



# Characterisation of old *azulejos* setting mortars: A contribution to the conservation of this type of coatings

Ana Leonor Damas<sup>a</sup>, Maria do Rosário Veiga<sup>b,\*</sup>, Paulina Faria<sup>c</sup>, António Santos Silva<sup>d</sup>

<sup>a</sup> Department of Civil Engineering, NOVA University of Lisbon, 2829-516 Caparica, Portugal

<sup>b</sup> Buildings Department, National Laboratory for Civil Engineering, Lisbon, Portugal

<sup>c</sup> CERIS and Department of Civil Engineering, NOVA University of Lisbon, 2829-516 Caparica, Portugal

<sup>d</sup> Materials Department, National Laboratory for Civil Engineering, Lisbon, Portugal

## HIGHLIGHTS

- Characteristics of *azulejos* setting mortars is gathered from literature and analysed.
- *Azulejos* setting mortars of 16th–20th cent. are studied and found to be air lime based.
- Lisbon mortars have mostly calcitic air lime while dolomitic air lime is found in Coimbra mortars.
- The 1:4 binder:aggregate weight ratio is in agreement with the literature results.
- Compressive strength of *azulejos*' setting mortars follow similar trends as old wall coating mortars.

## ARTICLE INFO

### Article history:

Received 3 July 2017

Received in revised form 10 March 2018

Accepted 13 March 2018

Available online 21 March 2018

### Keywords:

*Azulejo*

Glazed tile

Wall coating system

Setting mortar

Air lime

Architectural heritage

Characterisation

Building conservation

## ABSTRACT

One of the most typical Portuguese facades' coatings is the glazed tile (*azulejo*) wall coating. *Azulejos* are in Portuguese history for six centuries, being considered a historical heritage and a mark of Portuguese culture. The setting mortar used in the *azulejos* application plays an important role for the correct functioning of the entire coating system. Therefore, for correct conservation its study and well detailed characterisation are fundamental.

Within the scope of DB-HERITAGE project (*Database of building materials with historical and heritage interest*), a deep gathering of data from literature, concerning the characteristics of *azulejos* setting mortars, from the 16th to the 20th centuries, was made. Adding to the existing data, a physical, mechanical, chemical and mineralogical characterisation of a set of *azulejos* setting mortars, from the 16th to the 19th century, from Lisbon and Coimbra cities, was carried out.

The results obtained in the experimental study were analysed and compared with the ones gathered from literature leading to establish useful conclusions for the prescription of future conservation interventions for this type of coating.

© 2018 Elsevier Ltd. All rights reserved.

## 1. Introduction

In Portugal, the state of degradation of the built heritage is notorious and alarming, a condition that stands out especially when it is shown by the facades' coatings, whose main function is the protection of the walls. Several factors may be responsible for the degradation of a wall coating: excessive humidity namely from capillary rise, climatic exposure conditions, biological colonisation, pollution, lack of maintenance or even poorly planned con-

servation interventions that reveal to be incompatible with the characteristics of the building to be conserved.

One of the most typical types of wall coating in Portugal is the glazed tile coating system – named *azulejos* in portuguese (Fig. 1), which is closely linked to the Portuguese history, thus constituting an important testimony of great cultural and touristic interest.

*Azulejos* coating is distinguished by its important aesthetic value and by its specific technique. Additionally, when well applied, its longevity is one of the most important and attractive characteristics, which increases the preference and the demand for this type of coating. Just like all the traditional wall coatings (external or internal), when subjected to the mentioned degradation factors, *azulejos* coatings also deteriorate. The most affected

\* Corresponding author.

E-mail addresses: [a.damas@campus.fct.unl.pt](mailto:a.damas@campus.fct.unl.pt) (A.L. Damas), [rveiga@lnec.pt](mailto:rveiga@lnec.pt) (M.R. Veiga), [paulina.faria@fct.unl.pt](mailto:paulina.faria@fct.unl.pt) (P. Faria), [ssilva@lnec.pt](mailto:ssilva@lnec.pt) (A.S. Silva).



Fig. 1. Azulejos facade coating of a building in Calçada do Cardeal, Lisbon.

targets: the substrate (the masonry), the *azulejos* setting mortar and the *azulejo* itself.

In these old coatings, the mortar is the bond between the substrate and the *azulejo* itself; so its behaviour directly influences the system as a whole (Fig. 2).

