



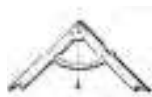
7th Historic Mortars Conference (HMC 2025), Padova

edited by
JACOPO BONETTO, SIMONE DILARIA,
CATERINA PREVIATO

INTERNATIONAL CONFERENCE
2ND - 4TH SEPTEMBER, PADOVA

COSTRUIRE NEL MONDO ANTICO 11

ROMA 2025
EDIZIONI QUASAR



Direzione scientifica/Scientific direction:

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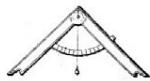
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Prodotto finanziato dall'Università degli Studi di Padova nel quadro del programma World Class Research Infrastructures (WCRI) - SYCURI: SYnergic strategies for CULTural heritage at Risk.

This work is funded by the University of Padova under the World Class Research Infrastructures" (WCRI) programme - SYCURI: SYnergic strategies for CULTural heritage at Risk.

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Roma 2025
EDIZIONI QUASAR

In copertina:

Fabric of a binder- rich lime mortar with pores after plant fibres and silica-rich binder-related inclusions.

ISBN 978-88-5491-636-4

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via Ajaccio 41-43, I-00198 Roma
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Finito di stampare nel mese di settembre 2025

Macro- and microstructural characterisation of rendering mortars from the 18th century Fishing House of the Recreational Farm of Marqueses de Pombal (Portugal)

1. Introduction

The Casa da Pesca (Fishing House) is an 18th-century complex located within the Recreational Farm of Marqueses de Pombal in Oeiras, Portugal. The complex is located in the northern part of the farm and consists of the main house, surrounding gardens, the Taveira waterfall, and a pond. In 1940, the Casa da Pesca complex, along with the gardens and the Marquês de Pombal palace, was classified as a National Monument¹, thus becoming subject to the protection and safeguarding regulations for cultural and built heritage. Due to the historical and cultural significance of the complex, the City Council of Oeiras requested the National Laboratory for Civil Engineering to conduct an extensive macro- and microstructural characterisation of the Casa da Pesca rendering mortars. The goal was to analyse the original renders and paintings and assess their characteristics and performance, in order to support the design of appropriate and effective future conservation and intervention measures.

2. Materials and methods

With the aim of characterising the constitution, composition, conservation state, and performance of the renders, several samples were collected from the Casa da Pesca complex and tested at both macro and micro levels. To determine the stratigraphy and evaluate the pictorial layers, samples were observed using a stereozoom microscope and analysed with scanning electron microscopy (SEM) and energy dispersive spectrometry (EDS). To evaluate their functional capacity and conservation state, physical and mechanical characteristics were assessed through several laboratory tests, which were developed and validated in previous studies²⁻³. These tests included capillary water absorption by contact (EN 15801), dynamic modulus of elasticity via ultrasound, compressive strength (EN 1015-11), and open porosity (NP EN 1936).

3. Results and discussion

3.1 Microstructural characterisation

The rendering mortars studied generally consist of four layers: (1) a calcium aerial lime-based mortar with a cream-orange colour, containing siliceous and carbonate sand aggregates with traces of clay minerals, possibly of marine origin due to the presence of shells in its composition, with a binder/aggregate ratio between 1:5 and 1:5.5 (by mass); (2) a mortar with a composition similar to that of the first layer but lighter in colour; (3) a white calcium lime-based stucco; and (4) a lime-based paint finishing layer, typically consisting of a single coat with pigments of mineral origin (likely natural earths), ranging in colour from red-ochre to yellow-ochre (Figure 1). The first two layers – 1 and 2 – are present in all the samples collected.

¹ DGPC. 2020.

² Veiga et al. 2004.

³ Valek and Veiga 2005.



Figure 1. Collection area for one of the samples from the north-facing wall of the staircase (A); external (B) and internal (C) faces of the rendering mortar collected from (A); and stereozoom microscope image of the rendering mortar sample (D)

Some of the rendering mortars collected from lower areas like the wall of the staircase on the side of the Casa da Pesca, the wall to the north of the pond, and the plinth of the north façade of the Casa da Pesca lacked the stucco and paint layer in their composition. These stratigraphic differences, particularly the absence of the stucco layer, could indicate areas where conservation or repair work has been performed, or they may suggest that different application techniques were used in these areas. Additionally, on the north façade of the main house of Casa da Pesca, where a red ochre-coloured paint layer was identified, an area with multiple colours has been observed, with the oldest layer containing ultramarine, blue pigment (Figure 2A). Based on this finding, it cannot be ruled out that this façade was originally decorated with some type of drawing (mural painting). A similar pattern seems to have existed on the south-facing gutter wall, where the paint does not appear to form a continuous layer (Figures 2B and 2C).

