

6th Historic Mortars Conference

21st to 23rd September 2022
Ljubljana, Slovenia

BOOK OF ABSTRACTS



Book of abstracts of the 6th Historic Mortars Conference - HMC 2022
21-23 September 2022, University of Ljubljana, Ljubljana, Slovenia

Edited by
Violeta Bokan Bosiljkov
Andreja Padovnik
Tilen Turk
Petra Štukovnik

CIP - Kataložni zapis o publikaciji
Narodna in univerzitetna knjižnica, Ljubljana

691.53(082)(0.034.2)

HISTORIC Mortars Conference (6 ; 2022 ; Ljubljana)

6th Historic Mortars Conference [Elektronski vir] : 21st to 23th September 2022, Ljubljana, Slovenia
: book of abstracts / [edited by Violeta Bokan Bosiljkov ... et al.]. - Ljubljana : Faculty of Civil and
Geodetic Engineering, 2022

ISBN 978-961-6884-78-5
COBISS.SI-ID 124000259

Organizing Committee

Conference Chair

Violeta Bokan Bosiljkov (University of Ljubljana, Slovenia)

Members (University of Ljubljana, Slovenia)

Andreja Padovnik
Petra Štukovnik
Vlatko Bosiljkov
David Antolinc
Marjan Marinšek
Tilen Turk

Scientific Committee

Alvarez, José Ignacio University of Navarra, Spain
Biçer-Şimşir, Beril The Getty Conservation Institute, U.S.A.
Bokan Bosiljkov, Violeta University of Ljubljana, Slovenia
Faria, Paulina Universidade Nova de Lisboa, Portugal
Groot, Caspar Delft University of Technology, Netherlands
Gulotta, Davide The Getty Conservation Institute, U.S.A.
Hughes, John University of the West of Scotland, U.K.
Ioannou, Ioannis. University of Cyprus, Cyprus
Maravelaki-Kalaitzaki, Pagona-Noni Technical University of Crete, Greece
Martínez Ramírez, Sagrario Consejo Superior de Investigaciones Científicas, IEM-CSIC, Spain
Pachta, Vasiliki Aristotle University of Thessaloniki, Greece
Papayianni, Ioanna Aristotle University of Thessaloniki, Greece
Pasian, Chiara University of Malta, Malta
Pavia, Sara Trinity College Dublin, Ireland
Peter, Ulrike Lhoist Group, Belgium
Secco, Michele University of Padua, Italy
Stefanidou, Maria Aristotle University of Thessaloniki, Greece
Theodoridou, Magdalini Newcastle University, U.K.
Toniolo, Lucia Politecnico di Milano, Italy
Valek, Jan Academy of Sciences, Czech Republic
Van Hees, Rob P.J. Delft University of Technology, Netherlands
Veiga, Maria Rosário National Laboratory for Civil Engineering, LNEC, Portugal
Velosa, Ana University of Aveiro, Portugal

TABLE OF CONTENTS

Topic 1: Characterization of historic mortars and masonry structures. Sampling and test methods	1
Imperial Styles, Frontier Solutions: Roman Wall painting technology in the Province of Noricum	2
Anthony J. Baragona, Pavla Bauerová and Alexandra S. Rodler	
A discussion on service life prediction methodologies for external mortar cladding in historic buildings	3
Eudes Rocha and Arnaldo Carneiro	
Study of first cements of boulogne-sur-mer used in anhistoric aqueduct from the XIXTH century	4
Marwa Jebbawy, Vincent Thiery, Myriam Bouichou, Elisabeth Marie-Victoire, Catherine Davy, Laurent Izoret, Cyrille Albert-Mercier and Myriam Moreau	
Characteristics of Byzantine period lime mortars and plasters from Anaia church (Kadikalesi)	5
Tuğçe Işık and Elif Uğurlu Sağın	
The Decorative Plastered Relief in the Baroque Villa of the Argotti Botanic Gardens, Floriana, Malta: Characterisation of Original Materials and Techniques	6
Stephanie Parisi, Gianni Miani and Chiara Pasion	
Plaster characteristics of Byzantine wall paintings in Western Anatolia	7
Kerem Şerifaki and Hasan Böke	
Decomposition temperature of calcium carbonate in lime binders aged at elevated carbon dioxide concentration monitored by TGA/MS analysis	8
Dita Frankeová, Jan Válek and Zuzana Slížková	
Czech Mosaic Pioneer Viktor Foerster and the Mortars of His Mosaics	9
Pavla Bauerová, Magdalena Kracík Štokánová, Dita Frankeová, Zuzana Slížková and Martin Keppert	
A study on historic mortars for restorative applications in persepolis world heritage site: curing in site vs laboratory	10
Parsa Pahlavan, Stefania Manzi and Maria Chiara Bignozzi	
Making ancient mortars hydraulic. How composition influences type and crystallinity of reaction products	11
Simone Dilaria, Michele Secco, Jacopo Bonetto, Giulia Ricci, Gilberto Artioli	
Physico-chemical characterization of historic mortars from the Venetian Arsenals of Chania (Greece)	12
Pagona-Noni Maravelaki, Kali Kapetanaki, Anastastis Kaditis and Themis Krasoudaki	

