Deterioration of the "Quinta Nova Torres Vedras" wall tile panel – an analytical approach

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Wall tile panels were commonly used in recreational open outdoors spaces in 18th Century noble houses I Portugal. The nature of their location and the lack of maintenance of such spaces, which lost their purpose during the 20th century, contributed to their natural deterioration. In order to preserve one such panel and facilitate the conservation treatment, it was removed from its location and transported to the facilities of the Polytechnic Institute of Tomar, Portugal.

Tile panel before the intervention

The interest in studying this particular panel was prompted by the advanced stages of deterioration observed in some tiles, where natural succession of biological colonisation and weathering were registered as some of the main deterioration causes. Furthermore, the advanced deterioration stages indicate that removal was a necessary action, as natural weathering would lead to its destruction.

The study involved a thorough analysis of the environmental characteristics of the wall placement, the wall materials themselves, the mortar, the ceramic body and the glaze. The methodologies used involved microscopic and laboratory testing to evaluate the extent of lichen colonisation and its influence in the loss of glaze and posterior deterioration of the ceramic body.

Results indicate that natural and environmental characteristics, combined with substrate typology and micro-organisms, contribute to accelerate the deterioration process, though appropriate techniques of preventive conservation can be used in specific panels or broader situations. This study will enable the development of innovative methodological and technical approach to the conservation problem here portrayed.

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1. Introduction

Loss of glaze and evidence of biological colonisation

Ceramic tiles have a traditional use that dates back to ancient civilisations; they can be found in a variety of settings in diverse cultures and structures, ranging from residential buildings to religious ones. The availability of the natural material (clay) that through a simple manufacturing process converts into a very durable, long-lasting, attractive and easy to maintain product, made tiles a particularly appreciated building element. However, each type of clay possesses a fingerprint of special properties including plasticity, hardness, colour and texture, which will affect the quality and durability of the end product.

The panel used in the current study was located in a central coastal area of Portugal, specifically in Casa da Quinta Nova, locality of Matacães in the municipality of Torres Vedras. The panel dates back to the 18th Century and was located in a recreational area, framed within a garden setting. The panel was the object of a conservation intervention which included mapping all the damage.

The panel set of tiles represents three mythological scenes, painted in blue over a white glazed surface and framed using a double bar. The first two scenes are the myth of Perseus and Andromeda and Apollo and Daphne, while the third scene represents the myth of Piramo and Tisbe.

The farmhouse Quinta Nova is currently classified as a building of municipal interest, and is part of an architectural set built or rebuilt in the late 18th century. The simplicity of the facades creates difficulties in dating it precisely, however the tile work of its interiors, clearly represents the late 18th Century.

The panel exhibits a stile attributed to the first quarter of the 18th century, and when confronted with a study of the original markings on the back of the tile referring to positioning within the set, it becomes evident that this particular set is not chronologically contemporary with the house: it is most likely that the panel was not designed for this particular site, and that it was a later addition.

The damage observed in the panel may be partly attributed to the neglect of the garden and exposure to the elements.

2. Conservation assessment

The process of conservation and restoration of the panel implied careful removal from its location after recording its condition. The methodology used dictated the removal of local vegetation that covered part of the panel, the labelling of every tile, the identification of the position within the set and the application of facing on the tiles. All work documentation was finalised in the laboratories of the Polytechnic Institute of Tomar. This type of procedure allows an overview of deterioration, extent and furthermore interpretation of possible causes.

2.1. Production flaws

Crazing, pitting, pin-holes, crawling, structural fissures and temperature fissures, were identified as production flaws. Crazing or dunting (as it is called when it occurs immediately after the firing process caused by rapid cooling due to the difference of dilation coefficients between the ceramic body and the glazing), is characterised by the

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formation of a pattern of tiny cracks or crackles in the glaze. This may also be caused by humidity (sometimes called moisture crazing), when after firing, the ceramic material dries to its smallest possible size, and subsequently expands as it absorbs moisture from the air. This causes the glaze to go into tension because of its lesser capacity for expansion than the porous tile body. Unless the cracks visibly extend into the porous tile body beneath the glaze, crazing should not be regarded as serious material flaw. It does however tend to increase the water absorption capability of the tile unit.

