



Mortars for azulejos – Practice and Requirements

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SUMMARY: Azulejos (ceramic glazed tiles) are a specific Portuguese heritage widespread in urban facades from the 19th century - houses are clad with azulejos, in various colours and displaying a wide range of patterns and/or figures. After environmental exposure for around one hundred years, many of these facades display severe degradation and fatigue has often led to the failure of the mortar/azulejo system, creating loss of azulejos that frequently detach from facades, compromising the whole cladding system. One century ago, application techniques were widespread and simple, involving the previous wetting of azulejos and use of air lime mortars. Nowadays, there is a clear necessity for preservation of these facades with adequate mortars. The issue is therefore: which mortars should be used? Reversibility of solutions, compatibility issues and the demands of European standards must be taken into account. It is, however, fundamental to achieve adequate solutions towards the conservation of the unique heritage of azulejo facades

KEY-WORDS: mortar, azulejo, heritage, standards, preservation



INTRODUCTION

Glazed ceramic tiles, used as exterior claddings, are a strong component of Portugal's built heritage, giving it a distinctive characteristic that is shared, since the 19th Century, with Brazil. The use of glazed ceramic tiles with this purpose was initiated in the 16th Century and has evolved through various artistic styles. The cladding of façades with ceramic tiles became a popular practice in Portugal during the 19th century, conjugated with the semi-industrialization of glazed ceramic tile production. In this period, a vast number of patterns were produced by factories situated mainly in the areas of Porto, Lisbon and Aveiro, that used distinct production materials and methods. Façades all throughout the country became richly decorated with patterns displaying varied colouring and providing a distinctive visual outcome.

External cladding with tiles has a double aesthetic and functional purpose with varied chromatic and figurative amplitude, transmitting unique characteristics to buildings and urban nuclei. The existence of a national tradition in terms of the use of glazed tile external finishing is expressed in the high number of traditional buildings with this material. However, this unique heritage has been subject of interventions without the necessary accompaniment or formation in terms of the selection of materials, putting the preservation of the tile panels at risk.

Nowadays, glazed ceramic tile façades still characterize city centres throughout Portugal, with a special emphasis in the cities of Porto and Lisbon that used tiles from different factories and therefore display distinct sets of patterns. The city of Ovar, due to the concentration and variety of tiles in the city centre, is considered the Museum City of Glazed Tiles. However, tile use is widespread and varied from city to city – whereas Aveiro displays a unique set of *Art Nouveau* tiles, most city centres both in mainland Portugal and in the Portuguese islands of Madeira and Azores show impressive tiled facades (Figure 1).

This unique heritage, characteristic of Portugal, Brazil and ancient colonies (India, Cape Verde), is disappearing at a fast rate due to the inevitable degradation of the tile/mortar system and lack of maintenance. It has, therefore, an urgent need for intervention, due to lack of maintenance and difficulty to apply adequate conservation actions.

This complex system, composed by sustaining walls, mortar and glazed ceramic tiles often displays detachment of panels and/or lack of tiles that are often replaced by mortars or by different tiles, creating a heterogeneous, degraded effect. Recently, attempts to replace these tiles by replicas have generated an improvement in the conservation of these façades, but doubts on adequate intervention procedures remain. These difficulties in pursuing adequate conservation actions are due to lack of knowledge and/or lack of the adequate materials have accelerated the disappearance of this type of façades that are being replaced by rendered façades that are easier to execute and maintain.



