

Challenges of Post Earthquake Reconstruction of Heritage Sites

Structural Rehabilitation of Painted Buildings

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ABSTRACT

After the devastating earthquakes that first hit the city of Zagreb in March 2020 and then the nearby town of Petrinjar, Croatia was provided with funds from the European Union Solidarity Fund for the implementation of emergency measures to protect damaged cultural assets. To be able to spend these funds within the allotted period, the Croatian government passed a new law regarding the reconstruction of earthquake-damaged buildings applicable to Zagreb, Krapina-Zagorje County, Zagreb County, Sisak-Moslavina County and Karlovac County. The law made a distinction between structural reconstruction and the complete reconstruction of buildings, which unfortunately resulted in many valuable elements of historical buildings being overlooked at the expense of the structural rehabilitation. Structural rehabilitation is often invasive and unsparing with respect to historical elements of the building, especially the interiors, which are often painted with wall paintings and decorated with stucco. The legal framework and short deadlines made it challenging for the conservators, who had to reconcile the imperative of rapid restoration and preservation. This paper considers the structural renovation of the Archbishop's Palace in Zagreb, the methods applied to the wall paintings of the Chapel of St. Stephen, and the ceremonial hall, the best preserved space of the Archbishop's Palace.

Introduction:

The European Union Solidarity Fund and Structural Rehabilitation of Cultural Assets

Generally speaking, the funds of the European Union Solidarity Fund are to be used to undertake urgent rehabilitation; they cover the reconstruction of infrastructure and public buildings and cannot be used for the reconstruction and construction of family houses and residential buildings. The interiors of cultural assets may contain wall paintings or may be decorated with stucco, which means that conservation-restoration measures must be undertaken to protect these in advance of structural renovations being carried out, and fortunately, the fund covers a number of expenses related to such work, including temporary means of providing in situ protection of valuable architectural and stylistic-decorative elements of buildings as well as equipment and inventory; scaffoldings needed to carry out emergency dismantling and evacuation of valuable architectural and decorative building elements and endangered inventory; preventive protection and primary conservation of endangered parts of buildings and their equipment as well as of museum, archival, and library materials and movable heritage; and evacuation and temporary storage of stylistic and decorative elements of architecture.

The Archbishop's Palace and the Chapel of

St. Stephen: Description and Historical Summary

The Archbishop's Palace, a protected cultural monument, belongs to a group of most historically layered monuments in Zagreb and Croatia. It extends around the Zagreb Cathedral, with one wing located south of the cathedral and the other to the east. The first records of the buildings inside today's palace date back to the 13th century. It is also the largest Renaissance fortress and the largest preserved Baroque palace in northern Croatia, and until the earthquake in 2020, it was home to a large number of preserved, representatively furnished interiors, most of which were created at the end of the 19th century and during the 20th century.

The construction of the fortress that came to house the Archbishop's Palace that still stands today was begun under Bishop Oswald Thuz (1466–99) and completed during the time of Bishop Šimun Bakač Erdödy in 1521. During the construction of the fortress, the church of St. Emerik, the almshouse and chapel, the old bishop's palace, the Dominican monastery and trading houses in neighbouring Vlaška Street were demolished. The construction was led by builders from Italy (Magister Michael Italus).

The fortress has the shape of an irregular trapezoid, and it was originally reinforced with six cylindrical and two rectangular towers. The tower on the southern side of the fortress, which was built at the beginning of the 16th century, has not been preserved. Bakač's tower on the western side, along with the former small, pedestrian gate ('parva porta' in Latin), was demolished together with the western defensive wall in 1906. The entrance to the two-story rectangular tower that has a large vehicular gate ('magna porta') is on the east side towards Vlaška Street, where the remains of the earthwork rampart are still preserved. A new concrete staircase and portico have been constructed at the entrance to the offices of the Zagreb archdiocese's advisory board, but the semicircular moulded stone portals of the former entrance and sedilia and loophole niches that were original elements of the vestibule have been preserved. The late Gothic door and pear-shaped loopholes in the northern, cylindrical tower have been preserved, as have the cannon openings on the ground floor of the northwestern Domitrović tower, the pear-shaped loopholes on the first floor, and stone window frames on the second floor, detailed with bevelling and shutters that prove that this floor of the tower was residential. This tower features a ribbed vault made in 1612, as evidenced by the year and the initials of Bishop Domitrović carved into the keystone. Likewise in the Nebojan tower, the largest of the six, the stone frames of the pear-shaped loopholes have been preserved, but the original details on the southwest corner are visible only on the ground floor and attic and partly on the facades.

