CONSERVATION AND RESTORATION OF TILED FAÇADES OF OVAR – THE COLOUR OF THE REPRODUCTIONS – THE TEORY AND THE PRATICE

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ABSTRACT

Due to the degradation and consequent lack of the glazes of the tiles presented in the façades of nineteenth century constructions of Ovar, or even their inexistence, the use of reproductions, made with the original decoration technique is required.

During the Project of Urban Reintegration (PRU), several façades were intervened and reproductions were made. To analyse and improve the colour of the reproductions colour measurements of nine different tiles were made (in a total of eighteen pieces, nine reproductions and equal number of originals), to perceive the differences and the similarities, and how to improve the reproduction work.

The most similar colour of a reproduction to a tile was a glaze (PRU 1 Pdr), and the most different was observed in the brown colour of pattern light of building PRU 2 (PRU2 Pdr light), even though visually a green (Pru 6 Pdr) is the one which is most different.

This study had the purpose not only to support the reproduction work but also to evaluate the visual impact of the variations between original colours and reproductions.

KEYWORDS: Glazed tiles, Ovar, colour, reproductions

1. INTRODUCTION

The use of glazed tiles in public façades in Ovar, a semi-industrial production, go back to the nineteenth century, associated with a migrant wave to and back from Brazil. This solution shows longevity, that feature is not only related with their quality, but also with interventions which focus on the improvement or stabilization of their good conservation, performed by ACRA (Atelier of Conservation and Restoration of Tiles, from the City Hall of Ovar). However, the exposure to the climatic and environmental agents of degradation takes its toll on the tiles, which causes the irremediable loss of some samples. In that case, in order to prevent risking the whole system, some tiles need to be replaced with reproductions. These, which in every way, try to follow the ethics of an intervention of conservation and restoration, at the same time have the requirement to be integrated visually in the façade.

2. WHEN REPRODUCTIONS ARE NEEDED

2.1. The forms of alteration

Ovar is a city where the tiled heritage has its constraints. First of all, it's present in the façades of vernacular constructions from the nineteenth century (Fig. 1), exposed to the urban environment and the climatic characteristics of a city nearby the sea (five kilometers). In this scenery, the most fragile part of the tile is the interface between the ceramic body and the glaze, which is most likely to be lost, conducting to the loss of the glaze itself. This is the most incident form of alteration in the tiles, and it's associated mostly with wetting-drying cycles and the crystallization of soluble salts and temperature variations, derived from phreatic water, soil and saline fog. When the loss overpowers the tile and removes it from its purpose is necessary to substitute it (1). The tiles have not only a decorative function but also protect the façade, function that are not fulfilled when the ceramic body is itself exposed.

Fig. 1 – *PRU 9, before intervention in the PRU program.*

2.2. Why reproductions?

The immediate need for reproductions is the inexistence of some pieces (Fig. 2), caused by loss over the years or robbery.

In other cases it has to do with the bad state of conservation of the pieces (Fig. 3). In some cases, the loss of glaze doesn't reach a high point, and the restoration is possible. In other cases, a reproduction is needed, since the restoration isn't viable for several reasons. The economic reason imposes, when the intervention is backed financially for the owners, as does common sense. To recreate a "glazed" surface using other materials brings the problem of the increase of time needed for intervention, the reduction of the lifetime of the intervention (since these materials most of the times are not prepared to face the exposure associated), and the creation of points in the façade with accentuated different behaviour characteristics which may lead to the increase of the degradation of the surrounding tiles (2) (3). The reproductions are, beholding this scenery, the best option, with affordable costs and bigger compatibility with the system, both materially and visually.