Analysis of the behavior of original air lime mortars used in structural brick masonry walls of ancient buildings	13
<hr/>	
Ana Isabel Marques, Maria do Rosário Veiga, António Santos Silva, João Gomes, Ferreira and Paulo Xavier Candeias	
Mineral, chemical and petrographic characterization of hydraulic mortars & chronological building correlation of the Baths of Porta Marina in Ostia Antica (Italy)	14
<hr/>	
Sarah Boularand, Marcello Turci and Philippe Bromblet	
Characterization of lime mortar and plasters of the fortress of concepcion de La Vega, first mining town in America	15
<hr/>	
Esteban Prieto-Vicioso, Virginia Flores-Sasso, Sagrario Martinez-Ramirez, Letzai Ruiz-Valero, Gloria Perez	
Characterization of Natural cement in the buildings of the beginning of 20th century in Portugal: Casa Barbot	16
<hr/>	
Hamid Maljaee, Rosário Veiga, António Santos Silva and Ana Velosa	
Characterization of old mortars for the formulation of replacement mortars	17
<hr/>	
Isabel Torres, Gina Matias and Nilce Pinho	
Characterization of “Terranova” render samples as a contribution to XX Century heritage conservation	18
<hr/>	
Cesare Pizzigatti and Elisa Franzoni	
Pre-screening of lime mortars for 14C dating – preliminary results	19
<hr/>	
Wojcieszak Marine, Fontaine Laurent, Hayen Roald, Elsen Jan, Van den Brande Tess, Oostvogels An, Ligovich Gaia, Rich Mohamed and Boudin Mathieu	
Topic 2: Historic production, processing and application of mortars, renders and grouts. Lime technologies.	20
Atlas of traditional lime kilns in the Spanish territory: settlement, constructive typology and production process of lime as a historical material	21
<hr/>	
Elena Galdó-Ceballos, María Lourdes Gutiérrez-Carrillo and Anna Arizzi	
From high-performance pozzolans to proto cements: 1500 years of hydraulic binders in Padua and its surroundings	22
<hr/>	
Michele Secco, Simone Dilaria, Giulia Ricci, Matteo Volpin, Enrico Garbin, Sergio Tamburini, Caterina Previato, Gilberto Artioli and Jacopo Bonetto	
Characteristics of traditional korean lime plaster after the addition of perilla oil	24
<hr/>	
Sanha Kang and Soyeong Kang	
Mortars and binders during a time of emerging industries: 19th Century Austro-Hungarian fortifications in Montenegro	25
<hr/>	
Johannes Weber, Lilli Zabrana, Andrea Hackel, Susanne Leiner and Farkas Pintér	

