



# Proceedings of the 4<sup>th</sup> WTA International PhD Symposium

13-16 September 2017  
Delft, The Netherlands

W.J. Quist, S.J.C. Granneman & R.P.J. van Hees (eds.)



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Edited by W.J. Quist, S.J.C. Granneman & R.P.J. van Hees

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## TABLE OF CONTENTS

Introduction.....	7
<i>Rob P.J. van Hees</i>	
<b>Thursday 14 September</b>	
Design and development of special concretes - adaption of materials for special rehabilitation tasks .....	11
<i>Alexander Flohr, Alexander Gypser and Andrea Osburg</i>	
Mitigating salt damage in lime-based mortars with mixed-in crystallization modifiers.....	19
<i>Sanne J.C. Granneman, Barbara Lubelli and Rob P. J. van Hees</i>	
Learning from vernacular buildings- traditional rural architecture in Austria and it's adaption on climatic conditions .....	29
<i>Gregor Radinger</i>	
Influence of bio and nano fibers in clay mortars .....	37
<i>Aspasia Karozou and Maria Stefanidou</i>	
Reliability monitoring of the rainwater disposal system for historic buildings.....	47
<i>Nathalie Van Roy, Els Verstryngne and Koen Van Balen</i>	
Use of nanomaterials for the protection of historic stone architecture: laboratory methods for the evaluation and investigation of photocatalytic activity .....	55
<i>Marco Roveri, Francesca Gherardi, Sara Goidanich, Laura Niccolai, Valentina Dami and Lucia Toniolo</i>	
Historic wooden houses of Istanbul with the influence of European styles .....	65
<i>Saniye Feyza Yagci</i>	
External strengthening of stabilised earth-blocks masonry .....	75
<i>Kyriaki Papadopoulou and Ioanna Papayianni</i>	
Studying the technology and the architecture of different mosques left in northern Greece.....	83
<i>Maria Loukma and Maria Stefanidou</i>	
Determination of water penetration and reaction sites in limestones from the cultural heritage.....	91
<i>Adam Drici, Mandana Saheb, Aurélie Verney-Carron, Loryelle Sessegolo, Laurent Remusat, Adriana Gonzalez-Cano, Jean-Didier Mertz and Patrice Coll</i>	

Public private partnership in conservation and valorization processes: sponsorship initiatives.....	99
<i>Cristina Boniotti</i>	
Materials tested by time. quality and durability of the restorations of the temples of Paestum from the nineteenth-century approaches to the contemporary issues of conservation.....	107
<i>Stefania Pollone</i>	
<b>Friday 15 September</b>	
Analysis of rare events and weather imitation for the realistic testing of consolidated clay-bearing stones in building facades.....	117
<i>Ylenia Praticò, Fred Girardet and Robert J. Flatt</i>	
Renovating fusee ceramique vaults .....	125
<i>Wim Kamerling</i>	
Development of ammonium oxalate treatment for site conditions - initial results.....	133
<i>Tabitha Dreyfuss</i>	
Lightweight vaulting systems in the early 19th century, from Naples to Europe. knowledge for conservation of an adaptive built heritage .....	141
<i>Lia Romano</i>	
Retrofitting historical buildings: a probabilistic assessment of interior insulation measures and the hygrothermal risks.....	149
<i>Astrid Tijssens, Hans Janssen and Staf Roels</i>	
Urban microclimate: natural ventilation and open space in the historic city. Summary of critical evaluation on the Italian and international research .....	157
<i>Gaia Turchetti</i>	
Safety assessment of masonry structures using ordinal optimization.....	165
<i>Fernando Magdalena, Julián García, José Ignacio Hernando and Eva Magdalena</i>	
Literature review on the assessment of masonry properties by tests on core samples.....	173
<i>Samira Jafari, Rita Esposito and Jan G. Rots</i>	
Computational modeling of the cyclic pushover test on a calcium silicate element masonry assemblage.....	181
<i>Manimaran Pari, Samira Jafari, Francesco Messali, Rita Esposito and Jan G. Rots</i>	
Safeguarding historic structures by instrumented building monitoring.....	191
<i>Frank Lehmann and Michael Schreiner</i>	