Fig. 2 – *PRU 1, showing a gap of tiles.*

Fig. 3 – *PRU 2, showing an extensive loss of glaze.*

2.2.1 The production

The reproductions, in terms of production, try to approximate the original ways of making, regarding the decorative process. Regarding the ceramic body it's used industrial bisque since it has proven good results, compatibility with the original tiles, and allows celerity in the interventions, opposed to craft production. To the decoration it's used the stencil technique, original from the nineteenth century and ceramic inks. The approximation to the colours of the original tiles, so needed to their integration in the façade, was achieved by years of work, through consecutive tests, and has in consideration the nuances to be found within the same façade. Since this resulted from an empiric knowledge, to achieve a structured method in the production, it was necessary to analyse the colours from the original tiles and the reproductions from a theoretical point of view to see where they collide and where they differ.

3. THE THEORETICAL COLOUR

To analyse the colour a group of façades was chosen, which were integrated in PRU 16 (Project of Urban Regeneration), a project that intervenes in tiled façades in need of an intervention of conservation and restoration, for several reasons, including the necessity of substituting tiles or filling the space of missing tiles.

A colorimeter (Konica Minolta CM-700d[1]) was used, according to the EN 15886, which uses the colour space L*a*b[2]. It was chosen three points for each colour (Fig. 4), and the measurement was done exactly in the same spots for both the original and the reproduction. The colour used for reference resulted from the average of the three values for L, *a, and *b. Even though this is the system closer to the human eye, it has its constraints, since it doesn't mimic the adaptation of the human eye to the source of light, and it doesn't take in consideration the Helmholtz–Kohlrausch effect[3] (4).

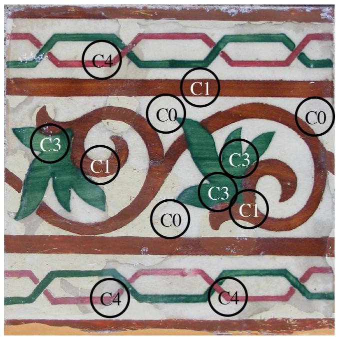


Fig. 4 – *PRU 6 Fr and the points of measurement.*

Once the measurements where made it was calculated de Euclidian distance (ED) between the colour of the original and the respective colour from the reproduction, to determine how different they were (Table 1 and Fig. 5). The results were analysed to see which colours were easily reproduced and if the results were cohesive with the visual perception (Table 2).

Table 1 – Euclidian distances between the colours of the original tiles and the reproductions.

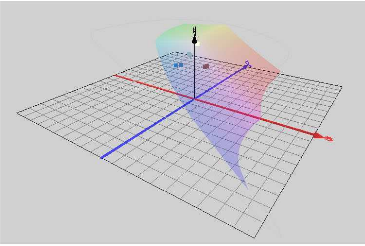
Colour / Tile	glaze	brown	dark blue	light blue	ochre	green	red	black	blue	pink
PRU 1 Fr	5.2	5.7	7.7	8.6						
PRU 1 Pdr	2.8	3.5	11.1	4.9						
PRU 2 Fr	9.8	4.6			18.3					
PRU 2 Pdr light	5.2	21,9			12.4					
PRU 2 Pdr dark	5.7	6.4			16.9					
PRU 6 Fr	6.5	5.4				13.5	3.5			
PRU 6 Pdr	5.0	8.6				7.3	4.6			
PRU 8 Pdr	5.0		8.3	9.0	18.3			12.8		
PRU 9 Pdr	5.2	4.1			4.5	8.9			20.8	6.2

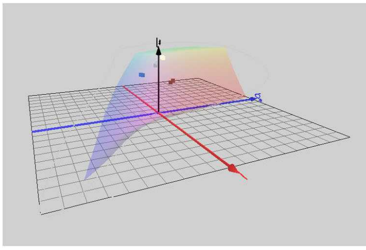
Caption ■ – ED lower or equal to 5 ■ – ED higher than 5, less than or equal to 10 ■ – ED higher than 10 _ - higher and lower ED values

[1] Specifications:
Illuminant – D65; Observer - 10° observer; Illumina tion/ viewing system - de: 8° (diffused illuminatio n, 8-degree viewing angle) and SCI (specular component included); Measurement/illumination area - MAV: Φ8 mm.
It was also considered as commercial factor (cf) 0.75 and the ratio of luminance and chroma (l, c) used to calculate the colour difference (CMC) was 1.5:1.