The late Renaissance structures of the complex created in the 17th century, when the palace was extended to the west and adapted (under bishops Petar Domitrović, Martin Borković and Petar Petretić), are no longer recognisable. Bishop Ignacije Mikulić built the Metropolitan Library building in 1692, which was demolished in 1906. In 1729, Bishop Juraj Branjug began the construction of the present-day man-



Fig. 1: Presentation of Christ in glory, mid-14th-century wall painting in the Chapel of St. Stephen, damaged by earthquake on 22 March 2022

or, a freestanding two-wing, two-story building of monumental dimensions. The spatial structure of Branjug's manor remains intact. It has arcaded, once open hallway on the courtyard side, that features a shallow Baroque cross vault on transverse arches. The four-flight staircase was subsequently reshaped. The hall in the eastern tower, the centre of social life in Croatia in the 18th and first half of the 19th century, has a mirror vault with rich stucco and once had mirrors on the walls. Some of the joinery with high-quality fittings and the original window work in the hall have been preserved. The facades are divided by large pilasters that have stylized composite capitals and lambrequins. The windows of the first and second floors feature bell-shaped bulging parapets and are connected in a compositional whole.

The window lintels above the windows of the first floor are flat, while those of the second floor are convex. The facade treatment was originally both rough and smooth and light ochre in colour. During the time of Bishop Aleksandar Alagović, a portico was added in the central part of the southern facade, in front of the staircase, by the builder Cocconi, and the part of the eastern wing north of the large tower was built following the plans of Antun Stiedl, a

Zagreb builder active in the first half of the 19th century. Alagović adapted the south eastern cylindrical, so-called garden tower, which features an open balcony with a wrought-iron fence designed by a locksmith named Lakner, on which appear the bishop's initials (AAEZ). In 1833, in accord with Stiedl's plans, a gardener's house was built along Bakač Street. The eastern and western courtyard entrances to the palace, which had pedestrian and carriage portals decorated with stone vases and forged classical doorways, were also built at this time. Until the restoration in 1981, the facades of the tower were detailed with shallow classicist rustication. After 1886, the Archbishop's Palace was modified in line with Hermann Bollé's designs. The southern facade was partially reshaped and a new portico with a stone fence and a gable with a statue of Blessed Virgin Mary were built. On the second floor, a hall with a wooden painted ceiling and wall decoration and portraits of rulers and bishops was also modified.

The Romanesque-Gothic Chapel of St. Stephen the First Martyr was built in 1250 during the time of Bishop Stjepan II. The rectangular space has a cross-ribbed vault organized in two fields. The ribs are pear-shaped, and the bundled columns have prismatic bases and carved capitals decorated with motifs of vines, wild roses, asp and sycamore leaves. A maskeron framed by vine leaves and a roaring lion

with cubs wrapped in a wormwood sprig, a symbol of the Resurrection, are carved into the vault's capstones. The northern vaulted field was damaged in the 18th century in the course of the construction of a corridor in the palace. The sanctuary of the chapel, which has a small trefoil oculus in its window, is on the south side, and today the hidden entrance is on the west, under a large five-leaf rosette. The remains of wall paintings executed in the 14th century by the master of the school from Rimini are found inside the chapel. In the vault is Christ in glory surrounded by evangelists and prophets (Fig.1). A fragment of the composition of the dispute in the temple has been preserved on the eastern side wall, and the northern side includes modest remains of saintly figures and angel musicians. In the sanctuary, where there was a representation of the Crucifixion, only part of the image of St. Magdalene has been preserved. The semicircular niches in the side walls that were deepened in the 18th century are painted with baroque frames. Graded buttresses and a fragment of the capital that date to the 10th or 11th century, probably part of the stone furniture of the first cathedral, are visible in the northern part of the chapel.¹

Description of Earthquake Damage

In the earthquakes of 22 March and 29 December 2020, the palace suffered enormous damage and is considered one of the most damaged protected buildings in Zagreb.

Stone elements that fell from the cathedral from a great height and the collapse of the chimney severely damaged the roof of the southern wing of the building. Tiles on the towers were loose and a number of them fell off. Structural elements in the wooden roof separated one from another. In the attic space of the south wing, the earthquake caused a longitudinal crack in the floor above the corridor of the second floor.

