Restoration of the Peristyle of Diocletian's Palace in Split

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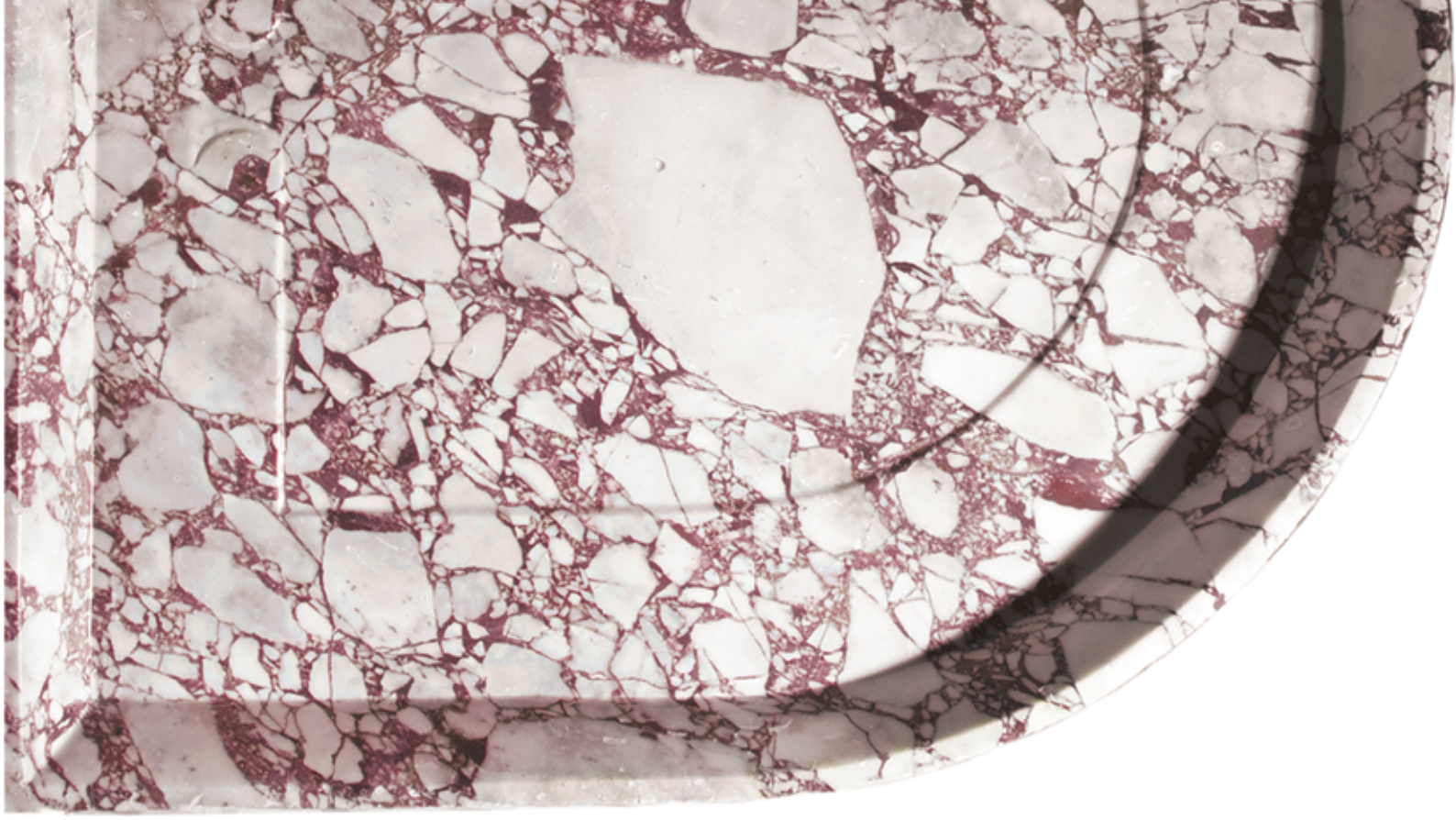

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CONTENT

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RESTORATION OF THE PERISTYLE OF DIOCLETIAN'S PALACE IN SPLIT

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Abstract

Various types of granite and marble used for the construction and decoration of Diocletian's palace and of its central square – the Peristyle – were imported from distant regions of the Empire, mostly from Egypt and Asia Minor. Apart from that, local limestone of the highest quality, quarried mostly on the neighbouring island of Brač, was used for building the monumental parts of the Palace. Organized by the City of Split and executed by the Croatian Conservation Institute, the restoration of the Peristyle constituted one of the most important conservation and restoration operations carried out in Croatia. Started in 2003 as a stone cleaning operation, it developed into a ten-year long, complex restoration project including archaeological, geophysical and geo-mechanical research, consolidation of foundations and upper structures, cleaning and conservation of stone, plaster and other materials, lighting and presentation of this multi-layered monument.

