

A petrographic study of the mortars from the Villa Reale di Marlia (NW Tuscany, Italy)

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Abstract – This paper focuses on the mortars from the façades of the *Villa Reale di Marlia* located about 10 km N-NE of the city centre of Lucca (northern Tuscany, Italy). It is a complex of historic buildings built during different constructive phases and embellished with beautiful gardens and botanic rarities, which are protected by high walls.

Based on several petrographic analyses the study has allowed us to reconstruct the evolution of the colours of the villa's façades from the transformation project of Elisa Baciocchi to that of Maria Luisa di Borbone, up to the great intervention of recovery of the Pecci Blunt accounts in the twenties-thirties of the twentieth century.

I. INTRODUCTION

Villa Reale di Marlia (VRM) is an historic monumental complex near Lucca, built in an exceptional location at the foot of the Pizzorne plateau. VRM is considered to be one of the most important historical complexes in Italy for its historic buildings and numerous gardens and botanic rarities encircled by high walls, seemingly protecting them from the passing of time [1, 2]. In 1806, Elisa Bonaparte Baciocchi, Napoleon's sister, Princess of Lucca and Grand Duchess of Tuscany, bought the Villa that took the name "Reale" (Royal) from Elisa's title as Queen of Etruria.

The restoration works of the complex, still in progress, is planned as a multidisciplinary project that, together with the archive investigations, would like to emphasize the recovery of the so-called 'material' source. In this approach the information derives directly from the building itself that is a true archive of himself, transferring the 'knowledge' also into a project able to guarantee the quality of the protection and conservation of the architectural heritage.

At the same time, an archaeological survey project was carried out on the external and internal structures, many of which consisting of Macigno sandstone [3-7], in order to reconstruct the historical constructive evolution of the

buildings of the whole complex, and to characterize the technical knowledge of the employees who worked in the different sites from the original phase to the last restoration work.

The VRM is the main building of the Marlia complex. Both historical and archaeological researches were most useful to reconstruct the various stages of the development process: from a single tower, at the first centuries of the Middle Ages, to a real fortified castle, transformed into a stately building already in the 15th century, with development sequences and subsequent modifications up to the current configuration, attributable to the structure desired by Princess Baciocchi.

One of the most important goals of the restoration project of the Villa concerns the finishing layers of the external surfaces, with particular attention to the colours of the façades.

The common characterization of ancient mortars is performed by combining chemical, mineralogical and petrographic analyses [8-17], but optical observations alone are often able to provide preliminary information on binding materials and can make easier to identify their raw materials.

The purpose of this work was to study some plasters coming from the VRM for determining their mineralogical and petrographic characteristics, observing their stratigraphic sequences and identifying the colours of each layer.

II. MATERIALS AND METHODS

To support the stratigraphic study of the external walls of the villa, samples of bedding mortars and plasters (over 300) were taken, all placed within the reference chronological sequence. The samples were used for macroscopic analysis in order to identify the main types, within which to perform laboratory investigations. The need to reconstruct the external appearance of the façades of the villa to support the choices of the restoration

project led to the selection of 15 representative samples. Firstly, they were carefully examined under the stereomicroscope (up to 200x), which provided a preliminary inspection of the microstratigraphic sequence. Then, thin and polished sections of samples were analysed under a polarized light microscope in both transmitted and reflected light.

III. RESULTS AND DISCUSSION

The results of the petrographic analyses on the fifteen selected mortar samples are summarized in Table 1.

Figures 1-7 are showing the sampling points and the microphotographs of some representative samples.

The collected data are showing the different plaster layer composition, which differs one from another mainly in the abundance of cocciopesto, pozzolana, sand, ochres and gypsum.



Fig. 1. East side cornice. The black arrow indicates the sampling point of the sample 1.

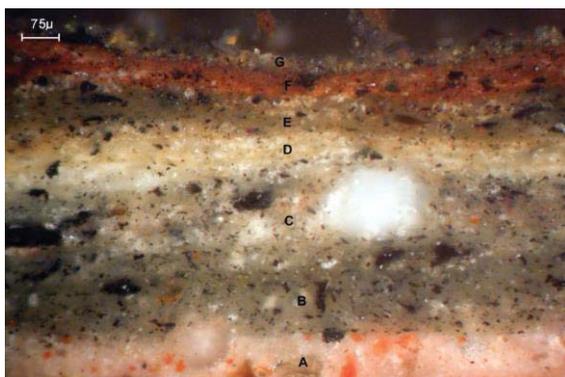


Fig. 2. Microphotograph of sample 1. The eight identified layers are indicated with the letters from A (bottom) to G (top).