Processing while slaking? Hot applied lime mortar (HAM) and hot lime wash revisited	26
<hr/>	
Thomas Köberle and Heiner Siedel	
Limewashes with vegetable oils: water transport characterization	27
<hr/>	
Cristiana Nunes, Paulina Faria and Nuno Garcia	
Topic 3: Mortars in archaeological sites. Construction history. Archaeometry. Dating of historic mortars.	28
Revisiting the chronology of early Christian architecture through mortar dating: the case of Paleochristian church in Bordeaux	29
<hr/>	
Petra Urbanova, Pierre Regaldo, Pierre Guibert, Phillipe Lanos, Gwenael Herve and Phillipe Dufresne	
Chemical and mineralogical characterization of lime plaster from 6th Century stone-chamber tomb of Baekje, Republic of Korea	30
<hr/>	
Eunkyung Kim and Soyeong Kang	
Characterisation of historic mortars related to the possibility of their radiocarbon dating, Mikulčice and Pohansko archaeological sites	31
<hr/>	
Petr Kozlovcev, Kristýna Kotková, Dita Frankeová, Jan Válek, Alberto Viani and Jana Maříková-Kubková	
Pulvis puteolana beyond the Maritime architecture. the use of Phlegrean Pyroclasts in structural mortars of Roman Nora (Sardinia, Italy).	32
<hr/>	
Simone Dilaria, Caterina Previato, Jacopo Bonetto, Michele Secco, Domenico Miriello, Donatella Barca, Gilberto Artioli	
Mortars of the Roman frontier on the Danube	33
<hr/>	
Emilija Nikolić, Ljiljana Miličić, Ivana Delić-Nikolić, Mladen Jovičić, Nevenka Mijatović, Snežana Vučetić	
Plasters of Augusta Raurica Roman Theatre: a petrographic characterisation	34
<hr/>	
Maria Thaís Affonso, Thomas Hufschmid and Philippe Rentzel	
Topic 4: Historic renders and plasters. Gypsum-based plasters and mortars. Adobe and mud mortars. Rammed earth constructions. Natural and Roman cement mortars. Assessment.	35
Repair mortar for a coloured layer of sgraffito render – a technological copy	36
<hr/>	
Jan Válek, Olga Skružná, Zuzana Wichterlová, Jana Waisserová, Petr Kozlovcev and Dita Frankeová	
Evaluation of the hygroscopic and CO2 capture capacities of earth and gypsum-based plasters	37
<hr/>	
Tânia Santos, António Santos Silva, Maria Idália Gomes and Paulina Faria	

Characterization of tapia materials from the Hospital San Nicolas De Bari, first hospital in the west Indies (1503)	38
<hr/>	
Virginia Flores-Sasso, Esteban Prieto-Vicioso, Sagrario Martinez-Ramirez, Letzai Ruiz-Valero, Gloria Perez	
Influence of natural sand replacement by mineral wastes on earth and air lime plastering mortars, and professionals training	39
<hr/>	
Tânia Santos and Paulina Faria	
Evaluation of physical and mechanical parameters in commercial NHL-based green plaster for the preservation of historical buildings	40
<hr/>	
Cristina Tedeschi, Maria Cecilia Carangi	
Topic 5: Historic Portland cement-air lime mortars. Historic Portland cement mortars.	41
Historical and production study of the cement and hydraulic lime factory N^o Señora De Los Dolores in Atarfe, Granada (Spain)	42
<hr/>	
Jorge Adolfo Porta Igual, Anna Arizzi and Eduardo M. Sebastián Pardo	
Characterization of mortars and concretes from the Mirante of Quinta da Azeda, Setúbal (Portugal). A case study from the beginning of the 20th century	43
<hr/>	
Luís Almeida, Ana Rita Santo, António Santos Silva, Rosário Veiga, Ana Velosa	
Concrete from the Rupnik military line	44
<hr/>	
Tilen Turk, Petra Štukovnik, Marjan Marinšek, Violeta Bokan Bosiljkov	
Early age properties of hydraulic lime mortar prepared using heavy metal contaminated aggregate	45
<hr/>	
Tilen Turk, Maks Alič, Violeta Bokan Bosiljkov and Petra Štukovnik	
Mineralogical-petrographic study of terrazzo from selected works of Plečnik heritage (Ljubljana, Slovenia)	46
<hr/>	
Sabina Dolenc, Maruša Mrak, Andreja Pondelak, Katarina Šter, Boštjan Rožič, Nina Žbona	
Topic 6: Conservation issues concerning mortars, plasters, renders and grouts. Diagnosis. Decay and damage mechanisms. Case studies.	47
Gaji, a gypsum-earth plaster in the wall painting technology of The Church of St. Demetrios of Thessaloniki, David Gareji, Kakheti, Georgia	48
<hr/>	
Mariam Sagaradze, Joshua A. Hill, Sophia Mikaberidze, Nana Khuskivadze, Manana Kavsadze, Stephen Rickerby, and Lisa Shekede	