Hygrothermal behaviour of building components in context with the room usage of a historic residential building in Jeddah, KSA .....	201
<i>Wolfgang Stumpf and Thomas Bednar</i>	
<b>Practical information</b>	
Symposium program .....	211
WTA Nederland – Vlaanderen .....	215





# **MATERIALS TESTED BY TIME. QUALITY AND DURABILITY OF THE RESTORATIONS OF THE TEMPLES OF PAESTUM FROM THE NINETEENTH-CENTURY APPROACHES TO THE CONTEMPORARY ISSUES OF CONSERVATION**

**S. Pollone<sup>1</sup>**

## **KEYWORDS**

Paestum Heritage, Archaeological Restoration, Durability, Compatibility

## **ABSTRACT**

The issues linked to the physical, mechanical and aesthetical compatibility between pre-existences and additions, as well as to their durability, represent one of the main challenges of a restoration project. An archaeological context makes such issues even more complex, as it requires more attention due to the need of preserving the fragile ancient materials. Starting from these premises, this paper proposes the archaeological site of Paestum – one of the most significant town of Magna Graecia – as a particular testing ground for the evolution of restoration principles and practices. In this case, in fact, the conservation proposals and the restorations of the temples – carried out since the end of the 18<sup>th</sup> century – show the high quality of the choices, all aimed at ensuring the compatibility between new and old materials, the durability of the additions, and their distinguishability. The results of these restorations, still well preserved today, testify the accuracy of the technical expedients and the durability of the materials chosen for the additions, and acquire even more importance if compared with the outcomes of the twentieth-century yards. Despite the methodological lesson provided by those earlier restoration projects, works performed on the site of Paestum during the first decades of the Twentieth century were instead characterized by a much less careful approach, in terms of both the compatibility of interventions and their durability. Specifically, such interventions led to a larger use of concrete injections, reinforced concrete additions, armed perforations, as well as undocumented reconstructions in correspondence of the city walls.

Taking these considerations into account, this paper's aim is to interpret the evolution of the techniques and the approaches used throughout the 19<sup>th</sup> century, by comparison with those carried out during the 20<sup>th</sup> century. Such an interpretation will allow us to evaluate the level of quality of the choices made, in terms of both durability and compatibility between old and new parts. This analysis is carried on considering the present state of conservation of the temples. In this respect, it emerges as a critical instance the fact that, after only few decades, the most recent materials have answered to the test of time worse than the older ones.

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## INTRODUCTION

The late Eighteenth century represents a key-period for defining the cultural basis and the principles of modern restoration. The approach and the analytic method defined by the academies of architecture within the Italian context – first of all by the French Academy in Rome – stimulated an increasingly aware dialogue with the vestiges of the antiquity to be scientifically interpreted. Moreover, the opening in the Neapolitan area of the main excavation yards of the cities of Pompeii and Herculaneum – rediscovered during the first half of the century – made possible unexpected and direct contact with ancient and fragile architectures which required new forms of interventions. Indeed, the conditions of great vulnerability of these structures required a large amount of urgent works of strengthening and protection that was carried starting from the second half of the century. Despite the heaviness of some additions, which sometimes determined the reconstruction of missing or collapsed parts and elements, these interventions can be considered as an early experimentation within the field of the archaeological restoration. These experiences were refined later, during the French Decade, when some of the most relevant restoration programs were carried out between the Roman and the Neapolitan contexts. During those years, and even after the retour of the Bourbon, technicians deepened their knowledge about issues related to protection and conservation, and started devoting more attention to the respect of the authenticity of the materials, as well as to the recognizability between additions and ancient parts.

