Famous Men Busts Decorating a Parisian Façade: Characterization and Decay Process of a Cast Artificial Stone from the XIXth Century

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Abstract After cleaning, four 19th century cast busts of illustrious men decorating a Parisian façade revealed severe deterioration. A network of large cracks 0.5 cm wide gave the appearance of a broken up puzzle, although each individual piece maintained good general cohesion. In order to determine the cause of the intense decay and to propose an adequate conservation protocol, the composition of this artificial stone was thoroughly investigated. Sample analyses showed that the material was composed mainly of crushed and probably sieved limestone aggregate bonded with hydrocerussite and an amorphous silica gel containing a small amount of potassium. The binder surrounded and linked calcite aggregates together. Analytical results were consistent with artificial stone recipes from the 19th century. In this paper, we report the results of analyses performed on those strange objects. We also will discuss two hypotheses of composition based on potassium silicate and propose an explanation for the peculiar degradation patterns.

1 Introduction

During the first decade of the 19th century, precisely between 1825 and 1828, René Bony, a rich speculator, commissioned Jules de Joly to build a pair of stone buildings in Paris: the Hôtel Boni in the 9th district, and a commercial building, 4, rue d’Aboukir, in the 2nd district. Each shows a similar decoration, including busts of famous men placed on the upper floor, as an attic level, and statues on the noble floor just below. The statues have disappeared from the lower façade of the Aboukir, though they are still in place at the Hôtel Boni. The four busts placed on the Aboukir’s upper façade represent illustrious men from Greek Antiquity:
Demosthenes, Socrates, Homer and Euripides (Fig. 1). Both architectural and decorative programs are very coherent and show how often those decorative elements were present on façades in the 19th century, illustrating the romantic taste for antique art. Hundreds of busts were cast using moulds made from original museum pieces. Antiques from the Louvre museum were often used to create replicas.

The 19th century was a period of technological progress, especially in the chemical industry, and diverse recipes of artificial stones were conceived, tested, applied, and finally modified or adapted by the moulding studios. Even though initial recipes are mentioned in the literature, the on-site material may have been modified in the workshops and over time. Therefore, it is sometimes difficult to establish a link between literature recipes and material observed in present day. The main source of information on innovative materials used in the 19th century in France is the book from Théodore Chateau published in 1880 [1]. He made a long list of chemical recipes for technological applications in the building industry. A specific chapter is dedicated to artificial stones and the different ways to make them. They are of three different types. The first one, based on chalk, cement or concrete, is mainly used in building construction. The second one is based on alkali silicates and the third one on plaster. The author specifies that these two methods can be used to mould architectural elements and cast figures.

Within the framework of the general conservation project, it was necessary to characterize the material used for the creation of these cast busts and to define the decay observed.

Fig. 1 On the left side, the Aboukir façade, showing the four busts before cleaning, and on the left the Hotel Boni conceived by the same architect and presenting the same iconography. (Photos after Sébastien Cord and François Brugel, architects)
2 State of conservation

The busts were cleaned in 2008 by micro-sand blasting after the elimination of bird droppings that partially covered them (Fig. 2). After cleaning, a network of large cracks about 0.5 cm wide and 1 cm deep was revealed and gave the heads the appearance of a broken up puzzle (Figs. 2 and 3). The cracks were blunt, did not penetrate the depth of the busts, and apparently had been present before cleaning, as they were filled with a mending mortar. The large cracks exposed the iron cord grids present inside the busts. The surface of the busts appeared very irregular because of differential erosion. Nevertheless, the busts kept a good general cohesion but, because the sealing mortar had been lost, were at risk of falling off the façade.

3 Materials and methods

As the busts have a hollow core, samples could be collected at their inner and external surfaces. Observations and analysis were conducted on polished cross sections and fresh broken pieces. The study included macroscopic observations to evaluate material texture, X-Ray diffraction to determine crystalline phases (Bruker AXS D8 ADVANCE), back scattered and secondary electron observations coupled with EDS analyses on scanning electron microscope to determine elemental composition and microstructure (Jeol JSM-5600LV).

Fig. 2 Cast busts of the four famous men before and after micro-sanding cleaning.
Observation of the interior samples under binocular microscope reveals the presence of grains from 10-50 µm bound with finer grains below 10 µm. The grains seem to be covered by a shiny veil. Some white grains are distributed throughout the material. External samples of the castings present similar grains as well as additional white grains, but no binder could be found.

