Ceramic Façades in Portugal - Conservation Issues

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Abstract
The use of glazed tiles on external façades became popular in Portugal in the 19th Century in a trend that was shared with Brazil. Nowadays the use of this material in external walls, providing colouring and texture, is a definite mark of Portuguese heritage. Many city centres have diverse patterns that were produced in several industrial sites, located throughout the country. The city of Ovar, with a small city centre is considered an open air Glazed Ceramic Tile Museum due to the diversity of patterns that it presents. Ceramic façades are often in a degraded state and many times, are not intervened accordingly, resulting in the total removal of ceramics and replacement by other types of external cladding. However, a few studies centred in the city of Ovar, together with the work of the city council towards the preservation of these buildings, have shed some light into the path that needs to be treaded. Ceramic tiles are usually placed with an air lime mortar and traditionally, there are no joints. Occasionally, small joints are filled with mortar with very fine stone powder. The main problems found in these façades are detachment due to the action of water or to differential behaviour of materials and loss of glaze in the tiles. Conservation actions have been performed replacing old tiles by replicas and the use of air lime mortars has been continued. However, the need to improve the process has brought about some issues: replicas and ancient tiles are very different and have a different behaviour, without joints, air lime mortars will have difficulty in hardening. Due to these issues, several tests have been performed on old façades, old tiles and old mortars and compared with areas that have been intervened and with new tiles and specifically designed mortars. This paper intends to present the specific problems related to the conservation of these façades and to create the basis for possible solutions.
1 Introduction

Glazed ceramic tile (Azulejo) façades create a lively image in many of Portugal’s city centres, providing them with patterns and colour and offering a distinctive representation of the urban landscape. Given its initial Islamic influence, the use of glazed tiles has a long history in Portugal, but the practice of applying these tiles as façade protection and decoration began in the 19th Century. This was possibly due to the influence of construction practice in Brazil. There is no doubt Portuguese emigrants took the tradition of the use of ceramics to Brazil, and it is said that for climatic and cultural reasons external cladding of façades became common and was quickly adopted into current construction practice (Fig. 1).

This period coincided with the industrialization of the ceramic tile production, with a particular emphasis on the north of the country, especially in the city of Porto and its surroundings. A few factories (Massarelos, Cavalinho, Devesas, among others) began to implement industrial techniques, incrementing tile production. In addition to Porto, other production centres existed, such as Lisbon, Viana and Aveiro; different raw materials, techniques, and patterns are linked to specific production centres.

![Fig. 1 Examples of houses with ceramic façades (city of Ovar)](image)

![Fig. 2 Degraded façade in Ovar](image)
Nowadays, this heritage is notable, yet degraded (Fig. 2) and sometimes not valued. Often, ceramic tiles are missing in façades, and in certain cases, they are totally removed to be replaced by mortars or simply to leave bare stone walls. The lack of maintenance also has led to the degradation of the ceramics themselves or to a malfunction of the wall-mortar-tile system.

2 Ceramic façades – materials and techniques

Ceramic tile façades are a complex system consisting of supporting walls, mortars, and tile cladding. This complexity is enhanced by the variety of materials and techniques used in different areas of the country and in different time periods. Throughout Portugal there is a wide variation in the construction materials and techniques of external walls. While there is a predomination of limestone in the south of the country; granite is the main material used in the north, and earth construction using tapia or adobe walls is widespread.

Ceramic tile raw materials varied, as local clays were used for the manufacture; however, they were often mixed with clays from other locations in order to achieve the required plasticity [1]. Throughout the country the new factories adopted the use of the mechanic press, enabling faster production and replacing traditional moulds. Most of the production followed a quadrangular shape of 140 mm x 140 mm; however, rectangular tiles were also produced with dimensions of 160 mm x 75 mm [1].

Recent studies [1-4] focused on the north of Portugal (cities of Porto and Ovar) concluded that most of the mortars used for the application of ceramic tiles were air lime mortars with local sand. The lime/sand ratio in these mortars varied from 1:4 to 1:9 in weight, suggesting adequate proportions with an inclination towards the use of more binder. The thickness of the mortar layer is also extremely variable, and there is often a strong variation related to the roughness of the façade itself.

Joints are usually very small or inexistent, and there is lack of information on the materials used for joint mortars. They are often left unstudied due to the fact that they are very thin or eroded; however, it is quite probable that they were executed with air lime and fine sand or stone powder.

