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Restoration of sepulchral plastic works made of cement compositions

Abstract. The restoration of sepulchral sculptures made of reinforced concrete is becoming increasingly relevant, as the issues of physical preservation of monuments are exacerbated by the lack of proper care and natural factors that are aggressive to this material. Timely professional restoration is important for keeping monuments in proper condition. Among professionals, it is usually more common to handle ancient works of art, however, artworks made of cement compositions, which were first used by architects and sculptors at the end of the 19th century, also need preservation. The study aimed to analyse modern methods and provide examples of their implementation, which were applied in restoration practice and tested on specific artworks. The authors' experience of handling sepulchral plastic, obtained during the 2019-2024 restoration work at the Department of Architecture and Restoration of Lviv Polytechnic National University, was analysed in the study. The history of the appearance of plastic cement compositions has been analysed. The methods, techniques and technologies of working with various damage to monuments were discussed in detail on three practical examples. The research results described in the study have practical value for a wide range of art restorers, as they will help practitioners preserve the integrity of sculptural and architectural objects made of cement compositions from the late 19th and early 20th centuries. The methods described in the study can also be applied to monuments made of reinforced concrete during the 20th century if similar technologies were used in their manufacture

Keywords: memorial plastic; artificial stone; conservation; destruction causes; monuments preservation

INTRODUCTION

The restoration of sepulchral plastic artworks from cement is relevant since under the influence of time, atmospheric influences and human action, all researched monuments require restoration. Restoration of this type of monument requires a detailed study of their state, and manufacturing technology, as well as knowledge of modern materials and techniques that can be applied in restoration. According to researchers of architectural history T. Klymeniuk *et*

al. (2019), Roman concrete, which was invented in ancient Rome and widely used in construction, was made from a mixture of slaked lime and pozzolana mixed with water. Researchers claim that pozzolana is volcanic ash, the deposits of which were mined in the vicinity of Puteoli, now Pozzuoli, in the Campania region, Italy. Other components of this ancient concrete were crushed and whole stones and organic additives (such as eggs).

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Concrete of the late 19th and early 20th centuries significantly differed both in terms of ingredients and manufacturing technology. Furthermore, sepulchral sculptures made using this technology do not often become the subject of research and practical restoration. This is determined by the complications in restoration, caused by destruction due to damage and neglect. In such a case, a customer prefer reconstruction, replacing it with a copy. Importantly, this approach is incorrect from the point of view of restorative science, since instead of an original artwork, even damaged, a copy is constructed, which has no historical or artistic value. A study by O. Kyryliuk (2020), which argued that the destruction of sacred places of Ukrainian memory by assimilators is a substantial step in the enslavement process, is noteworthy. The coloniser always seeks to destroy the memory carriers on the territory of the people to enslave, to replace the “sacred space” with the “abstract”, and to erase the graves of heroes from both physical and memory realms. An illustration of this thesis can be the example of the destruction by Soviet functionaries in 1950 of a reinforced concrete cross that was created in 1938. The history of the cross’s creation, destruction, and discovery was described by N. Datsko (2022). The cross was dedicated to the 950th anniversary of the baptism of Rus’ and Ukraine and was installed in the Holy Dormition Univ Lavra and is a beautiful example of Ukrainian modernism.

Reinforced concrete structures were actively introduced as structural and decorative elements in buildings constructed in the style of Ukrainian architectural modernism at the beginning of the 20th century. The famous architect and entrepreneur Ivan Levynskyi used many such elements. In particular, R. Hnidets & M. Yasynskyi (2021), studying the architect’s work, noted that “the characteristic and obligatory features of these buildings were the harmonious combination of folk architecture and art forms, translated into stone or concrete, decorating the facades with bright ceramic tiles, in the colours and patterns of which the stylisation of Ukrainian traditional embroideries or ornaments was notable”. Despite the folkloric decoration of the facades, their construction was made of the latest materials, often specifically reinforced concrete.