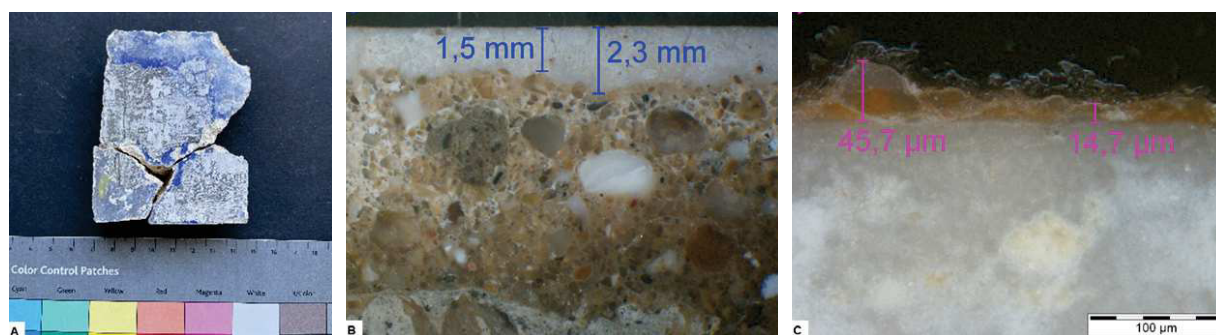


Figure 2. Sample collected from the north façade of the Casa da Pesca showing a blue pigment (A); and stereozoom microscope images of a rendering mortar sample collected from the south-facing gutter wall with measurements of the stucco (B) and finishing paint layer (C) thicknesses

3.2 Macrostructural characterisation

The main mechanical and physical results indicate that the original rendering mortars are cohesive and compact, exhibiting mechanical performance typical of high-quality lime mortars (compressive strength ranging from 1.5 MPa to 3 MPa and moderate to low water capillarity coefficients). These characteristics align with the composition, with traces rich in lime and well-graded sand. However, contrary to what would be expected, the presence of a finishing layer of lime (stucco) in some samples leads to more variable mechanical performance and, in general, a slight increase in the capillarity coefficient. This performance suggests the presence of micro-cracking, which may cause a loss of mechanical properties and contribute to an increase in the rate of capillary absorption. Besides, the finer grain size distribution of the stucco may also increase the porosity and consequently enhance water absorption and reduce mechanical strength. Overall, despite some biological colonisation, all the original rendering mortars are in a good state of conservation, reflecting well-formulated and well-executed mortars.

4. Conclusions

The results showed that all the external surfaces of the Casa da Pesca renders are composed with mortars consisting of two layers of calcium aerial lime with siliceous and carbonate aggregates. The mineralogical composition reflects the use of locally sourced materials. It appears that the internal layers have a higher binder/aggregate ratio than the external layer. Moreover, the internal layer contains finer aggregate particles than the external layer, with the presence of clay materials, such as mica, kaolinite and hematite. In addition, all the collected samples taken from a height of

~ 1 m are covered by a thin stucco layer composed of calcium lime, which is painted with mineral pigments ranging in colour from red-ochre to yellow-ochre, with some ultramarine, blue pigment also found. These differences in stratigraphy may suggest previous retrofitting interventions in areas showing a degree of stucco degradation, or they could simply reflect the original composition, with the existence of a mural painting on an upper level.

Overall, the results lead to the conclusion that the mortars are mostly original and in very good condition, showing only superficial biological colonisation. Given the historical and artistic value of the existing mortars, their conservation and preservation are strongly recommended. As a conservation strategy, it is suggested to preserve the existing renders, removing only the layers that have experienced functional degradation. For new repair mortars, materials with the same compositional and aesthetic characteristics should be used, specifically calcium lime-based compositions similar to the existing ones. The paints applied should also be compatible, based on aerial lime and mineral pigments, to potentially facilitate the elimination of moisture from within the walls. The study provided some information on the pigments used; however the patterns should be further investigated.

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