3 Degradation of ceramic façades

Due to lack of maintenance and the differential functioning of the wall-mortar-tile system, many façades are now in a degraded state. Problems of detachment, lack of ceramic elements, and loss of glaze can be considered the main forms of degradation. Inadequate conservation actions also have contributed to façade degradation.
3.1 Detachment

Many glazed tile panels suffer from detachment, as shown in Fig. 3. This may happen in the tile/mortar interface, in the mortar/wall interface, or between different mortar layers. Often this type of degradation is associated with areas exposed to water (capillarity, tubes), and its main cause is the differential behaviour of the materials that compose this system, in terms of hygric expansion. The lack of joints and the crystallization of soluble salts also contribute to this occurrence.

![Detachment of ceramic tiles and mortar](image)

Fig. 3 Detachment of ceramic tiles and mortar

3.2 Lack of ceramic elements

Often a façade only lacks a few ceramic elements (Fig. 4) due to differential behaviour of wall components, as explained in the above section. However, this is a starting point for quick degradation caused by increased water uptake at these locations and the impermeability of the tile cladding.

![Lack of ceramic tiles](image)

Fig. 4 Lack of ceramic tiles
3.3 Loss of glaze

The edges of ceramic elements in façades are especially prone to loss of glaze, which is favoured by stress that is caused by differential thermal expansion and is enhanced by the lack of joints. However, this also may be the result of chemical attack, as ceramic tiles are directly exposed to the environment. Pollution, salt dissolution due to water exposure, and biological attack all cause deterioration of the glaze.

Fig. 5 Loss of glaze in a ceramic tile belonging to a façade

3.4 Inadequate conservation actions

Due to the frequent loss of ceramic elements from façades, there is a need to fill the empty spaces, and often there are no similar ceramic pieces readily available. It is quite common to find these spaces filled with cement mortars, which behave differently than the rest of the panel (Fig. 6) and contain soluble salts that may cause further damage to the façade.

Fig. 6 Filling in of space left by tiles with a cement mortar
4 Conservation of ceramic façades

Despite the proliferation of inadequate conservation actions due to the volume, diversity, and dispersion of the heritage involved, a few institutions have become dedicated to the preservation of this particular heritage. Among them, ACRA – Atelier para a Conservação e Restauro de Azulejo (Atelier for the conservation and restoration of glazed ceramic tiles) has lead the preservation of the façades in the city of Ovar, known as the Glazed Ceramic Tile Museum because of the diversity of tile cladding patterns present in its small city centre.

In order to enable an effective conservation intervention in these façades, previous work encompassing the knowledge of raw materials, production processes, and application techniques has been initiated [1-4]. However, a deeper insight into this subject needs to be undertaken to increase the knowledge of the materials that were used (ceramic tiles and mortars), their interaction, and their degradation and to set the basis for compatible conservation actions.

Because of their specific function, mortars applied in this system have particular requirements that must be taken into account and encompassed in the general requirements for conservation mortars [5]. However, this may only occur after thorough investigation of the applied materials (Fig. 7) and the adjustment of existent testing procedures [6, 7], such as water vapour permeability test, as seen in Fig. 8.

![Fig. 7 Sampling of tiles from façade – sampling areas](image)

Research procedures will help increase the knowledge of the existent heritage and its degradation and will lead to compatible conservation actions based on laboratorial tests and in situ applications and tests. The development of mortars that promote adequate adhesion and may harden in a low CO₂ environment, as well as the execution of ceramic tile replicas with a similar behaviour to ancient tiles, are aims of further research.
Conservation actions also must be based on deeper knowledge of the wall-mortar-tile system, including the differential behaviour of materials and the stress induced by this factor. The adhesion between the materials used in this system and its changes with time is also crucial to understand degradation patterns and to propose adequate maintenance.

5 Conclusion

There is a vast heritage of façades decorated with glazed ceramic tiles in Portugal, mostly dating from the 19th Century and the beginning of the 20th Century. Part of this heritage is degraded, although studies have been initiated towards its conservation and there is ongoing work towards its physical preservation. However, the knowledge of the composition, degradation state, and behaviour of the materials and the wall-mortar-tile system is not sufficient; research must be undertaken in order to enable effective and compatible conservation actions.

A recently started research project – AZULEJAR – hopes to contribute to the conservation by increasing the knowledge of the applied materials and systems and studying solutions that may improve the quality and performance of conservation actions.

6 Acknowledgement

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