As for the use of reinforced concrete in memorial tombstones, many such monuments of sepulchral sculptures were present in western Ukrainian territories between the First and Second World Wars. As O. Mykhaylova (2022) noted, the traditions of honouring fighters for independence in Western Ukraine were more prominent. In the interwar period, memorials to Sich riflemen were already present. The author mentioned memorials at the Yaniv cemetery in Lviv and in Berezhany, Ternopil region. However, the author also noted that in almost all cases these memorials were destroyed by the Soviet authorities.

Military burials in Halych have become the subject of research, as the city and its surroundings have repeatedly become the centre of hostilities. Three locations of military burials in the territory of Halych have been preserved in varying conditions. Military burials were also done in the

church cemetery near the church of St. Dmitry in Halych. According to A. Chemerynskyi (2019), in 2011, one military concrete cross was found on the western side of this church cemetery, and during the landscaping of the territory in 2022, another one (both from the 1920s) was found. Notably, a local historian stated that the above-mentioned burials of fallen soldiers from the First World War were marked with “concrete military crosses”. The author also stated that “...in some places, the bases of broken crosses are still visible from the ground” (Chemerynskyi, 2023).

As for the monuments in the military cemeteries of Volhynia, they are closely correlated with historical events of Galicia, being a part thereof. S. Havryliuk (2022) in a study on the military cemeteries of Volhynia stated that “...time and objective circumstances have hidden many places where those who died in this war rest. The region currently has 34 cemeteries and mass graves from the First World War, which have signs of military necropolises”. Many of these burials were also made of reinforced concrete and were destroyed primarily due to the policy of the Soviet government. As for restoration measures for such monuments, they primarily require scientific study. For instance, the tombstones in the cemetery of the village of Tobolya in Volyn were first arranged in the interwar period. The existing cemetery in the centre of the village has two large concrete structures resembling a memorial complex. This is a unique monument that requires more detailed study and determination of ways of its restoration. A large proportion of these memorials are made of concrete or reinforced concrete. Technological problems of preserving such monuments rarely become the subject of separate research, although the causes of destruction and the means to eliminate them are of key importance in this case.

As for the reasons for the mass use of reinforced concrete in sepulchral sculpture, functionality and the possibility of mass copying of similar monuments were important. This thesis can be confirmed by the article by G. Twardowski (2023), dedicated to the use of concrete in early 20th-century architecture in Poland. The study noted that “a lifeless, monotonous geometry of repetitions, devoid of radical accents – often arose from purely functional reasons, but was also an artistic demonstration of modern achievements”. Furthermore, the very nature of the material and its strict aesthetics often led memorial creators to choose this material.

The study aimed to highlight problems during search, identification and restoration of monuments of sepulchral plastic made of concrete, as well as to determine ways to solve them based on theoretical research and practical experience of the authors of the article on the example of the study and restoration of three monuments.

MATERIALS AND METHODS

Traditional methods of reinforced concrete monuments research included visual inspection, as well as scientific methods of historical analysis. Complex studies of the technological aspects of their creation were also conducted to





determine the components, means, materials and features of each artwork. The inventory and accounting methodology was used in compiling documentation during the study of monuments made of historical concrete (Stasyuk, 2022).

From the first reinforced concrete products their widespread use, sepulchral plastic was primarily used to construct artworks. The study described three monuments of sepulchral plastic made of reinforced concrete, which underwent the restoration process as part of the diploma works developed at the Department of Architecture and Restoration of the Institute of Architecture and Design of the Lviv Polytechnic National University (Bevz *et al.*, 2022). The study authors participated in the research of all three monuments, as well as advised the executors of the works. The studied monuments are: the first half of the 20th century reinforced concrete gravestone cross of the Ukrainian People's Republic diplomat Volodymyr Mursky, from the city of Istanbul; a commemorative reinforced concrete cross from the collections of the Museum of the Holy Assumption Univ Lavra, which was made and installed in honour of the 950th anniversary of the baptism of Ukraine-Rus' in 1938 and a cross preserved in the city cemetery of Belz on the grave of eight unknown riflemen of the Ukrainian Galician Army. In the example of these monuments, both positive and negative technological features, which are inherent in reinforced concrete structures, are considered.