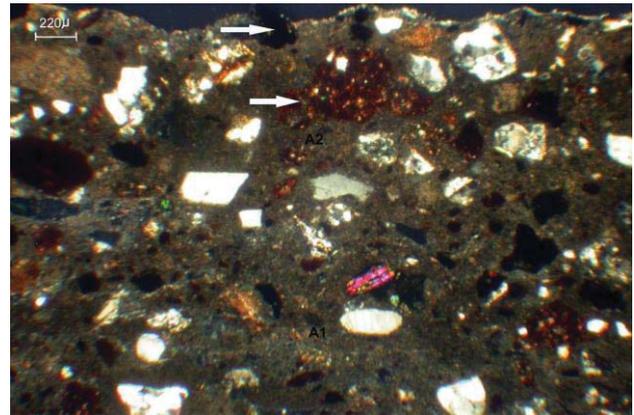


Fig. 3. Microphotograph of the first and second deeper layers of the sample 1 (A1 and A2).

Table 1 - Layers of the analysed samples from Villa Reale di Marlia.

Sample	n. of layers	Type of layer
1	8	LL-S+P+C, LL-P+C+S, LL-P+C+IS, LL-CB, LL-CB+RO+YO, LL-YO+CB, LL-CB+SE, LL-BO+RO+SE+CB+G, LL-G+AP
2	8	LL-S+P+C, LL-P+C+S, LL-CB, R, LL-YO, LL-YO+ICB, LL-YO+CB, LL-RO
3	8	LL-S, LL-B, LL-YO+OO+GE, LL-W, LL-IYO+IRO+ICB, LL-G, LL-YO+OO, LL-G
4	8	LL-S, LL-YO+OO+RO, LL-IYO, LL-DEP, LL-IYO, LL-IYO, LL-IGE, LL-GE
5	6	LL-S+C, LL-C+IS+IP, LL-CB, LL-IYO, LL-IYO+ICB, LL-IYO
6	5	LL-C+S+P, LL-C+IS+IP, LL-IYO+IOO, LL-W, LL-YO
7	1	LL-S
8	10	LL-S+C, LL-C+S+IP, LL-C+IS+IP, LL-CB+IYO, LL-CB, LL-IYO+IOO+ICB, LL-YO+ICB, LL-YO+OO+CB, LL-YO+RO+OO+CB, LL-YO+OO
9	5	LL-S, LL-W, LL-RO+OO, LL-CB+YO, LL-YO+OO
10	5	sandstone, LL-W, LL-CB+RO+YO, LL-RO+OO+ICB, LL-RO+OO+SE+ICB
11	7	LL-C+IS, LL-S, LL-RO+OO, LL-IRO+IOO, LL-IRO+IOO, LL-YO, LL-GE+IYO, LL-GE+IYO,
12	4	LL-S, LL-W, LL-YO+RO+ICB, LL-RO+OO+SE+ICB, LL-RO+OO+SE+ICB
13	3	LL-CB+RO+YO, LL-RO+OO+CB, G+AP
14	2	LL-S, LL-W, LL-RO+OO+ES
15	9	LL-S, LL-S+CB, LL-CB+IYO, LL-CB, LL-ICB+YO, LL-CB+YO, LL-ICB+YO, LL-ICB+YO, LL-ICB+YO

AP = atmospheric particulate; BO = brown ochres; C = cocciopesto; CB = carbon black; DEP = pulverulent deposit; ES = earth of Siena; G = gypsum; GE = green earth; l = low amount of; LL = lime layer; OO = orange ochres; R = layer containing calcite of recarbonatation; RO = red ochres; S = sand; P = pozzolana; SE = shade earth; YO = yellow ochres; W = white.

In all the analysed samples, the binder is made up of aerial lime (i.e. lime putty with inhomogeneous structure for the presence of numerous lumps). Historically, the Monte Pisano marble was used to produce ashlar for monumental buildings, but also to produce aerial lime in the area of Pisa and Lucca [18].

The colour in Table 2 refers to the colour in direct contact with the surface of the plaster (or of the finishing surface) and it is interpreted as original one.

All the colours are lime-based, and the pigments are common colouring materials.

Table 2 - Colour of the deepest layer of the analysed samples from *Villa Reale di Marlia*.

Sample	Colour
1	grey-green grey
2	grey-green grey
3	yellow
4	reddish-orange
5	grey
6	yellow
7	white
8	grey-green grey
9	reddish-orange
10	grey-green grey
11	reddish-orange
12	reddish-orange
13	grey-green grey
14	brown
15	grey-green grey



Fig. 4. South side cornice. The black arrow indicates the sampling point of the sample 8.

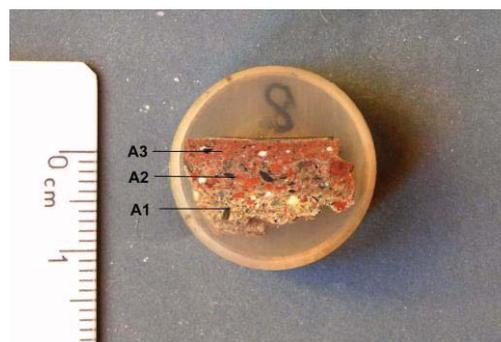


Fig. 5. Sample 8. In the picture the first three deeper layers are indicate with the letters A1, A2 and A3.