Within this phase of cultural and methodological evolution, the restoration process of the temples of Paestum (in the province of Salerno, Campania) played a major role both for the precocity of the solutions and the variety of the conservation approaches [1]. Since the second half of the 18<sup>th</sup> century, the ancient city of Paestum – one of the most significant example of settlement of Magna Graecia, in which structures and stratifications belonging to Greek, Lucan, Roman and Medieval Ages coexist – began to attract the attention of Italian and European scholars, first of all for the presence of three well-preserved Doric temples: the so-called Basilica and the temples of Athena and Neptune. The methodological proposals and the operating practices employed on the temples since 1805, testify a relevant variability both in the choice of techniques and in the use of materials, as well as a strong connection with the aim of the contemporary archaeological restoration. Moreover, the possibility to make a comparison between the results of the nineteenth-century restorations and of those of the following century allows the analysis of the evolution of approaches and methods. This interpretation may become even more relevant once taking into account the relationship between theoretical assumptions and actual effects on ancient materials in terms of compatibility, recognizability and durability.

### **‘INSIDE’ AND ‘AROUND’ THE ANCIENT. THE TEMPLES OF PAESTUM AS ATLAS OF METHODOLOGIES AND TECHNICAL APPROACHES**

#### **The nineteenth-century experimentations**

Although the ancient city of Paestum attracted the national and international interest since the Forties of the Eighteenth century, at that time the central government focused its attention and resources almost entirely on the sites of Pompeii and Herculaneum. However, the precarious condition of conservation of the ancient temples of Paestum and their rapidly progressing damages, due to the state of abandonment and the lack of maintenance, urged intervention towards the end of the 18<sup>th</sup> century. All the restorations carried

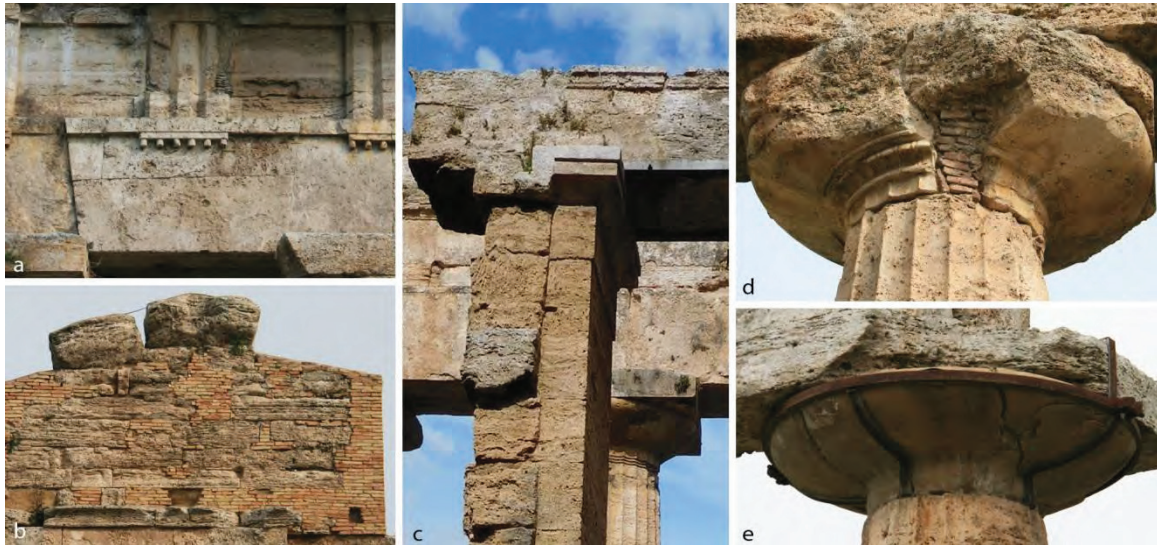


Figure 1: a) temple of Neptune, western architrave. Integrations in travertine blocks (1805); b) temple of Athena, eastern gable. Additions in brick masonry (1829-30); c) temple of Neptune, architrave and pillar of the order of the cell. Additions in travertine blocks and iron chains (1850-53); d) temple of Athena, column of the eastern side. Addition in fragments of bricks (1853-54); e) Basilica, capital of an internal column. Strengthening with iron devices (1855-56).

out on the temples – from the first proposals (1795) until the works performed in the Eighties of the Nineteenth century – appear to be characterized by conscious choices, aimed at ensuring the necessary compatibility between additions and old parts, as well as the durability and distinguishability of the new materials. This awareness, gained over time through the experiences of many architects and technicians, brought to culturally advanced approaches, close to the aims of the contemporary archaeological restoration – in particular for the will of adjusting the extent of the intervention to the actual conservation needs, having due regard not to adulterate the portions of the ancient structures.