Unconditional advantages are the relative ease of creating structures made of this material, their strength and ability to carry large loads (provided the proper construction technology), the possibility of creating a wide variety of forms (thanks to the use of iron reinforcement and the possibility of pouring concrete mixture into the form), the monolithic nature of monuments (Sanytsky *et al.*, 2002). However, reinforced concrete has its technological limitations, as well as several features that can cause damage or destruction of a monument made of this material. Usually, when creating certain works from reinforced concrete, it is difficult to achieve ideal conditions, the use completely appropriate materials, and sometimes there is non-compliance with the technology (Gralińska-Grubecka, 2019). This article study addressed these problems and, thanks to the conducted research and acquired practical experience, a certain section of the problems was presented and the ways of their solution during restoration were indicated.

The main goal of restoration with reinforced concrete monuments is to stop destruction and stabilise the construction of reinforced concrete objects, conservation, replenishment of losses and preservation of the authenticity of monuments. Therefore, in all three cases, the prominent issue was reinforcement. During the restoration process, stainless steel was used as reinforcement, as the most optimal material. This steel was used in additions and reconstructions to replace corroded material as necessary. When performing additions and reconstructions, historical technologies for making wooden formwork were used as a form. This was used to recreate the historical texture of the finished product. As for the cleaning of all types of

contamination, strengthening, and glueing, modern chemical materials were used here with the obligatory performance of samples of each of the applied materials on each of the objects with which they worked.

RESULTS AND DISCUSSION

All three monuments described in the article were made of reinforced concrete at the beginning of the 20th century. All were admitted for restoration in unsatisfactory condition. Notably, each of these monuments was damaged differently and each required a different method of restoration. The first of the monuments is the reinforced concrete tombstone cross of the Volodymyr Murskyi Ukrainian People's Republic diplomat (Fig. 1), a cross of the early 20th century from the city of Istanbul. The work performed by the Student Zhala Zakhar, within the framework of the diploma, was successfully defended in 2021 at the Department of Architecture and Restoration of the Lviv Polytechnic National University (Bevz *et al.*, 2022).



Figure 1. Reinforced concrete tombstone cross of the Volodymyr Murskyi view before restoration
Source: authors' photo

The tombstone cross was submitted for restoration in an unsatisfactory condition. It was on the brink of destruction. However, at first glance, the cross did not appear in poor condition. It was practically intact, with almost no damage. During the initial inspection, washing out of the front surface of the concrete and the marble memorial slab, numerous biogrowths on the surface of the cross and the marble slab, minor losses of concrete around the perimeter of the cross, and many cracks on the concrete surface was notable. That is, a wear and tear caused by age, which does not cause alarm initially. However, after a detailed inspection, it was noted that the cracks on the concrete surface were primarily caused by the corrosion of



iron fittings, which changed the appearance of iron oxide inside the monument to appear “swelling”, the loss of the integrity of concrete and metal, as a result of which a cavity was visible in the middle of the cross. Such destruction of reinforced concrete structures is dangerous as they are, as a rule, hardly noticeable, have a progressive nature and require urgent emergency restoration works.

After a detailed study of the object, a decision was made to clean the monument from biogrowths and metal from corrosion; to prevent the recurrence of these processes by the method of preservation of the metal and concrete cross; to glue the preserved, but damaged fragments to the object in its original place; to paste the lost parts with a complementary mass that is not aggressive to the authentic material (Ciabach, 1998); to fill the cracks on the concrete surface and the cavity in the middle of the cross, and tint the addition. As a result of the measures carried out, the monument was stabilised, it was given an exhibition appearance and transferred to the Lviv Museum of the History of Religion for safekeeping (Fig. 2).