The surface of the glazing presented some concentration of small orifices identified as pitting: this flaw is usually caused by the high surface tension and viscosity of the glass that after cooling retains gas bubbles. Pin-holes are similar but characterised by their larger dimension.

Crawling was a less significant flaw on this panel, and was identified as areas of irregular shape, associated to the thickening of the borders, allowing the ceramic body to be left exposed. This flaw may occur as a result of fat matter on the surface of the ceramic body, excessive thickness of the glaze or of the area around a firing spot.

2.2. Degradation of tiles

Damage of the tiles included general losses, fractures, fissures, loss of glaze, glaze spalling, superficial deposits and stains, and finally biological colonisation.

The latter was extensive and occurred where the glazing was absent, which contributed significantly to the spread of the problem.

Pre-existing fractures and posterior detachment of the support mortar caused the total loss of tiles. Fissures were identified and attributed to the structural movements of the support. Some fissures were only identified during the removal work, resulting in the fracture of the tile.

Glaze spalling is present at the edges of the tiles exhibiting partial glaze loss. The development of micro-organisms is also associated with pores and loss of glaze.

In both forms of degradation the glaze is not lost, just detached from the ceramic body.

Anthropic damage was identified sparsely throughout the panel, mainly impact damage attributed to previous interventions.

Biological colonisation under the glaze

2.3. Damage to the panel

Problems caused by past conservation treatments are associated with material and support degradation. These types of damage extended to significant areas of the panel and compromise the understanding of deterioration causes, possibly leading to inadequate or unnecessary conservation interventions.

The most significant damage observed on the panel structure is the loss, misplacement or detachment of tiles, due to loss of mortar adherence, incorrect laying and vegetation.

The panel was set on a lime mortared rock masonry wall, exhibiting advanced deterioration features with loss of mortar due to poor adhesion to the rock support.

Also significant damage to the panel is the loss of tiles, with severe implications for the conservation process. Mortar deterioration is the direct cause of the detachment of the tiles. This factor did however allow the identification of their positioning and dismissed any suspicions of vandalism.

Misplacement of tiles is localised and limited to the area bordering the panel with tiles belonging to the same panel. However some tiles in other areas were identified as not belonging to the set. Both situations are common in repair works, reflecting lack of care and knowledge in the setting of tiles.

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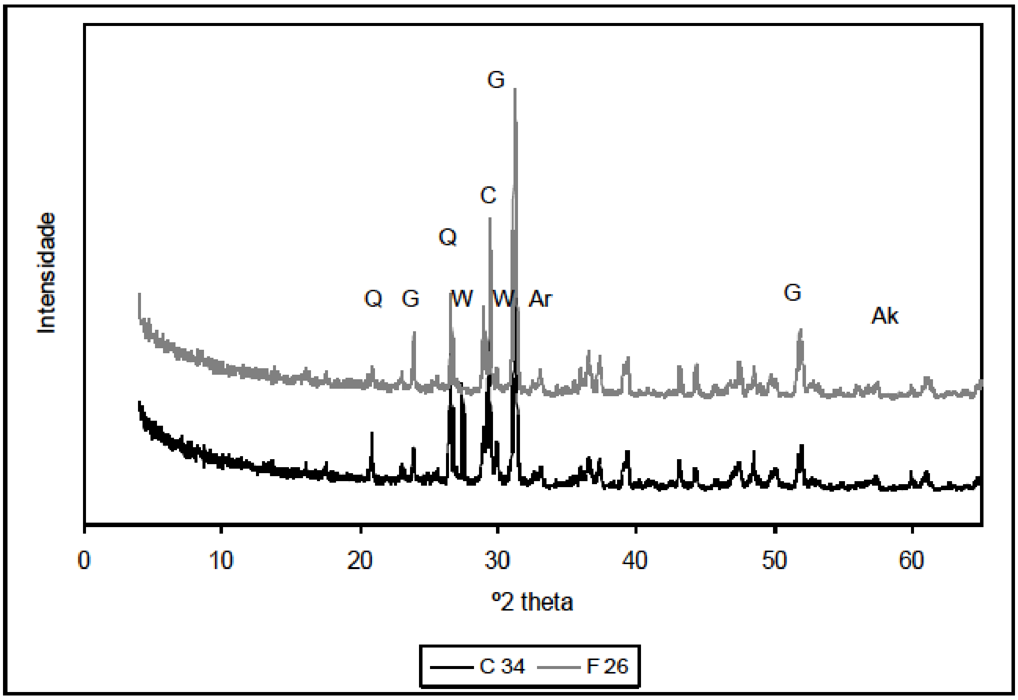
The thick vegetation covering the set contributed to the increased humidity of the whole panel wall and, specifically at ground level, caused the build-up of organic matter. The condition of the panel was considerably affected by the neglected state of the garden.