Basing on an in-depth knowledge of the material and mechanical properties of these temples, the methodological acquisitions and the practical skills of the first half of the 19<sup>th</sup> century showed an increased attention in the selection of materials considered more compatible with the travertine of the temples. These experimentations were characterized by a high variability in terms of building materials and constructive techniques, in the case of the necessary integrations. Among these it emerges the choice of using blocks of the same travertine of the temples – well-finished and shaped in simplified geometries – connected to the ancient parts through iron braces and chains. Elsewhere, instead, some portions of brick masonries were defined and made recognizable, where possible, from the ancient palimpsest through the use of clearly different materials and constructive techniques. In addition to these stereotomic integrations, where the type of damage did not need integrations or additions, the reinforcement of stone elements were obtained through the installation of iron braces and chains.

In this context, the proposals by Francesco La Vega (1795), a military engineer already involved in direction of the excavations of Pompeii, emerged. After an in-depth analysis of the state of conservation of the temple of Neptune, La Vega proposed to strengthen a portion of an architrave using iron bars covered with «a good concrete», made of lime mortar «suited to the nature of the stone blocks», in such a way to prevent the oxidation [2]. Therefore, together with proposing the use of simple iron elements to brake the collapse of the architrave, La Vega also considered necessary to ensure the durability of the intervention

by the apposition of a layer to protect the metals from the weathering. Although these interventions did not take place, the principles of compatibility and durability behind them guided the work carried out by Antonio Bonucci in 1805 on the same temple [3]. The technician filled the largest gaps of the architrave of the western front and of the underlying columns using travertine blocks fixed with visible iron clamps and the smaller ones with stone splinters tied with lime mortar. These additions, well preserved today, appear materially and chromatically compatible, while remaining always distinguishable from the ancient layers because of their regular geometry or particular finishing. In the case of the temple of Athena, Bonucci opted for iron chains – removed during more recent restoration yards – as a way to connect and bind some collapsing elements in correspondence of the north-eastern corner.

Another remarkable intervention is the partial reconfiguration of the gables of the same temple with brick masonry intentionally chosen by Ciro Cuciniello in order to ensure the distinguishability of the new parts [4]. After a detailed work of analysis of the state of conservation of the structure (1829), the architect decided to use the brick masonry to re-define the geometry of the missing portions «so as not to confuse – he wrote – the modern work of restoration with the venerable ruins of that ancient monument». In this case the additions, well-preserved over time, appear today like prostheses with simplified geometries which adhere to the profile of the ancient portions without compromising their perception. The same constructive expedient was used for smaller gaps where Cuciniello realized local brick insertions.

During his Direction of the site of Paestum (1849-1860), Ulisse Rizzi showed a notable ability in adding, only where indispensable, iron chains, limited portions of brick masonry or travertine blocks with well-smoothed surfaces, all clearly different materials from the ancient ones [5]. In his contribution to the restoration works of the three temples, the technician was able to adjust the entity of the intervention and choose technical expedients and material solutions in relation to the specific structural issues to deal with. In the case of the temple of Neptune, the architect defined the integrations, necessary to avoid the collapse of the western portions of the inner order of the cell, by reusing some of the fallen stone blocks and by adding new parts made of the same travertine and connected by iron chains. This intervention successfully combined the aesthetical and historical instances carrying on a culturally aware dialogue between existent parts and additions. Whilst retaining the same material and geometries of the ancient parts, the new blocks were indeed well-smoothed in the surfaces in order to ensure the differentiation from the ancient rough finishes. Elsewhere, in case of limited integrations, the technician used brick blocks tied with lime mortar as to fill the smaller gaps and to redefine single elements. For the Basilica and the Athena's temple, which did not display equivalent critical situations, Rizzi decided to curb some limited collapse mechanisms of the columns by placing iron chains and circles, adapted to the profile of the different elements – abacus, capitals, shafts – and adjustable as needed. Many of these interventions, well-preserved today, show the good quality of the formal and technical choices. In particular, the travertine integrations appear in good state of conservation and remain always well recognizable from the nearby ancient portions, despite the effects of time and weathering on surfaces.