Keywords
Peristyle, laser cleaning, stone restoration

Diocletian's Palace has been a topic of scientific interest for a long time, but there has been no full consensus about some of its basic elements, from the typological definition to the original purpose of the building, from the original appearance of the whole down to the reliable reconstruction of the architectural parts. Traditionally, Diocletian's Palace has been described as a unique combination of an imperial villa and a typical Roman fortification, a blend of a lavish *villa rustica* and a military camp.[1]

Recent research has proposed a new understanding of the original purpose of the imperial complex in Split: Diocletian's Palace was first conceived for the imperial manufacture of textiles, and was later, probably already during the construction, adapted for the residence of the retired emperor. The Palace, which only looked like a fortified villa, housed an unusual combination of functions: a textile workshop, imperial apartments and religious buildings serving the cult of the deified emperor.[2]

In parallel with a fresh historical and architectural reinterpretation, new insights have been made in recent years into the use of structural systems and of materials.[3] Among the materials used for building of the imperial palace, local limestone of the highest quality, quarried mostly on the neighbouring island of Brač, was the prime structural material, especially in the most prominent places, such as the perimeter walls, the religious buildings – the Mausoleum and the temples – and the central square, or courtyard – the so-called Peristyle – placed between them.[4] To enhance the monumental expression of the conspicuous exteriors and interiors, the builders used a variety of decorative stones and marbles, imported from various parts of the empire, mostly from Egypt and Asia Minor.[5]

In the light of new interpretations of the original function of Diocletian's palace, a fresh perspective can be offered on the architecture of its central square – the Peristyle. (Fig. 1) As a result of changes in design introduced during the construction, the architecture of the Peristyle assumed an ambiguous character, between the solid, massive structure of the Vestibule on the south side and the light, free-standing colonnades, separating it from the sacred enclosure of the Mausoleum to the east and that of the temple area to the west. From the beginning the Peristyle had some serious weaknesses and mistakes built into its very structure.

1 NIEMANN 1910; HÉBRARD, ZEILLER 1912; BULIĆ, KARAMAN 1927; MARASOVIĆ 1994.

2 BELAMARIĆ 2003; BELAMARIĆ 2004.

3 NIKŠIĆ 2004; NIKŠIĆ 2011; NIKŠIĆ 2015.

4 In the imperial palace in Split other building materials – brick, mortar and concrete – had equally important roles, especially in places where they were not expected to be seen. An overview of building techniques and materials in Diocletian's Palace is given in: BUBLE 2009. On the use of brick in Diocletian's Palace see: NIKŠIĆ 2015.

5 BULIĆ 1923; MARASOVIĆ, MATETIĆ POLJAK 2010; MARASOVIĆ, MATETIĆ POLJAK, GOBIĆ BRAVAR 2015.

Fig. 1. View of the Peristyle before restoration (photo: B. Ostojić)

The link between the longitudinal free-standing arcaded colonnades and the transversal porch of the Protyron – the entrance to the imperial quarters – at the south end of the square was not resolved very successfully, either at the conceptual level or in the execution, with the blank wall at the end of the colonnades, and the corners of the Protyron pediment "eaten away". The Protyron was presumably first conceived as a classical porch, free on three sides, and then transformed into a scenographic decoration squeezed between two massive walls. Evidence of that situation was found already by Niemann who pointed out the difference between the mouldings of the trabeations of the Protyron pediment and of the lateral colonnades.[6] The ends of the pediment are covered by the walls at the south end of the colonnades which were obviously added in a later variant of the design, putting out of context the piece of the trabeation still visible on top of the wall on the east side of the Protyron.

The great majority of columns in the Peristyle, as well as in other parts of the Palace, were imported from Egypt as ready-made elements taken from existing buildings. The small differences in height of these columns were compensated by variations in height of limestone capitals and bases which were made locally.