3. Material Characterisation

A mineralogical study was carried out using X-Ray Diffraction (XRD). The chemical data was obtained by wavelength dispersive X-ray fluorescence (WDXRF). Lost on ignition values (LOI) were obtained by heating samples at 1000 °C for 3 hours. The preparation of samples is the same one used for the XRD.

From the macroscopic observation of the ceramic body of the tiles it was possible to assume that the clay was roll-stretched over a wooden shape. Excess clay was removed possibly using a wire or a wooden tool. From the sand markings on the back of the ceramic body we established that the tile was placed onto a sanded board to dry.

Results obtained by DRX and FRX point to a faience of calcite composition, though the presence of high levels of Mg, corresponding to the crystalline phase akermanite in sample F26 when compared with sample C34 may indicate distinct productions. The presence of crystalline phases resulting from the firing process, gehlenite, wollastonite and akermanite, which are observed in both samples, indicates firing temperature of around 1000ºC. Crystalline phases result from high temperature transformations, essentially controlled by the elevated content of Silicon, Aluminium, Calcium and Magnesium (Si, Al, Ca, Mg).



X-Ray Diffraction of the samples C34 and F26, from the bar and panel respectively. Q – Quartz; G – gehlenite; W – wolastonite; Ar – aragonite; Ak - akermanite

The presence of aragonite and calcite, corroborates the thesis of free Calcium Oxide (CaO) deriving from the firing process or from lime mortar composition witch in both cases suffers posterior re-crystallisation. Aragonite is a metastable crystalline phase, as a result of situations associated with deterioration of these materials.

The glaze resulted decorated exclusively with blue cobalt colour.

4. Biological decay and deterioration

Biological deterioration of materials depends on the complex interplay between climate, chemical processes and biological processes, which in turn may be further complicated by new chemical elements arising from the combination of the chemical substrate characteristics, the biological colonisation and pollution factors.

Biological agents that contribute to tile deterioration include moisture, temperature, solar radiation, air movement, pressure, precipitation, chemical and biochemical attack and the intrusion of micro and macro-organisms. Deterioration caused by environmental factors is characterised by erosion, dissolution of material, chemical changes, volume change, porosity change and biological processes. Environmental deterioration was evident on the panel with biological damage identified as biofilms, lichens and plants.

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Biofilm formation follows sequential stages in which the initial attachment of planktonic bacteria to a solid surface is followed by their proliferation and accumulation as multilayer cell clusters. In the final stages of formation the bacterial community is enclosed in a self-produced polymeric matrix. Once the structure has developed, some bacteria are released into the liquid medium, enabling the biofilm to spread over the surface.

However, for the purpose of this study lichens were the main focus of the investigation. Following a preliminary observation of the whole panel it was decided to choose two tiles that were fully representative of the species abundance and diversity, labelled F1 and H3. The F1 tile exhibited near total loss of glaze, while tile H3 exhibited partial loss of glaze.

The procedure involved mapping of both tiles using a Geographic Resources Analysis Support System (GRASS GIS), which allowed calculation of the areas occupied by different elements. Lichen identification involved optical and stereoscope microscopic observation was confirmed with chemical spot tests.


Biological degradation on tile H3

5. Conclusion

It became evident that biological processes played a major role in the deterioration of the tiles. Lack of maintenance, exposure to the elements and overgrowth of vegetation, created the perfect conditions for the initial development of biofilms and consequent colonisation of lichens and vascular plants.

Obvious alteration of the mechanical properties led to permeability to water, which in turn led to the detachment of the glaze, exposing a perfect porous surface for further colonisation.

Naturally tiles exhibit flaws, deriving from several processes inherent to their production and final laying. These, together with the joints of any panel, represent entry points of contamination and the highway for deterioration of each tile, starting from the glaze to the ceramic body and even the mortar.

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