Performance Evaluation of Patch Repairs on Historic Concrete Structures (PEPS): An Overview of the Assessment Methodology.	49
<hr/>	
Simeon Wilkie Ana Paula Arato Goncalves, Susan Macdonald, Elisabeth Marie-Victoire, Myriam Bouichou, Jean Ducasse-Lapeyresse, Nicki Lauder, David Farrell, Paul Gaudette, Ann Harrer	
Influence of thickness of covering and boundary conditions in bonding of rebars used to repair and reinforce masonry structures.	50
<hr/>	
Esperanza Rodriguez-Mayorga, Fernando Ancio and Beatriz Hortigon	
Traditional techniques on Post-Civil War in Spanish Modern Architecture: the ceramic wall on OSH pavilion in the Casa del Campo (Madrid)	51
<hr/>	
María del Mar Barbero-Barrera and José de Coca Leicher	
Measuring water absorption in replicas of medieval plaster assessing their reliability as models for conservation trials	52
<hr/>	
Mette Midtgaard	
The sgraffito in Križanke - interdisciplinary approach to the conservation-restoration of coloured historic plaster	53
<hr/>	
Maja Gutman Levstik and Anka Batič	
Topic 7: Preservation. Consolidation materials and techniques. Development of new products. Preventive conservation.	54
Experimental study on properties of hydraulic mortars with mixed in crystallisation inhibitors	55
<hr/>	
Ameya Kamat, Barbara Lubelli and Erik Schlangen	
Utilization of lavender waste in traditional mortars	56
<hr/>	
Maria Stefanidou, Vasiliki Kamperidou, Chrysoula Kouroutzidou and Petrini Kampragkou	
Restoring historical buildings amid climate crisis: hydraulic, waste-based lime	57
<hr/>	
Jelena Šantek Bajto, Nina Štirmer, Ana Baričević	
Criteria for the utilization of perlite by-products in traditional mortars	58
<hr/>	
M. Stefanidou, F. Kesikidou, S. Konopisi, E. Tsardaka, V. Pachta and E. Tsampali	
Development and testing of lime-based mortars using perlite by- products	59
<hr/>	
Maria Stefanidou, Vasiliki Pachta and George Konstantinidis	
Durability of lime mortars treated with ammonium phosphate	60
<hr/>	
Greta Ugolotti, Giulia Masi and Enrico Sassoni	

Topic 8: Repair mortars and grouts. Requirements and design. Compatibility issues. Durability and effectiveness. Adequacy of testing procedures.	61
Long-term mechanical properties and durability of lime-spongilite mortars Martin Vyšvařil, Martin Krebs and Patrik Bayer	62
On the effect of poor-quality aggregates on the physico-mechanical performance of repair lime-based mortars Revecca Fournari, Loucas Kyriakou and Ioannis Ioannou	63
Fine pumice as pozzolanic additive in restoration lime mortars Tomáš Žižlavský, Martin Vyšvařil and Patrik Bayer	64
The relationship between natural stone joint design, surface area and the properties of lime mortar joints Matthew Cook	65
Comparative evaluation of repair mortars for the conservation of historic masonry Divya Rani and Manu Santhanam	66
Development of a gypsum-based grout for the stabilisation of gypsum-based plasters Gvantsa Potskhishvili, Chiara Pasian, Francesca Piqué	67
Morphological evolution of calcium carbonate crystals in dry hydrated lime mortar Anupama V.A. and Manu Santhanam	68
An investigation of the salt weathering resistance of heritage repair mortar mixes Anupama V.A., Divya Rani S., Swathy Manohar and Manu Santhanam	69
Design rationale and field testing of a gypsum-based grout for wall painting stabilization in the Chapel of Niketas the Stylite, Cappadocia, Turkey Jennifer Herrick Porter, Yoko Taniguchi and Hatice Temur Yildiz	70
Comparative evaluation of properties of laboratory test specimens for masonry mortars prepared using different compaction methods Vadim Grigorjev, Miguel Azenha and Nele De Belie	71
The challenge on development of the repair mortars for historical buildings in severe marine environment: Paimogo Fort, a case study Maria do Rosário Veiga and Ana Rita Santos	72
Practical test for pozzolanic properties by A. D. Cowper: implementation and innovation Marlene Sámano Chong, Alberto Muciño Vélez, Ivonne Rosales Chávez and Luis Fernando Guerrero Baca	73
Determination of the salt distribution in the lime-based mortar samples using XRF and SEM – EDX characterisation Marina Aškrabić, Dimitrije Zakić, Aleksandar Savić, Ljiljana Miličić, Ivana Delić-Nikolić and Martin Vyšvařil	74