One of the consequences of the abrupt transformations of the plan was the misalignment of the transverse axis of the square and the east-west axis of the *temenoi*. An *ad hoc* solution was found by using columns of different colours – red granite columns were positioned in front of the Vestibule (the entrance to the imperial apartment) and in front of the Mausoleum and the Temple.[7] The red granite (syenite) was used as a substitute for the purple porphyry, which was the most precious material and had an imperial significance. (Fig. 2) For the remaining two pairs of columns at the north end of the square grey marble was used.[8] Of those, the two columns

6 NIEMANN 1910, 47.

7 NIKŠIĆ 2009.

8 Previous authors described those columns in different ways, but the most recent article (MARASOVIĆ, MATETIĆ POLJAK, GOBIĆ BRAVAR 2015, 1004) identifies the material of all four columns as Proconnesian marble, although only the western pair is easily recognisable as such.

Fig. 2. Peristyle, west colonnade, a red granite column (photo: G. Nikšić)

Fig. 3. Peristyle, west colonnade, a Proconnesian marble column. Toolmarks are still visible (photo: G. Nikšić)

on the east side were reused from an earlier, probably Egyptian building, and carry incisions made with a sharp object.[9] Facing them are two columns of Proconnesian marble which seem to be commissioned specially for the Peristyle and have never received a final polish. (Fig. 3)

All these improvisations contribute to the overall impression of an eclectic, heterogeneous, *ad hoc* solution of the difficult problem, reflecting in a nutshell the complexities of the Palace as a whole. Diocletian's Palace is full of examples where serious mistakes were committed and instant solutions were found by the highly skilful Roman builders. It is fair to say that, considering the circumstances, the end result is in a way successful. Once we understand that the builders did not look for perfection because it would have been an improbable task, with overwhelming time pressure and crazy deadlines, and with the design brief changing probably several times in the course of construction, we can only admire their skill in masking the imperfections of the details and diverting the onlooker's attention from them.

The already complex architecture of the Roman Peristyle became even more intricate with the addition of many buildings of different periods. It can be said that the imperfect architecture of the Peristyle was enhanced by later accretions which are an added value to the remarkably well preserved original structure which took on a new meaning as cathedral square and centre of the city.

Over the past two hundred years, the Peristyle has seen numerous conservation and restoration interventions of various scopes and outcomes, reflecting the attention it has always attracted from experts and general public. Such partial interventions resolved specific problems, but sometimes also resulted in the creation of new ones. At the beginning of the third millennium, we have finally witnessed a comprehensive project which, for the first time, encompassed the complex in its entirety.

A ten-year restoration campaign was stimulated by the initial grant of the World Monuments Fund, and an additional financial support of the Ministry of Culture of the Republic of Croatia, while most of the funding was provided by the City of Split. The work was organized by the Service for the Old City Core and executed by the Croatian Conservation Institute. Started in 2003 as a stone cleaning operation, it developed into a complex project including archaeological, geophysical and geo-mechanical research, consolidation of foundations and upper structures, cleaning and conservation of stone, plaster and other materials, lighting and presentation of this multi-layered monument.

9 These incisions called *wusum* are frequent in Egyptian sacred buildings and were made to extract powder of the sanctified material for prophylactic use. Personal relation of J-P. Brun.

Geotechnical and archaeological investigations of foundations and the ground beneath them, performed to collect data necessary for the structural design, revealed important new information about the history of the buildings and about the causes of decay. It was established that the Roman structure was mostly founded on solid ground or on solid remains of older structures and, to a lesser extent (pillars of the *decumanus* porch) on insufficiently stable ground. Archaeological investigation provided new insight into the historical development of the buildings.[10] Of special interest was the insight into the foundations of the east colonnade, which seem to have belonged to an earlier structure, and a large ceramic vessel – an ancient *pithos* – which was damaged by a drainage channel belonging to the construction of Diocletian's Palace.

Seventeen centuries of demolition and construction have left traces in the robust Roman structure, as well as on buildings dating from later periods. Some of the problems encountered during the structural rehabilitation were already present in Diocletian's time. The "arcuated lintel" of the Prothyron from the beginning exerted a horizontal thrust that still continues to cause structural damage. At their northern ends, long arcades push the arches of the decumanus porticos, and consequently the house and the church attached to them, inflicting structural damage on them. The low terminal arches of the porticoes buttress the tall colonnades quite unsuccessfully, anticipating medieval structural ideas in an awkward way.