Figure 2. Reinforced concrete tombstone cross of the Volodymyr Murskyiview after restoration

Source: authors' photo

Another destroyed object that was sent to the Department of Architecture and Restoration of the Lviv Polytechnic National University for restoration is a memorial reinforced concrete cross from the Saint Assumption Univ Lavra museum's collections (Vuitysk, 1997). The memorial cross was made and installed in honour of the 950th anniversary of the baptism of Ukraine-Rus'. The construction was done on October 2, 1938. During the communist occupation, in 1954, the cross was toppled and broken by order of the communist authorities. The villagers hid the fragments of the cross by burying them under a linden tree. After the Ukrainian Greek-Catholic Church returned to

normal operation, fragments of the cross were found, and a few years later they were processed for restoration (Fig. 3).



Figure 3. Memorial reinforced concrete cross from the Saint Assumption Univ Lavra museum's collections before conservation

Source: authors' photo

In 2020-2021, Student Volodymyr Petryshyn conducted restoration at the Department of Architecture and Restoration of Lviv Polytechnic National University under the supervision of Doctor of Architecture O. Rybchynskiy and PhD in Architecture V. Melnyk. At the time restoration, the condition of the object was unsatisfactory. The monument lacked structural integrity. The cross consists of three main large parts and many debris and fragments. The main part is the upper half of the cross with two arms and two separate parts of the lower arm. The cross was soiled with earth, splashes of paint, and moss. The cross is made of reinforced concrete, which includes different fractions of sand, crushed stone, and bricks, which is another destructive factor since ceramics (brick fragments) are porous materials that accumulate moisture. The monument required mechanical cleaning, preservation of metal elements, glueing of existing parts into a monolith, reinforcement, and restoration of lost elements by pouring concrete into formwork. Moreover, measures had to be taken, which involved pouring concrete to form a monolithic structure, which lost its integrity when destroyed.

The first step in the preservation and reconstruction was to expose the lower arm to its current position, keeping the arms parallel. The next step was the manufacture and installation of the armature. The armature was made of stainless-steel rods. The reinforcing bars were glued to the concrete with epoxy resin in drilled holes. A two-component epoxy resin was used alongside sand as a filler. In this case, sand was used to reduce fluidity and increase strength. Missing parts were patched with a filler compound that is not aggressive to the authentic material, cracks on the concrete surface and a cavity in the middle of the cross were filled, and the addition was tinted (Fig. 4). As a result of the measures taken, the monument was stabilised, restored and transferred to the Saint Assumption Univ Lavra museum for safekeeping.





Figure 4. Memorial reinforced concrete cross from the Saint Assumption Univ Lavra museum's collections after conservation

Source: authors' photo

The third memorial is a cross preserved in the city cemetery of Belz on the grave of eight unknown marksmen of the Ukrainian Galician Army who died in battles with the Polish army for Belz in 1919. The cross was transferred for restoration as a result of the expedition of the teachers of the Department of Architecture and Restoration, Vasyl Petryk, Olena Stasyuk, Viktor Melnyk, Serhiy Siry, as well as the Student Vladyslav Lelitka, who conducted further restoration of the cross as part of a diploma thesis. When it was received for restoration, the cross was in an unsatisfactory condition (Fig. 5). During the initial inspection of the object, it was established that the cross was exposed and substantially damaged. The cross was separated from the pedestal. The body of the cross was broken into pieces, parts of which were missing, the armature was twisted and covered with rust. The memorial required mechanical cleaning, conservation of metal elements, reinforcement, restoration of lost elements by pouring concrete into the formwork, and addition of lost parts from concrete to form a monolithic structure that lost its integrity when destroyed.

As a result of the measures, the lost parts were pasted with a complementary mass that is not aggressive to the authentic material, and the cracks on the concrete surface were filled. As a result of the measures taken, the monument was stabilised and given a proper appearance. As of 2024, it is located at the Department of Architecture and Restoration of Lviv Polytechnic National University (Fig. 6) and is awaiting transfer to the State Historical and Cultural Reserve in the city of Belz.