Developing a lime-based injection grout with no additives for very thin delamination: the role of aggregates and particle size/morphology	75
Chiara Pasian, Jennifer H. Porter, Mariia Gorodetska and Stephanie Parisi	
Enhancement of latent heat storage capacity of lime rendering mortars	76
Andrea Rubio-Aguinaga, José María Fernández, Íñigo Navarro-Blasco and José Ignacio Álvarez	
Obtaining of repair lime renders with microencapsulated phase change materials: optimization of the composition, application, mechanical and microstructural studies	77
Andrea Rubio-Aguinaga, José María Fernández, Íñigo Navarro-Blasco and José Ignacio Álvarez	
Time-dependent deformations of lime-based mortars and masonry specimens prepared with them	78
Ioanna Papayianni and Emmanuella Berberidou	
Adhesive strength assessment of lime injection grout using standardised and modified test method	79
Andreja Padovnik and Violeta Bokan Bosiljkov	
Influence of methyl cellulose in injection grout on mould growth on mural paintings - preliminary results	80
Andreja Padovnik, Violeta Bokan Bosiljkov, Polonca Ropret and Janez Kosel	



**Topic 3: Mortars in archaeological sites.
Construction history. Archaeometry.
Dating of historic mortars.**

MORTARS OF THE ROMAN FRONTIER ON THE DANUBE

Emilija Nikolić¹, Ljiljana Miličić², Ivana Delić-Nikolić², Mladen Jovičić¹, Nevenka Mijatović², Snežana Vučetić³

- (1) Institute of Archaeology, Serbia, e.nikolic@ai.ac.rs
- (2) Institute for Testing of Materials, Serbia,
- (3) Faculty of Technology, University of Novi Sad, Serbia

Keywords: Roman mortars, Danube Limes, mortar characterization, conservation mortar, conservation science

Abstract: The mortars have been always one of the most interesting topics for the researchers of Roman building constructions. The knowledge on this complex building material used in Roman architecture is mostly based on the research of the monumental structures in the territory of today Italy. However, many mortar examinations were executed by the researchers of provincial Roman archaeology as well, who tried to find evidence of the quality of building activities in the provinces. The territory of today's Serbia, except for the existence of scarce studies, was never in the research focus. Even the monumental bridge over the Danube, built at the beginning of the 2nd century that made Trajan's conquest of Dacia possible, was not researched thoroughly enough when we speak of its building materials. During the last few years, the interest in the Roman buildings at the Danube territory has grown. Mortar Design for Conservation – Danube Roman Frontier 2000 Years after (MoDeCo2000) project is funded by the Science Fund of the Republic of Serbia. Its aim is to investigate the mortars used in Roman buildings along the former Danube Limes in Serbia, as well as to offer mortar recipes for building conservation practice. The project includes 24 archaeological sites, dating to the period spanning from the 1st to the 6th century, with more than 120 different mortar samples that originate from 40 buildings of military and civilian function. The project results are intended to be an important contribution to the nomination dossier of a cultural property tending to be included in the UNESCO World Heritage List, named "Frontiers of the Roman Empire – Danube Limes in Serbia". Conducted laboratory analyses showed a great diversity of mortar samples. Immensely important are the results offering the characterization of some local raw materials known to date as used for masonry, as important components of the mortars, but also the possibility to conclude that the mortars for the most important buildings in this territory were made using the rare or imported raw materials. After sampling and research, laboratory models of mortars were done, the most promising recipes were chosen, and the application of new mortars was performed in real environmental conditions and on historic walls. The project results formed a database on archaeology, architectural and construction history, conservation science, technology, geology, and chemistry of raw materials and mortars, that will contribute to heritage protection in Serbia, as an exceptionally important input for conservation practice. The objectives of the MoDeCo2000 project are connected to the research of physical elements and social aspects of the creation of Roman fortresses and cities in Serbia, as well as to the conservation practice and contribution to contemporary engineering. Its biggest scientific significance is in the revealing of different aspects of building technologies in the Roman period at the mentioned territory, but also of the economy, trade, and everyday life of its inhabitants.

Acknowledgements: This research was supported by the Science Fund of the Republic of Serbia, PROMIS, #6067004, MoDeCo2000.



**IBZ–Salzchemie
GmbH & Co. KG**



Zavod za varstvo
kulturne dediščine Slovenije
*Institute for the Protection of
Cultural Heritage of Slovenia*



ZAVOD ZA
GRADBENIŠTVO
SLOVENIJE

SLOVENIAN
NATIONAL BUILDING
AND CIVIL ENGINEERING
INSTITUTE

Supported by



Mestna občina Ljubljana
City of Ljubljana