Structural problems were partially dealt with on several occasions. At the beginning of the 20th century a part of the east colonnade was dismantled and reassembled, and two columns of grey marble were patched with cipollino marble. Approximately at the same time, an attempt was made to stop the deformations in Prothyron. Stone blocks of the arch and the wall were reinforced with copper clamps. Steel ties were set on two levels connecting the pediment wall to the Vestibule.

During the recent restoration works at the Peristyle, for the first time, the structure was analyzed as a whole and the problem of structural stability was fully addressed. The leading principle of the structural strengthening consisted in recovering stability and preventing further deformation using minimum and non-invasive interventions. Monitoring of stress and strain was conducted before, during and after the treatment in critical locations in order to determine deformation growth – its intensity and speed. Stress measurement of the copper clamps on the Prothyron pediment has shown that the hundred-year-old intervention is still effective.

Fig. 4. Peristyle, relieving arch above the portal leading into the Vestibule before restoration (photo: Ž. Bačić)

From the structural point of view, the Peristyle is exceptionally heterogeneous, with Roman elements that are partly free-standing and partly embedded in later buildings. In order to understand the behaviour of the complex structure, a computer model was used to test vertical and horizontal (earthquake) loads. Based on the results of these tests, a program of structural rehabilitation was designed. Critical areas of foundations and walls were grouted with lime-based material. Special attention was given to the grouting of joints between capitals, columns and lintels, so that their edges would be discharged of some of the concentrated load created by the tilting of the columns.

In order to slow down further deformation of the Prothyron, non-invasive interventions were conducted that have greatly reclaimed its stability. The roof of the Prothyron, which was (unjustifiably) installed in mid-20th century, was improved to add rigidity to the structure. A threefold wooden revetment was firmly fixed to the wooden roof beams anchored in the stone pediment on the north side and in the massive wall of the Vestibule on the south. Old copper clamps on the pediment were kept, and steel were replaced with stainless steel ties.

A large relieving arch built of brick and tufa stone above the portal leading from the Prothyron to the Vestibule was heavily damaged and was, probably in the Middle Ages, supported with stone masonry. In this way the load of the wall was transferred onto the stone lintel which consequently broke in the middle (Fig. 4). The arch was restored using blocs of tufa stone and bricks matching the original ones in shape and dimensions (Fig. 5).

Structural rehabilitation of the church of St. Roch, attached to the northern end of the east colonnade, was another complex task. Carbon straps were fixed to the masonry vault, to the longitudinal cornices and to the interior surface of west façade. Several crushed stone

10 MADIRAZZA 2013.

Fig. 5. Peristyle, relieving arch above the portal leading into the Vestibule after restoration (photo: Croatian Conservation Institute)

Fig. 6. Peristyle, east colonnade, pilaster capital, laser cleaning (photo: G. Nikšić)

blocks on the outer side of the same façade were replaced or patched with stone or artificial stone. The wall was grouted to reduce the load concentrated on the exterior edges of ashlars which had originally been carved with slanted sides and installed without joints.

Previous to the restoration treatment of the stone surface, extensive investigation was conducted in order to determine the stone type, the composition of the crust and patina, the type and quantity of salts in the stone. Detailed laboratory tests helped to determine compatible materials to be used in restoration, methods of cleaning and consolidation of the stone surface.

Mineralogical and petrographic comparison of stone samples from the Peristyle and from quarries on the island of Brač established that the stone used for building of the Peristyle was biomicrite limestone of the wackestone type, very similar to the stone from the quarries at Škrip, Plate and Rasohe on Brač. There were several types of soiling and damage found on the Peristyle stone: surface sediments (black crusts and greyish patinas), harmful (soluble) salts, biological soiling, eroded areas and mechanical damage.