Figure 5. Reinforced concrete cross rifleman of the Ukrainian Galician Army from the city of Belza before the conservation

Source: authors' photo



Figure 6. Reinforced concrete cross rifleman of the Ukrainian Galician Army from the city of Belza after conservation

Source: authors' photo

All three reinforced concrete monuments described in the article constructed made at the beginning of the 20th century. Each has been restored, received a proper appearance. In the context of the different nature of the damage, a different method of restoration was applied to each of the monuments, which was described in detail in the article. Description of restoration accounted for special problems of each of the monuments and ways of solving them. The results of the restoration were illustrated in detail with photographs.

Cement is an artificial inorganic viscous substance. Artificial stone is one of the main modern-day building materials. On an industrial scale, was first produced in the 19th



century. This new material was strong and cheap. The oldest objects made of reinforced concrete are over 100 years old, many of them are monuments that need preservation and restoration. Restorers of both Europe and America are faced with the problems of restoration of historical reinforced concrete. For example, in 2017-2018, conservation of large-scale reinforced concrete sculptures took place in Canada. Conservation efforts addressed three different objects built at different times from the beginning to the middle of the 20th century. The Centre Street Bridge Lions (1916), Dinny the Dinosaur (1934) and the Maurice Savoie Mural (1966). They are three examples of large-scale outdoor artworks that adorn the roadways and buildings of Canada. Despite the difference in age, size and scale of these works of art, they share similar challenges associated with old historic concrete (Caldwell *et al.*, 2018).

The same large-scale reinforced concrete sculptures decorate the roads and squares of European cities. The statue of an African elephant opposite the Africa Museum in Brussels is a notable example. The sculpture was created by Albéric Collin in 1935. As of 2023, the sculpture was severely damaged, cracked, with many gaps, chips, and substantial corrosion (Chini, 2023). The restoration was initiated to preserve the historical value, structural integrity and appearance as well as to strengthen the structure and remove current damage.

Large-scale concrete sculptures, which were on city streets in the 70s of the 20th century, also often require restoration. An example of such a sculpture can be the congratulatory modernistic compositions of the city Hojnec (Poland) created by Norbert Jażdżewski in 1973-1975. These objects were in bad condition, cracked, lost their original colouring, and visible corrosion of metal elements (Conservation of a set..., 2022). The restoration recovered their original shape, texture and colour, and strengthened them as much as possible.

The Iwo Jima Monument conservation is an example of historical reinforced concrete memorial plastic conservation. Iwo Jima Monument is located on Parris Island South Carolina. This monument holds significant value to the Marine Corps representing all Marines who bravely died in service to their country. Based on the technical analysis and detailed visual inspection, all cracks, defective fittings and areas of the base material were identified (Chemello, 2019). Conservation of this monument preserves not only its physical materiality but also its rich historical, spiritual value and emotional connection with the Marines.

In Ukraine the Tula Bridge was the first reinforced concrete object. O. Noha (1995) defined it as the first curved product of this material in the world. Notably, Lviv Polytechnic was among the pioneers in the introduction of reinforced concrete structures into mass use. An example of this is the Tula Bridge, which has been preserved to the left of the Main Academic Building of the Polytechnic.

Restoration of reinforced concrete structures was substantially addressed in the literature on building structures of the late 19th and early 20th centuries. As of 2024,

buildings constructed using this material are already showing “age-related issues” that often require urgent and radical solutions, such as partial replacement of reinforcement, strengthening of concrete structures, etc. An example is the comprehensive restoration of the Hall of the Century in Wrocław, which has been on the UNESCO World Heritage List since 2006 (Ilkosz, 2006). The building was constructed in 1911-1913 by architect Max Berg. In 2009-2011, the reinforced concrete structure and the interior decoration was repaired, restored and reconstructed (Laska, 2010). After the restoration was completed, a conference was held in Wrocław, where reports were made, including information on the restoration of reinforced concrete structures. Comparing the methods of reinforced concrete structures restoration of the Hall of the Century and monuments of sepulchral plasticity, which was conducted at the Department of Architecture and Restoration, certain common features can be noted, namely: in both cases, the conservation of metal structures was done using agents containing corrosion inhibitors.

