Physico-chemical, Colorimetric and Mineralogical Characterization of a Plaster Sample Coming from "Palazzo Governi", Cagliari (Italy)

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Abstract

Aim of this work is the physico-chemical, colorimetric and mineralogical characterization of the plaster of "Palazzo Governi", a historical building located in Cagliari (Italy). As a fact the plaster shows a bad conservation state and such characterization has been requested as a useful support for its maintenance. Up-today we analyzed only samples, coming from the same area of the facade, because the scaffolds are not yet mounted and it is therefore impossible to make a more significant sampling. To replicate the original color, it was measured by a colorimeter and by a "panel test" using the comparison with a color atlas so obtaining a comparison between its subjective perception and objective measure.

Introduction

"Palazzo Governi" is a hystorical building located in the Cagliari old town, district Stamapace in Cagliari, founded by Pisans in the thirteenth century and rich of archaeological remains from Roman and Punic.

The building that we are considering stands on the ruins of the Church and Convent of "San Francesco dei Minori" (XIII century) and is dated circa 1880 i.e. after several accidental collapses and a final disastrous fire, occurred in the Church in 1871, that destroyed the roof.

Some parts of the load-bearing walls, in tufa cantons, of the church have been used for the building construction and are still visible on the ground floor along with the adjacent cloister. The bearing walls was also completed with tufa cantons.

The building was damaged by bombing during the war of 1943, particularly with regard to floors of coverage in the left area looking the facade facing Corso Vittorio Emanuele.

After the war, the Civil Genius of Cagliari has worked on the restoration of the building.

The building architectural style respects the neoclassical canons: it bases on a strong axial symmetry with a slight alternating rhythmic pattern; it consists of four orders, marked by cornices modestly jutting from the line of the facade, and finished at the top by a wide frame.

Colorimetric and by "panel test" analyses were performed on the colored surface while, in order to individuate the degradation factors, measures of pH, conductivity, redox potential (ORP), ionic chromatography (IC) and Inductively Coupled Plasma/Optical emission spectroscopy (ICP/OES) were performed on the solution coming from the extraction of soluble components present in the plaster (3 samples in triplicate). Results were compared with those obtained for two plaster samples, in "by eye" good conservation state, coming from foundation of a building inside the "Sapienza" University (Rome) and from a fresco of "Santa Anastasia" Church (Palatino area, Rome). Optical and Scanning Electron Microscopy (OM and SEM) were performed on polished cross-sections.

The percentage of binder present in the plaster has been evaluated by weighing an aliquot of sample first and after attack by diluted acetic acid.

Materials & Methods

716 compact IC ion cromatograph (by Metrohom, Switzerland), equipped with column AS4+AG4 (by Dionex, USA), conductivimeter model 160 equipped with 192/K1 electrode (by AMEL, Italy), pH-meter pH211 (by Hanna, USA) equipped with electrode 52-02 (by Crison, Spain), pH/Mv meter Micro pH2002 (by Crison, Spain) equipped with electrode 97-78-00 (by Orin, USA),

colorimeter CM2006-D (by Minolta, Japan), optical microscope Stemi SR (by Zeiss, Germany), analytical balance PM 460 (by Mettler, Switzerland). The panel test was carried out by a group of students, no needing glasses, on five different samples of the plaster, 2 analyzed such as and the other 3 as filtrate of the solutions prepared for the salt content analysis. Through the Sikkens colour palette (AkzoNobel Coatings, Italy) code the L*a*b* coordinates and the dominant wavelength were obtained.

Results

The color perceived by the "panel test" is reported in fig. 2 as a function of b*. The corresponding dominant wavelength ranges from 600 to 609 nm so meaning that the same hue was perceived; the significant difference in saturation is mainly due the real difference of the samples (see ΔE values in table 1); the darker are the two untreated samples.

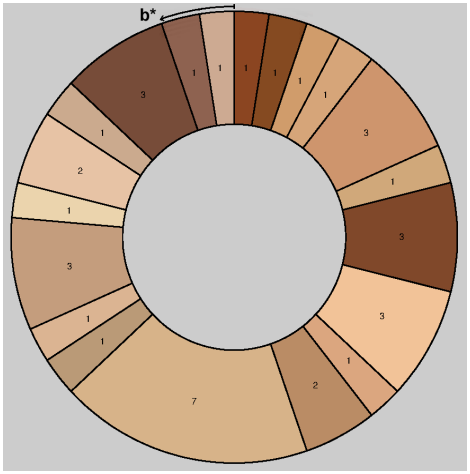

Fig.2; Results obtained by the "panel test" for the plaster surface

The OM, SEM/EDS and the weight difference between the sample first and after acetic acid attack let to state that the plaster is a lean plaster. The macrophoto in fig. 1 evidence a brown thin layer (about 100 μm and iron oxides based, by SEM) on the surface (bottom), and colored grains of coarse size and variable roundness (ranging from angular to sub-rounded), a big uncarbonated lump.

The IC analysis revealed a neglectable chloride and nitrate content in all the analyzed samples with the exception of the sample coming from the "Santa Anastasia" Church that, basing on some European guidelines, results slightly contaminated; on the contrary sulphate content results in the range corresponding to a medium contamination for all the sample (about 1% w/w) with, also in this case, the exception of the Church that results very severely contaminated (about 43 % w/w). Anyway, he last datum is surely not significant due to very low available amount of sample, i.e. 23 mg, but it was impossible to sample more on a fresco; may be the sample come from a stucco plaster.

sample	1	2	3	4	5
1		45	25	72	97
2	45		3.8	230	274
3	25	3.8		182	220
4	72	230	182		2.5
5	97	274	220	2.5	

Tab.1; ΔE calculated for all samples

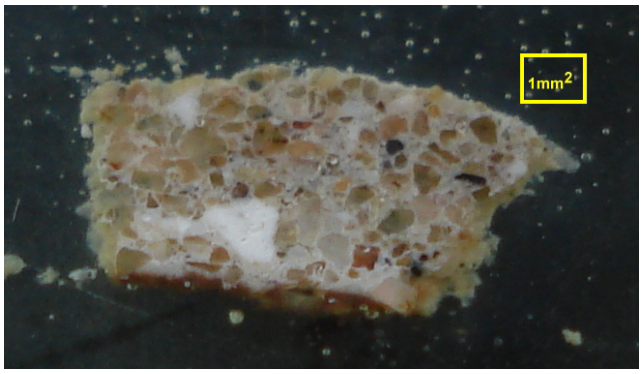

Fig.1; Macrophoto of a polished section of a plaster sample

Conclusions

With regard to the color to be used to paint in the restoration intervention, basing on the "panel test" we have defined the original hue and let the architect and Sovrintendance the choice of the saturation.

The degradation state must be mainly imputed to the lean plaster while the sulphate content correspond to a moderate risk of damage. Surely more samples must be analyzed in order to better understand if the plaster was originally lean or, as an example, the lime has undergone a sulfation and subsequent leaching.

References

1) M. P. Sammartino, G. Cau, R. Reale, S. Ronca and G. Visco. A multidisciplinary diagnostic approach preliminary to the restoration of the country church "San Maurizio" located in Ittiri (SS), Italy, *Heritage Science,* 2(4), (2014) 1-13

2) C. Arcolao, Le Ricette del Restauro *Malte, intonaci, stucchi dal XV al XIX secolo,* (1998) 284, ISBN 88-317-6911-1