The dark crust on the stone, up to one centimetre thick, generally consisted of gypsum, soot and iron oxides, with occasional calcium oxalate dihydrate (weddellite) particles. The greyish patina was identified as weddellite and, at places, gypsum. The yellowish patina found beneath the black crust consists of calcium oxalate monohydrate (whewellite) and dihydrate (weddellite). In addition to mineral patinas, algae and lichen covered large surfaces of stone. They were removed by washing and applying biocidal products based on quaternary ammonium salts, which proved to be effective in preventing the renewed growth of lichen.[11]

The main method selected for removing the dark sediments was laser cleaning, which has many advantages over other cleaning techniques: minimum invasiveness, high precision and level of control, and selectiveness (Fig. 6). Together with the simultaneous work on the Golden Gate, the Peristyle project was the first case where this most advanced technology was used for cleaning not only the decorated parts, but the whole surface of stone, marking the start of its widespread use in Croatian conservation practice. It was also a unique opportunity to test and compare, on the same scaffolding, the performance of different types of laser machines.[12]

Only after the removal of the soiling could fine details of original Roman carving be fully appreciated, revealing the skill and beauty of the stonemasonry of the ancient masters (Figs. 7-10). Another virtue of the laser cleaning method is the possibility of removing the harmful sulphate crusts without damaging the yellowish natural patina, which acts as a protective layer due to the fact that calcium oxalate is far less soluble in the acidic and neutral environment than calcium carbonate.

In areas which had been exposed to intensive washing by rainwater, the oxalate patina disappeared, and the stone became exposed and vulnerable. To recreate the protective layer a method normally used for treatment only of sculptures and decorated surfaces was adopted for the whole of the stone structures of the Peristyle: an artificial layer of calcium oxalate was created through the reaction of ammonium oxalate (applied directly or in poultices) and calcium carbonate present in the stone. In the same way highly soluble gypsum was transformed into more stable calcium oxalate.

For desalination of salt-contaminated areas of stone the common ammonium-barium method was used.

11 MUDRONJA 2013, 27.

12 MATIJACA 2013, 42.

Fig. 7.
Peristyle, east colonnade, detail before restoration (photo: G. Nikšić)

Fig. 8.
Peristyle, east colonnade, detail after restoration (photo: Croatian Conservation Institute)

Fig. 9. Peristyle, cornice of the Prothyron gable, detail before restoration (photo: Croatian Conservation Institute)

Fig. 10. Peristyle, cornice of the Prothyron gable, detail after restoration (photo: Croatian Conservation Institute)

Fig. 11. Peristyle, general view after restoration (photo: G. Nikšić)

It consists of two steps. The first step involves treating the gypsum on the stone with an ammonium carbonate solution, which transforms the gypsum into a soluble ammonium sulphate. In the second step, barium hydroxide is used to transform the remaining gypsum and ammonium sulphate from the preceding step into stable barium sulphate.[13]

To minimize future exposure to rainwater and soluble salts, and to increase the resistance to weathering, stone surfaces were protected with a solution of silicic acid ester (ethyl silicate), with the addition of Paraloid b-72 for partial consolidation. Lead flashing with a drip edge was applied on upper horizontal surfaces. Bird control netting and spikes were installed to prevent damage from bird droppings.

Inappropriate cement patches from previous restorations were removed as were metal elements anchored in stone. Corroded iron clamps and dowels were replaced with stainless steel ones. In cases where this was not possible, they were treated with a solution of corrosion inhibitor.

Completely disintegrated stone elements were replaced with new stone. Partly damaged elements were repaired with stone or mortar patches, depending on the condition of the stone, its size and structural role. Traditional tools were used for finishing of the reconstructed surface.[14]

Apart from stone, plastered surfaces were cleaned, repaired and consolidated.

Particular attention was given to the final presentation of the Peristyle. The new lighting discreetly enhances the architectural features and creates a unique atmosphere at night.

Due to the Peristyle's importance in the fields of classical archaeology, art history and architecture, and given the complexity of the conservation-restoration problems, numerous Croatian and foreign experts and institutions were involved in the project. The multidisciplinary approach, which is becoming an increasingly important feature of contemporary conservation and restoration practices, has been shown here as an essential component without which the set objectives could not have been accomplished. The contributions of experts from different fields gave the project additional scientific weight.[15]

Because of the importance of the Peristyle as the most significant element of the historic core of Split,

13 MUDRONJA 2013, 28.

14 MATIJACA 2013, 46-47.

15 MARINKOVIĆ 2013, 49.

inscribed on the UNESCO World Heritage List, and in view of the complexity of conservation issues, involving a large number of Croatian and foreign experts and institutions, the project has been one of the most important conservation and restoration campaigns in Croatia. It provided an excellent opportunity for the professional development of young experts in state-of-the-art restoration procedures, and raised the bar for improving the conservation standards in the historic core of Split and in the region (Fig. 11).

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