Between 1889 and 1890, some other restoration interventions were carried out and their outcomes are still visible. Even in this case the works were limited to the extent necessary to curb the deformations of portions of architraves and the problems were solved by adding iron braces and chains [6].



### Restoration works between 1907 and 1962

As seen, the acquisitions deriving from the experimentations of the Nineteenth century were all aimed at reaching a right balance between aesthetical and historical instances without forgetting the issues of compatibility and durability. Despite this cultural and methodological lesson, the works carried out starting from the first decades of the Twentieth century were less careful about these problems. These interventions led indeed to a larger use of integrations in cement-based mortars, concrete injections, reinforced concrete additions, armed perforations, as well as undocumented anastylosis and reconstructions in correspondence mainly of the city walls. The trust in ‘modern’ materials as the reinforced concrete – also supported by the official guidelines of the Athens Charter (1931) and of the Italian Charter of Restoration (1932) – determined a widespread use of these latter. The prudent stone additions and the removable iron chains were abandoned in favour of heavier and not reversible integrations realized with wet mixtures, scarcely compatible with the travertine of the temples in terms of physical and mechanical behaviour.

Starting from 1907, further restoration works were carried out following the new and more systematic excavation yards led by Vittorio Spinazzola [7]. In a first phase, the interventions determined the reconstruction of some of the columns of the forum mixing tambours found on site with other stone integrations [8]. Later, during the Twenties and the Thirties, Amedeo Maiuri carried out restoration yards characterized by a generalized inclination toward the replacement of the nineteenth-century iron devices with thinner bars placed at the intrados of the architraves, as in the case of the north-eastern corner of the Athena’s temple. Elsewhere, Maiuri replaced some of the nineteenth-century stone additions – considered mechanically and aesthetically unsuited – with new integrations realized by «working from inside» the columns with localized injections of a mixture of cement and volcanic sand filled, in some cases, with a core of brick blocks [9]. Let alone his undocumented reconstructions of a large portions of the northern city-walls, Maiuri also completed the anastylosis of one of the columns of the so-called temple of the Peace within the forum of the city. In this case, he reused three ancient tambours and one capital found on site and integrated these latter with six new stone tambours, tied through brass bars and cement. Starting from the Fifties, new and heavier works were carried out, in a first phase, by Pellegrino Claudio Sestieri: in particular, some structures of the forum, the so-called Votive column and two columns of the upper order of the cell of the Neptune’s temple were integrated by resorting to extensive cement additions [10]. Within the same structure, several gaps of the shafts of the columns of the inner order were filled with cement mortars coloured in shades of orange in order to chromatically level out additions and existent parts [11].

Furthermore, what emerges from the following works, carried out during the Sixties, is the complete indifference shown with respect to the comprehension of the construction history and structural functioning of the temples – elements that should be considered, instead, as cultural guidelines. The project, in fact, determined the realization of a heavy strengthening intervention which was not aimed at all at ensuring the material and mechanical compatibility with the ancient structures. In particular, the eastern front of the Athena’s temple – already object of the nineteenth-century restorations, partially removed during the previous works – was strengthened by the definition of a dense network of steel bars linked to capitals by reinforced concrete anchors and diffused integrations with cement mortar. In addition, hundreds of armed perforations were realized to connect architraves and capitals, as well as to strengthen the shafts of the columns [12].



Figure 2: a) temple of Athena, column of the northern side. Addition in fragments of bricks and concrete (1926); b) temple of Neptune, column of the upper order. Integrations in bricks and concrete (Fifties); c) temple of Athena, column of the eastern front. Reinforced perforations (1962); d) temple of Neptune, column of the northern front. Integration made of lime mortars (1997-2002).

This intervention showed immediately its technical and cultural limits: in addition to being particularly invasive and totally irreversible, it determined the complete and definitive alteration of the structural behaviour of the temple. Moreover, it showed over the years several problems linked, including an increased vulnerability to damages caused by lightning strikes – attracted by the presence of metallic devices –, and limited durability and resistance in the interaction with the ancient materials. These issues remain critical nowadays for the conservation and protection of those architectures.