Figure 1 - Variety of patterns in façades



ACTUAL ISSUE – GENERALIZED DEGRADATION

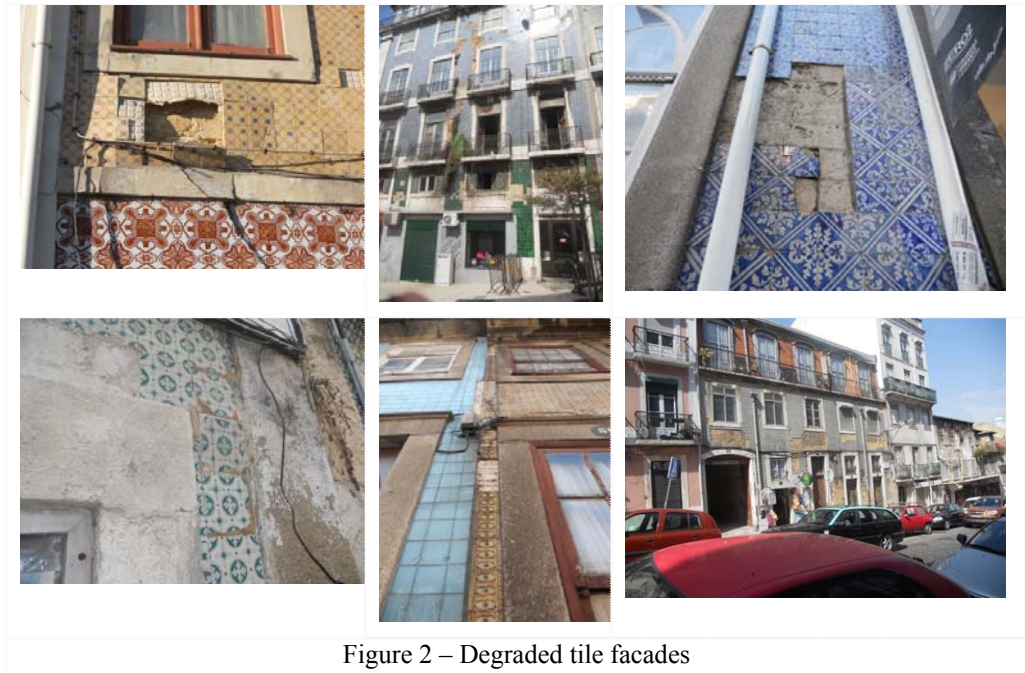


Figure 2 – Degraded tile facades

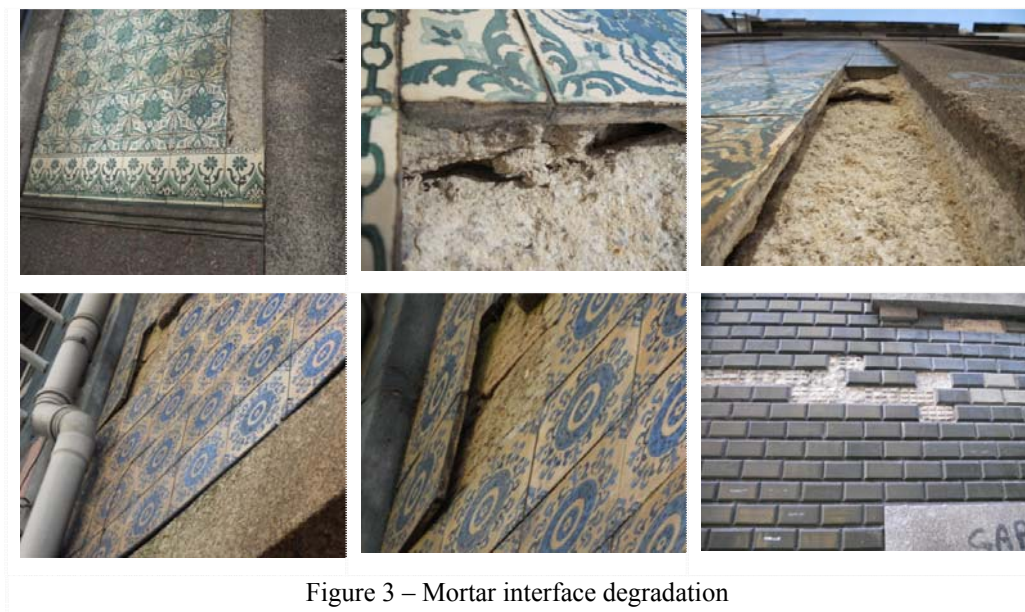


Figure 3 – Mortar interface degradation



Figure 4 – Typical degradation process

Degradation of a system that has been on the walls for decades is especially complex and is indeed inevitable. Degradation mechanisms as shown in Figures 2 to 4 are most likely linked with the action of water and with differential expansion/shrinkage cycles. Detachment occurs in the wall/render interface, between render layers or in the interface between the render and azulejo (Figure 3). Besides natural actions, the use of metallic elements on the facades, mostly linked to publicity, piping or energy/communication cables is also a trigger for degradation. Unfortunately, theft of azulejos also has to be mentioned as a possible cause. The initial degradation promoting the loss of a unique azulejo is the beginning of the path for complete loss of the system, since this allows for the entry of a much higher quantity of water, creating posterior detachment of adjoining elements and eventually of the whole panel (Figure 4).