Deflection of the roof cornice above the entrance to the palace was visible, as were small cracks all over the facade. The facade in general sustained significant damage. The central part of the south side of the facade with the portico was the most damaged. The top of the gables collapsed and damaged the wrought-iron railing of the balcony as well as the stone parts of the terrace railing. Alagović's tower in the eastern wing had the most pronounced cracks, and the western wall of the tower was pushed out of the plane in the upper zone.

In the interior, on the ground floor of the building, surface damage was mostly noticeable on the

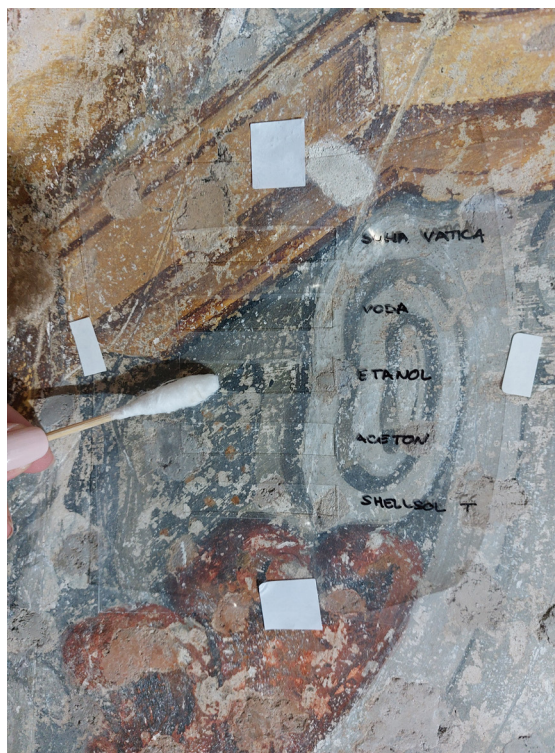


Fig. 2: Binder solubility and stability test being conducted at the Chapel of St. Stephen

load-bearing walls, and the partition walls had structural damage. Numerous cracks were visible on the vaults (mainly barrel vaults with cut vaults) and on the joints of the arched parts of the vault with the walls. Plaster had fallen from the vaults. All the walls and vaults on the first floor were significantly more damaged than those on the ground floor. In the corridors with cross vaults, there was a longitudinal crack at the top and a network of smaller cracks, and the plaster had fallen in places. There was also a large crack in the floor along the outer north wall of the corridor of the south wing. The surface of the load bearing and partition walls were severely damaged, and many had significant structural cracks (5–10 millimetres wide). The southern part of the east wing and the western part of the south wing were damaged the most. The arched structures of the openings in the towers had cracks.

The Second floor was damaged the worst. The cross vaults of the corridor were significantly damaged, and in the places where the chimney collapsed and the stone parts of the cathedral tower fell, certain cross fields had collapsed. A longitudinal crack also appeared in the corridor floor, along the outer wall. There was major structural damage to load-bearing walls on all staircases. Significant structural damage to the walls and vaults was noticeable in the southern part of the eastern wing, as well as on the vaults of the circular towers. The surfaces of the walls and ceilings of rooms in the western part of the south wing were badly damaged, and there was also damage to the carpentry and clay ovens.

The Chapel of St. Stephen suffered no major damage. Part of the stone rib from the cross-ribbed vault broke off, and the effects of moisture on the walls were visible.²

Post earthquake Reconstruction of the Archbishop's Palace with the Chapel of St. Stephen

After the earthquake on 22 March 2020, urgent work was carried out to remove collapsed and damaged chimneys, support damaged vaults, arch structures and door lintels. Protective scaffolding was also installed on the northern facade of the southern wing of the Archbishop's Palace. In the organization of the owner, the Archdiocese of Zagreb, most of the movable inventory and works of art (furniture, paintings, sculptures, objects of artistic craft), as well as part of the inventory of the Diocesan Museum, were moved and stored in a safe place outside the building of the Archbishop's Palace. In the great hall, the cen-

tral chandelier remained, as did the paintings-portraits of the archbishops of Zagreb. Two tapestries were stored in the adjacent hall, and in the area of the Archbishop's Palace there were also several pieces of furniture and several damaged stone sculptures.