## THE TEST OF TIME. SOME RECENT ISSUES IN CONSERVATION

Starting from the late Eighties, new and culturally aware restorations concerning the three temples were carried out by multidisciplinary teams of scholars and technicians. These interventions were particularly significant both for their experimentation in the use of innovative and more compatible materials, and for their consideration of the previous restorations, with the aim of evaluate the solutions in terms of their durability and compatibility with the ancient substratum. In particular, these studies highlighted substantial differences between nineteenth-century and twentieth-century interventions [13]. Analysis carried out at the time of these more recent restorations verified the higher level of resistance of the additions performed in the 19<sup>th</sup> century and their stronger congruence with the structural behaviour of the ancient temples. The stone integrations, designed and built according to the ancient constructive technique and use of materials, resulted in excellent conditions of conservation. Despite the presence of some discontinuities, the brick masonries seemed respectful of the constructive system, while the materials and building techniques, although different from the ancient ones, showed several similarities with these latter in terms of behaviour and durability. Furthermore, the analyses of the iron devices – totally reversible, replaceable and maintainable –, testified of the accuracy in the choice of materials and in the design of the shapes, always suited to the different elements to strengthen. In particular, iron chains, braces and clamps, despite some physiological phenomena of oxidation – which however did not have negative effects on the stone surfaces – appeared well-preserved and partially still in action.

By contrast, the analyses of the twentieth-century interventions showed a more rapid obsolescence of materials and a worse state of conservation, mostly due to a lack of aware-

ness in the technical choices. The diffused cement additions displayed advanced phenomena of decay as erosion, disintegration, and pulverization, only a few decades after their realisation. Moreover, the cement integrations carried out during the Fifties on the columns of the Neptune's temple in absence of the preventive cleaning operations, have determined diffused detachment, scaling and delamination. The evaluation of the state of conservation of the eastern front of the Athena's temple represented an even more complex issue. In this case, the presence of the armed perforations determined two relevant problems: first, this system – characterized by the definition of strong bonds between architraves and columns – had completely changed the structural identity of the building by introducing a hyperstatic behaviour. Second, the choice to carry out totally irreversible and invisible perforations and cement injections did not allow technicians to evaluate the state of conservation of the internal reinforcing steel. In addition, the study that preceded the more recent restorations highlighted the general incompatibility between this system and the physical and mechanical characteristics of the travertine, whose porosity did not react well to the injected mixtures, and favoured, at the same time, the penetration of meteoric water and moisture, increasing the risk of oxidation.

Following a culturally aware approach, the restorations carried out starting from the end of the Eighties were aimed at preserving all the stratifications as much as possible, removing only the most degraded additions or what considered harmful for the ancient structures. Taking into account the results of the nineteenth-century acquisitions and the negative impacts of the use of heavy and incompatible materials, the overall logic of these interventions was to minimize the extent of the operations, as well as to ensure the durability and compatibility of the additions. After an accurate study and a first critical phase of cleaning of the surfaces, in the case of the Athena's temple the works consisted in fixings and micro-fillings made with resins and lime mortars added with pozzolan, chromatically uniformed with the pre-existence. The cement plugs at the beginning of the perforations of the eastern front were removed, in order to protect the steel bars, and, subsequently, reintegrated with lime mortars [14]. For the temple of Neptune, stone elements that were cracked or at risk of a collapse were anchored with steel or fiberglass pins, resin reinforcements, or more simple bonding, calibrated according to the different needs. In most of the cases, the iron devices were fixed and, only if necessary, replaced with new steel elements; the gaps were filled with particular mixtures of lime mortars placed undercut and calibrated in their textures in order to be chromatically and aesthetically compatible with the travertine surfaces [15].

As seen, the approach recognizable in the last restorations of the temples of Paestum appears to be largely influenced both by an interpretation of the methodology of the interventions carried out starting from 1805 and an analysis of their outcomes. If, in the intentions, one can recognize the will to minimize the operations, and to ensure the compatibility and the reversibility of the additions, even in these case, the good quality of the practical results – obtained even by an extensive use of innovative materials – can be verified only after having passed the test of time.

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