The identified crystallized phases are calcite (\(\text{CaCO}_3\)) and lead carbonate hydrocerussite (\(\text{Pb}_3(\text{CO}_3)_2(\text{OH})_2\)) in both interior and external parts of the casting. The interior sample appears to be composed of large grains rich in calcium and carbon (calcite grains) bound with finer grains of calcite mixed with a lead carbonate charge (white spots on Figs. 4 and 5). In the external sample, the lead carbonate remains around the aggregates but the fine calcite grains are not present. The interior sample appears to have retained its calcite binder, which seems absent from the environmentally exposed external surface of the bust.
A broken surface of a sample taken from inner part of the bust was observed under secondary electron and revealed two morphological characteristics:

The presence of fungal hyphae and spores indicating biological colonization (Fig. 4).

The presence of an amorphous gel covering and linking the grains (Fig. 7). This gel can be crackled in the same way as a broken glass (Fig. 6) and is composed of silicon (Si) and potassium (K). This composition and microstructure are consistent with “water glass” gel, which was in use during the XIXth century for stone consolidation.

On the basis of our analytical results, the hypothesis of a silicatisation treatment can be expressed. Sodium and potassium silicates were utilized in the 19th century in two different ways. The most common was the so-called “dry way,” which was initiated by the German chemist Fuchs in Munich in 1825 and then by the English chemists Wern and Siemens in 1848. The dry way was further developed by Ransome [1] or Kuhlman [2] and finally largely applied by 19th century architects such as Viollet le Duc. The silicate solution had the ability to penetrate and...
combine with stone components during drying and to form a hard and resistant substrate. Viollet le Duc applied it to consolidate and prevent stones from further weathering on several medieval monuments [3]. Brand new sculptures could also be treated with silicate solutions as a preventive protection measure. The statues decorating the Napoleon courtyard in Louvre Palace were treated in this way [4].

Another way to use potassium silica solution consisted of mixing it directly with stone powder, moulding the mixture as a mortar and drying it in an air oven between 50 and 100°C for a period dependant on the size of the moulded object.

This method also has been used for producing artificial stones for construction or architectural elements. Metallic oxides could have been added to simulate the colour of natural stones.

This process was most probably the one used to create the busts we have studied. If potassium silicate had been applied after casting, it would not have penetrated to the inner core of the material (the gel was found deep in the material, at 5 cm depth). Our assumption is that potassium silicate has been mixed with stone powder, moulded, and probably dried in an air oven, rather than applied to the bust surfaces. Lead carbonate may have been added to obtain a colour close to that of natural stone.

This last process may have initiated cracks, as important thermal variations or shrinkage may take place following air oven drying. Indeed, the cracks we observed cannot be due to oxidation of the cord grids or dilatation, as they are not in star or chipping shape. Instead they form a polygonal network typical of swelling patterns. The external surface of the casting was in direct contact with the mould and may have been exposed to the strongest temperature variations. When temperature gradient varies from the surface to the depth, cracks are likely to be located in the stressed area rather than penetrating the depth of the object, which, here, is the first few centimetres of the castings. Too high a temperature or too rapid cooling of the castings may be the source of the final observed degradation pattern.

5 Discussion and conservation plan

Cast and cord grid busts of the famous men placed on the façade of the Aboukir are made of limestone powder and lead carbonate grains bound with potassium silica gel. References to those recipes exist in the literature, but as far as we know, no existing proofs of their existence for decorative elements had been previously described. The only proof we have are ancient moulds still existing in moulding studios. They are called "moules à pièce" or "pieces mould," and their pieces were connected with a sealing mortar. The mortar needed to be broken to open the moulds and take the casting out. However, it was impossible to find any further information on the way the cast busts were finally prepared. Casters have probably
tried new recipes or made mistakes in artificial stone preparation that involved strong cracking.

The conservation initiative has been to relocate the busts to the entrance of the building and to install on the façade new busts similar to the original, but cast in resin. They were made by the Louvre moulding studio and recently placed in January 2010 (Fig. 8).

Probably the same sponsor and surely the same architect are at the origin of the Hotel Boni and Aboukir street façades. Their similar iconography suggests that other similarly decorated façades may exist. A starting study and research have been initiated with the Aboukir façade and may lead to new research on historical buildings of the 19th century.

Fig. 8 New cast busts made in resin by the moulding studios of L’Atelier des Moulages de la R.M.N., and replaced in January 2010 on the façade, rue d’Aboukir N°4th.

6 References

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