When lack of adhesion occurs between the setting mortar and the masonry or the setting mortar and the *azulejo*, a conservation intervention is needed and a replacement setting mortar is used. The most compatible replacement mortars are those that have physical, mechanical, chemical and mineralogical characteristics similar to the original ones [1]. To assure compatibility, it is essential to determine in the first place the characteristics of the existing materials. Therefore, a well-fundamented matrix of knowledge can be developed to support future conservation and refurbishment interventions.

Considering the few works developed in the characterisation of old *azulejos* setting mortars, and given the increasing awareness for the preservation and conservation of this cultural and aesthetic heritage, the increase of knowledge regarding the characteristics of this type of mortars is extremely important and relevant.

The main objective of this article is the characterisation of old *azulejos* setting mortars in order to expand the knowledge matrix regarding the conservation and refurbishment of *azulejos*, on which still little information is available. To accomplish that objective, an experimental campaign was carried out on a set of 40 samples of old *azulejos* setting mortars provided by *Museu Nacional do Azulejo* (Portuguese Glazed Tile Museum, in Lisbon, Portugal), and the results obtained were correlated with those few results collected from literature and compared with other Portuguese coating mor-



Fig. 2. Azulejos coating system.

tars. It was also an objective of this study the evaluation of possible trends in *azulejos* setting mortars formulation through history, regions and types of building from which they come from.

## 2. Literature review on *azulejos* setting mortars

In several studies related to the characterisation of old mortars, the gap existing in the characterisation of *azulejos* setting mortars and the existing techniques for their application is recurrent and clear [2]. This gap may be due to the difficulty in the collection of significant samples, especially because they are under *azulejo* coating. During interventions in *azulejo* coatings, it is common to reject the mortar that is adhered to the rear face of the *azulejo* and this justifies the lack of samples.

In Portugal, Portland cement emerged in construction in the late 19th century but was only consolidated in the market for masonry coatings in the second half of the 20th century. Therefore, until then the mortars used in the settlement of *azulejos* were typically based on air lime [3].

In the absence of detailed information regarding the characterisation of *azulejos* setting mortars, most professionals that work directly in the conservation of old *azulejo* coatings base their techniques on the few references found in the literature and end up following the usual patterns, regardless of their suitability to the case being treated. A common example of the lack of experience and knowledge in poorly planned conservation interventions is the use of mortars with cementitious binders for the replacement of old *azulejos*. This type of mortars is completely inadequate for this kind of works, either chemically, because of their content of soluble salts, physically because of their low porosity and lack of water vapor permeability, or mechanically due to their high strength, stiffness and low deformability [4].

Fortunately, in a context where *azulejo* coatings heritage has become an increasingly important conservation and preservation target, the fundamental role that mortars play in the behaviour and durability of that type of coatings was recognised. Some investigations have emerged, which value the characterisation of this type of mortars, although briefly when compared to the importance given to the *azulejos* themselves [5–15].

A deep gathering of data, from the literature, concerning physical, mechanical, chemical and mineralogical main characteristics of some case studies of *azulejos* setting mortars is summarised in Table 1. The collected case studies are essentially from residential and religious buildings, from the Portuguese towns of Aveiro, Oporto, Santarém and Évora, from the 16th to the 20th centuries. It is verified that, in general, *azulejos* setting mortars present a calcitic lime binder, with rare exceptions in Oporto and Santarém, which show dolomitic lime binder. The aggregates are mainly siliceous, often containing clay minerals and rarely traces of ceramic fragments. Most of the samples considered in Table 1 are from building facades and so they are exterior mortars. But when they are compared with the few cases from interiors, no significant differences are found, leading to the assumption that no special distinction was made in the formulation and application of the two types. However, only further studies could prove this hypothesis.

The mean binder:aggregate weight ratio obtained from the gathered case studies is approximately 1:4. The mean value of compressive strength is 1.67 N/mm<sup>2</sup> and the only value found of dynamic modulus of elasticity by ultrasounds is 1610 N/mm<sup>2</sup>. Hydrated calcium silicates and silico-aluminates are present in some samples. Salts were generally found, namely gypsum (calcium sulphate), mainly in samples taken from the interior, and halite (sodium chloride), more often in the exterior walls, as well as arcanite (potassium sulphate). The presence of gypsum could be due to several factors: the migration of the sulphate ion from

Download English Version:

<https://daneshyari.com/en/article/6713937>

Download Persian Version:

<https://daneshyari.com/article/6713937>

[Daneshyari.com](https://daneshyari.com)