PRACTICE AND REQUIREMENTS

Currently, intervention techniques are extremely diversified. It is still common that this legacy, is underestimated and new painted renders are the substitution choice. Figure 5 depicts a traditional approach with the use of air lime mortars similar to the mortars used in the original application while in Figure 6 a distinct approach that has been currently used is shown, with the removal of all of the old cladding system and a complete façade renewal with new tiles and cement-based adhesive mortars. However, legislation, such as municipal regulations, is becoming tighter and deep façade renovation such as that shown in Figure 6 will be difficult to justify. It is clear that materials and methods for façade conservation as shown in Figure 5 must be discussed as the approach is far from consensual.



Figure 5 – Façade conservation



Figure 6 – Deep façade renovation



Current European Standards integrate NP EN 998-1 which specifies compressive strength classes for general mortars and other specific requirements for renovation mortars, such as values for capillary absorption and water vapour permeability, with a wide enough range to incorporate a variety of solutions. This standard is actually used for rendering mortars and is widely applied. However NP EN 12004 standard for tile adhesives is used for the generalized application of ceramic materials and has strong demands in terms of bond strength. This standard classifies adhesives taking into account adhesive type, adhesive class and adhesive characteristics. Table 1 displays adhesive characteristics for normal and improved classes (C1 and C2). It is evident from Table 1 that bond strength is of extreme importance for current practice. and the need to attain high values is definitely linked to demands of new build but doesn't take into account reversibility needs for 19th century azulejo applications.

Table 1 – Adhesive characteristics as in NP EN 12004

Characteristics	Class C1	Class C2
Initial bond	$\geq 0.5 \text{ N/mm}^2$	$\geq 1.0 \text{ N/mm}^2$
Bond after water immersion	$\geq 0.5 \text{ N/mm}^2$	$\geq 1.0 \text{ N/mm}^2$
Bond after artificial ageing	$\geq 0.5 \text{ N/mm}^2$	$\geq 1.0 \text{ N/mm}^2$
Bond after freeze-thaw	$\geq 0.5 \text{ N/mm}^2$	$\geq 1.0 \text{ N/mm}^2$

Figure 7 illustrates the removal of azulejos applied with air lime (lighter mortar on the top of the figure), hydraulic lime (being removed) and cement mortars (bottom right hand side). Results were extremely different, with a great difficulty of removal of tiles applied with a cement mortar base (broken tiles, removal of wall joint mortar together with cement – Figure 7, bottom right hand side) and an ease linked to lime mortar use (top of Figure 7, simple removal of tiles). This understating of the distinct behaviour of mortars due to the employment of different binding materials is a crucial aspect. Excessive bond, in the specific case of azulejo façades, may be the determinant factor for the lack of adequacy of an intervention.

According to the European Construction Products Regulation no. 305/2011, performance declarations may be subject of derogation when “the construction product is manufactured in a traditional manner or in a manner appropriate to heritage conservation and in a non-industrial process for adequately renovating construction works officially protected as part of a designated environment or because of their special architectural or historic merit, in compliance with the applicable national rules”. This aspect is critical for the conservation of azulejo façades and should be taken into account, as azulejo facades may undoubtedly be considered of architectural and historic merit. Conservation actions in this case should therefore be seen as an exception to strict application of European Standards.



Figure 7 – Removal of mortars based on different binders

CONCLUSIONS

Azulejo are of extreme value in terms of Portuguese cultural heritage, a unique and colourful expression of identity. Due to their longevity and exposure, these façades are currently in need of urgent intervention. However, intervention techniques must take into account reversibility the direct application of current standards is therefore inadequate. A solution that takes into account this heritage and assures the quality of intervention is a path to be treaded in the near future.

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