An architectural and construction survey of conditions after the earthquake of 22 March 2020 was made in June 2020, and preliminary restoration research got underway. On 23 February 2021, the first meeting regarding the reconstruction of the Archbishop's Palace and the Chapel of St. Stephen was held. The conservation guidelines for the reconstruction of the complex were recorded by the *Gradski zavod za zaštitu spomenika kulture i prirode*, the City of Zagreb institute dedicated to the conservation of cultural assets. These guidelines stipulated that “the original features of the exterior and interior of the building, the scale, shaping, building and constructive elements, especially the facades, roofs, staircases and the basic structural system, as well as preserved valuable original design elements and equipment in the interior” had to be preserved, that “interventions that may threaten the character of the monument are not permitted, whether they pertain to reconstruction, reshaping or repurposing”, that any modifications made to accommodate modern needs had to conform to the building structure and that elements, materials and equipment used for repairs had to be “appropriate for the historical and monumental character of the building”. The document also called for “more detailed investigation work (conservation, restoration, archaeology)”.³ It specified that this further study should review and analyse the history of the building “from its construction until today”, drawing on archival documentation; undertake “a detailed survey of the existing state of the building, a complete 3D scan and an architectural survey of the current state of the building”; expand on conservation-restoration research regarding the interior and the facades by supplying “a detailed description of the findings” along with a proposal detailing the conservation and restoration that would be required; conduct further studies to “determine the exact composition and condition of the structure” in order to assess its “mechanical resistance and stability” and determine how to rehabilitate it and strengthen its seismic resistance; and explore the effects of moisture on the building and ways to mitigate them.

The *Gradski zavod za zaštitu spomenika kulture i prirode* noted that whoever undertook the conservation study would need to be granted permission to



Fig. 3: The process of facing being carried out at the Chapel of St. Stephen



Fig. 4: Presentation of Christ in glory, mid-14th-century wall painting in the Chapel of St. Stephen protected by facing

carry out the work the institute had outlined in its guidelines in accordance with the provisions of ordinance of 7 November 2018, amended 13 October 2023 (Narodne novine 98/18, 119/23).⁴ Guidelines specified that established protection measures had to be respected in the course of strengthening the building's seismic resistance, using methods that were “minimally invasive for historical constructions”. The institute argued that “special attention should be paid to the restoration and presentation of the chapel of St. Stephen”.⁵

Certified engineers were subsequently granted permission to provide project documentation for the complete restoration of the building. The documentation called for upgrading seismic resilience to level 4; reinforcing foundations by grouting and micro piling, reconstructing demolished parts of the foundation with reinforced concrete; constructing 5 new transverse walls in reinforced concrete, 4 in the southern wing, 1 in the eastern; reinforcing vaults by grouting and the application of carbon bands on extrados; reinforcing outside walls with a fibre-reinforced cementitious matrix; inserting multiple oriented structural boards on the upper side of floor constructions; inserting steel I-profiles between the wooden joists; and inserting steel profiles in the roof with transverse tension beams of kingbolt, rafters and pole plates.⁶

Preventive Conservation and Restoration Measures on Wall Paintings

Considering the relative invasiveness of the proposed and approved measures, because it would not be possible to raise the earthquake resistance of the building to level 4, it was determined that urgent preventive conservation and restoration measures had to be carried out in the most valuable spaces of the complex before the structural rehabilitation was begun.

Two such spaces were the Chapel of St. Stephen, home to the most significant example of Gothic wall painting in Croatia and the central area of the southern wing of the palace and the ceremonial hall (in Bollé's floor plan called ‘Spiegel-Saal’). Both are recognised as the most valuable spaces of the complex from the conservators' point of view and as the most demanding with respect to restoration.

The Chapel of St. Stephen's entire surface is painted with biblical scenes of Italian provenance that evince characteristics of the Rimini school, whose painters were familiar with the works of Giotto (1266–1337). These paintings were repainted on two occasions by Baroque artists, once during the time of Bishop Branjug (1723–47) and during the time of Bishop M. Vrhovac (1787–1827). Over the course of restoration between 1946 and 1953, the two Baroque layers were removed and the 14th-cen-

tury wall paintings recovered. The ceremonial hall owes its present appearance primarily to Bollé's extensive work carried out after the 1880 earthquake. Since it is a room in which the decorations on the ceiling and partly on the walls have been preserved, everyone participating in the restoration project agreed that this room should be restored in a way that respected the last complete phase, that of Bollé.