The problem of conservation and the implementation of additions to lost details is related to restoration philosophy and ethics. Decisions about additions are preceded by extensive theoretical research. This includes the identification of the object, detailed study, search and study of archival and photographic documents, analogues, etc. After theoretical research, a clearing, strengthening and addition methods can be selected. The sequence of all these stages must be followed.

CONCLUSIONS

The professionalism restoration, among other things, is based on knowledge of the tools and materials used in modern restoration. As a result of the activities conducted at the Department of Architecture and Restoration, monuments were stabilised and saved from destruction. Despite the variation in size and degree of preservation of the three artworks discussed in the study, each demonstrates similar problems associated with old historic concrete. The primary issue is the corrosion of reinforcing steel, which is associated with the water accumulation by concrete and its cyclical freezing-thawing, which is highly destructive for concrete. The performed activities also demonstrated the importance of a detailed, in-depth, comprehensive study of the monument for the correct identification of problems and the choice of a restoration concept. Among other things, methods of stabilisation, strengthening, addition, arrangement and toning were tested on each of the artworks. The technical methods and technologies described in the article, in combination with practical skills and various techniques for sepulchral plastic artwork preservation, can be beneficial in the restoration of this type of artwork. Notably, such problems are present in restoration efforts globally. The study described the processes of restoration and conservation of cement artworks, as well as those materials and restoration technologies that were tested by the authors in practice, which can be valuable for other





restoration works on similar objects. Monitoring of the completed restoration is an important stage. Monitoring of the restored monuments described in the article demonstrated a successful choice of materials and technologies. All objects demonstrate structural stability and no new damage. The only aesthetic defect is a little change in colour in the areas of additions and reconstructions. This problem remains for further research and experiments.

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**Реставрація надгробних пластичних творів
з цементних композицій**

Анотація. Реставрація сепульклярної пластики із залізобетону набуває все більшої актуальності, оскільки проблеми збереження фізичної субстанції пам'яток посилюються відсутністю належного догляду та агресивними для цього матеріалу природними факторами. Важливе значення для збереження пам'яток у належному стані мають своєчасно проведені фахові реставраційні роботи. Серед професіоналів зазвичай більш поширена робота зі старовинними творами мистецтва, однак і твори з цементних композицій, які увійшли в практику архітекторів і скульпторів наприкінці XIX століття, також потребують збереження. Метою дослідження було проаналізувати сучасні методики роботи з цементними композиціями в реставраційній практиці та навести приклади їх реалізації, апробовані та застосовані на конкретних пам'ятках. У дослідженні проаналізовано авторський досвід роботи зі сепульклярною пластикою, набутий під час реставраційних робіт у 2019-2024 рр. на кафедрі архітектури та реставрації Національного університету «Львівська політехніка». Проаналізовано історію появи цементних композицій. На трьох реальних прикладах детально розглянуто методи, прийоми та технології роботи з різними пошкодженнями пам'яток. Описані в статті результати досліджень мають практичне значення для широкого кола реставраторів мистецтва, оскільки допоможуть практикам добитися збереженості скульптурно-архітектурних об'єктів із цементних композицій кінця XIX – початку XX століття. Методи, описані в цій роботі, також можуть бути застосовані при реставрації пам'яток із залізобетону створених протягом всього XX, а також початку XXI століття, якщо при їх виготовленні були використані такі ж технології

Ключові слова: меморіальна пластика; штучний камінь; збереження; причини руйнування; охорона пам'яток