is made of Italian marble Bianco Carrara, Bianco, Lassa, Portuguese marble Rosso Levante, Greek onyx insert.

Also in the winter of 2004, gilding of the main dome of the cathedral was carried out and at the same time a wooden bell tower was restored on its historic site.

In conclusion, the silhouette of the cathedral was emphasized by special means of artistic lighting, which made it a decoration of the surrounding landscape of the city at night, a coastal landmark for ships.

Conclusions

The experience of Ukrrestavratsiia Corporation in the reconstruction of destroyed architectural monuments testifies to the expediency and fundamental possibility of preserving valuable remains (foundations, fragments of walls, ceilings and vaults, decor elements), as well as modern architectural and reconstructive technologies to recreate outstanding architectural monuments.

Evidence of this can be recreated St. Michael's Golden-Domed Cathedral, Assumption Cathedral of the Kyiv-Pechersk Lavra, St. Volodymyr's Cathedral in Chersonesos and other monuments. Evidence of this can be recreated St. Michael's Golden-Domed Cathedral, Assumption Cathedral of the Kyiv-Pechersk Lavra, St. Volodymyr's Cathedral in Chersonesos and other monuments.

Observations of these architectural monuments in the post-restoration period show that elements restored (or reproduced) using modern materials and technologies are better preserved than similar elements restored using traditional technologies. This proves that in some cases the use of modern technologies and materials in the reproduction and/or restoration of architectural monuments is rational and acceptable.

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Received: January 20, 2022
Accepted: September 2, 2022