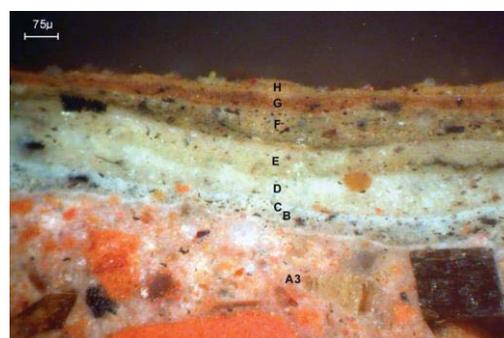


Fig. 6. Microphotograph of sample 8. Eight of the ten identified layers are indicated with the letters from A3 (bottom) to H (top).

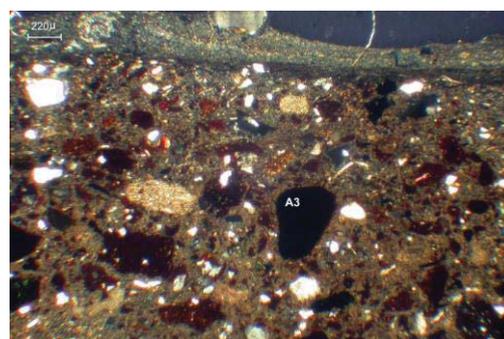


Fig. 7. Microphotograph of the third deeper layer of the sample 8 (A3).

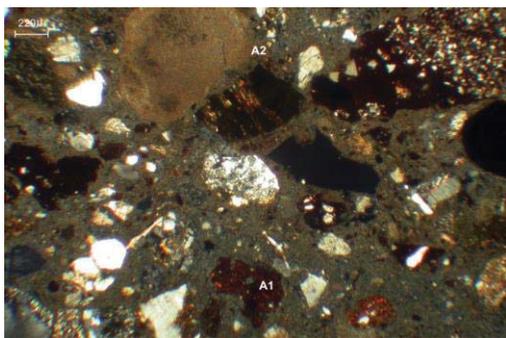


Fig. 8. Microphotograph of the first and second deeper layers of the sample 8 (A1 and A2).

IV. CONCLUSIONS

After the reconstructed historical construction sequence and the macro-observation of several samples of bedding mortars and plasters, a series of fifteen samples were selected to carry out petrographic analyses by polarizing optical microscope on thin and opaque sections, with the purpose of determining the mineralogical and petrographic characteristics of the plasters, the colour layers and their stratigraphic sequence.

The study has allowed us to reconstruct the evolution of the appearance of the villa's façades from the transformation project of Elisa Baciocchi to the one of Maria Luisa di Borbone up to the great intervention of recovery of the Pecci Blunt accounts in the twenties-thirties of the twentieth century.

The Royal Villa designed by Elisa Baciocchi was presented with walls covered with pozzolana and cocciopesto hydraulic mortar, on which a plaster with a brown surface colour was spread, (see samples n. 4, 11).

The architectural elements (cornices of the openings, cantonal, etc.) and the plaster on the ground floor, modelled in imitation ashlar, were, instead, coloured lime with carbon black, in imitation of the sandstone (see drawings n. 1, 2, 5, 6, 8, 15).

Perhaps a few decades after the Baciocchi project, during the duchy of Maria Luisa di Borbone, the external plaster was repainted.

On the original brown-coloured layer, a new colour was spread to lime with yellow ochre (see samples n. 4, 11).

Even in the nineteenth century, and perhaps in the middle of the century, the villa took on a new look. A new colour of green earth was spread on the cream layers, still widely preserved (see samples n. 4, 11).

Probably, in the early decades of the twentieth century, during the restoration of the Pecci-Blunt counts, the old plaster was partly demolished and

partly tapped to ensure the adhesion of a new layer of coating (the current one), consisting of aerial lime and sandy aggregate (see samples n. 3, 7, 9), which is characterized by its use as an aggregate of fragments of the demolished plaster.

On the plaster, a lime colour was spread with yellow-orange ochre.

At the same time, a new mock-up was created on the ground floor, with a recipe of dough similar to that used for plastering the walls of the upper floors.

The false ashlar were characterized by a lime-coloured pigmented with ochre from yellow to orange red and added with charcoal black giving a light brown colour (see drawing n. 12).

Given the colour of the ashlar masonry, it is possible that the fragments of brown pictorial film present on some sandstone frames of the windows and ashlar can be traced back to this new redaction of the building's appearance (see samples n. 10, 13).

The survey, in addition to being an indispensable tool for defining the criteria for reconstructing the colours of the façades, has also allowed us to give a scientific support to the relationship between the colours used on the plasters and historical periods, revising some customs in attributing certain colours to specific and exclusive historical periods, as evidenced by the reddish colour of the villa in the Napoleonic phase or light green in the full nineteenth century period.

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