The conservation methods used for the wall paintings both in the Chapel of St. Stephen and in the ceremonial hall were the same. First, a preliminary review of the condition of the wall paintings was undertaken. Next, the condition and damage found was documented by thorough photographs of segments that were joined together in panoramic views. Photographs were taken in the visible, ultraviolet and infrared spectrum. Cracks, delaminations, caverns, and salt damage as well as the position of damage to the wall paintings and stone elements have been pencilled into graphic documentation generated by the *Hrvatski restauratorski zavod* in 2005 in order to simplify the process of monitoring of operations at the chapel. Then binder solubility and stability tests were performed on the Gothic, Baroque and wall paintings from the period of historicism where the

pigment showed mostly stable (Fig. 2). After that, preventive protection of the paintings was initiated using the method called facing (Fig. 3). A layer of 50% cyclododecane in white spirit was applied first directly to the fresco and then a layer of 4% Klucel G in ethanol was applied over segments of Japanese paper (Fig. 4). The cracks and delaminations were also preventively injected and the damaged parts of plaster were protected by edging with lime plaster. Finally, the wall paintings in the Chapel of St. Stephen were secured by a light wooden construction that was separated from the paintings by a thicker sponge and a layer of geotextile.⁷ It was only after these preventive protection measures were implemented that the structural renovation could finally be carried out.

In conclusion, the conservation-restoration methods applied to the wall paintings of the Chapel of St. Stephen and the ceremonial hall were imperative prior to the structural rehabilitation of this built complex that was severely damaged by the earthquake, and they met all the conservator's requirements set out in the conservation guidelines and enabled a successful structural rehabilitation of the complex, without further damaging and endangering these valuable historical paintings.

List of Figures

- 1 Nives Maksimović Vasev, 12 August 2022.
- 2 Nives Maksimović Vasev, 27 July 2022.
- 3 Nives Maksimović Vasev, 19 August 2022.
- 4 Nives Maksimović Vasev, 25 August 2022

Endnotes

- 1 The description and the historical summary of the built complex comes from the Ministry of Culture, Proclamation of the cultural good of the complex of the Cathedral of the Assumption of Mary, the Archbishop's Palace and the Chapel of St. Stephen, fortifications and Ribnjak Park, class number UP/1-612-08/02-01/393, registry number 532-10-1/8(JB)-02-2, Zagreb, 28 May 2002.
- 2 The description of the damage is taken from the questionnaire used for recording earthquake damage on cultural goods developed by Ministry of Culture and Media. The damage was documented on 23 April 2020 by Maja Gorianc Čumbrek, Silvije Novak, Antonia Matković Šerić and Andrijana Tadić, all conservators from the Gradski zavod za zaštitu spomenika kulture i prirode u Zagrebu.
- 3 Conservation guidelines, Gradski zavod za zaštitu spomenika kulture i prirode u Zagrebu, class number 612-08/21-010/66, registry number 251-18-03/001-21-03, Zagreb, 23 February 2021.
- 4 For the ordinance, see: https://narodne-novine.nn.hr/clanci/sluzbeni/full/2018_11_98_1896.html
https://narodne-novine.nn.hr/clanci/sluzbeni/full/2023_10_119_1665.html (last access 13 June 2024).
- 5 Conservation guidelines, Gradski zavod za zaštitu spomenika kulture i prirode u Zagrebu, class number 612-08/21-010/66, registry number 251-18-03/001-21-03, Zagreb, 23 February 2021.
- 6 do plus za d.o.o., project documentation for the complete restoration of the Archbishop's Palace, ZOP NT/ND-06-21-GP, May 2021. Level 4 seismic resistance is the highest level described by current Croatian regulations; renovated buildings that have to meet level 4 are expected to satisfy current Croatian technical regulations for the structural design of HRN EN series buildings, see https://www.hcpi.hr/uppo/?info/razine_obnove (last access 13 June 2024).
- 7 The data on preventive conservation and restoration measures on the wall paintings comes from the restorer's report: Nives Maksimović Vasev, Konzervatorsko-restauratorski radovi u sklopu projekta sanacije i rekonstrukcije građevine Nadbiskupskog dvora u Zagrebu (Conservation-restoration works as part of the rehabilitation and reconstruction project of the building of the Archbishop's Palace in Zagreb), Zagreb 2022.