[2] Three-dimensional space model. L refers to lightness (from 0 to 100, respectively black and white), *a to a range of green (negative values) to red (positive values) and *b to a range from blue (negative values) to yellow (positive values). The advantage in the use of this colour space is its ability to mimic the human eye perception of colour.

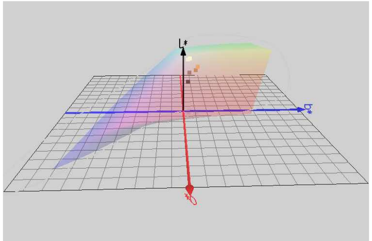
[3] Entropic phenomenon where the eye perceives saturation as luminosity. The higher the saturation the lighter the eye sees the object.

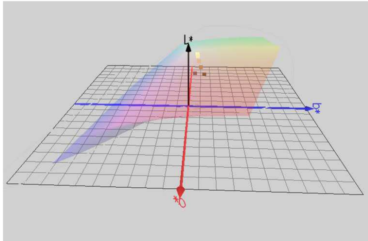


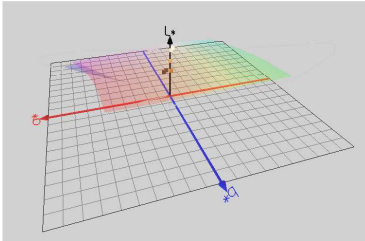


PRU 1 Fr

PRU 1 Pdr



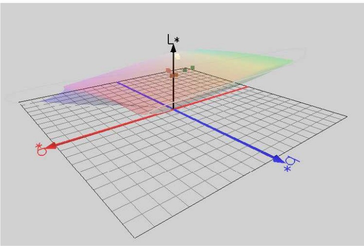


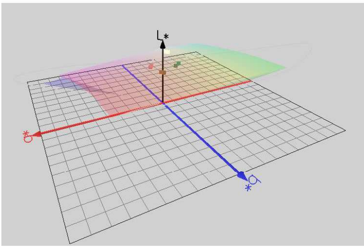


PRU 2 Fr

PRU 2 Pdr light

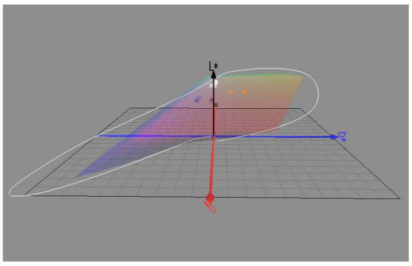
PRU 2 Pdr dark



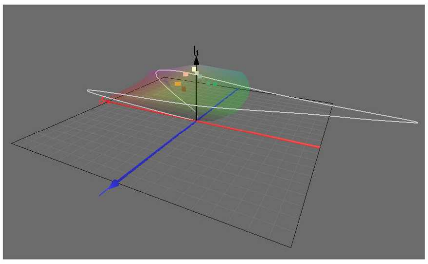


PRU 6 Fr

PRU 6 Pdr



PRU 8 Pdr



PRU 9 Pdr

Fig. 5 – *Representation of the colours on the L*a*b colour space.*

Table 2 – Colours of the originals (O) and the reproductions (R).

Colour / Tile		glaze	brown	dark blue	light blue	ochre	green	red	black	blue	pink
PRU 1 Fr	O										
PRU 1 Fr	R										
PRU 1 Pdr	O										
PRU 1 Pdr	R										
PRU 2 Fr	O										
PRU 2 Fr	R										
PRU 2 Pdr light	O										
PRU 2 Pdr light	R										
PRU 2 Pdr dark	O										
PRU 2 Pdr dark	R										
PRU 6 Fr	O										
PRU 6 Fr	R										
PRU 6 Pdr	O										
PRU 6 Pdr	R										
PRU 8 Pdr	O										
PRU 8 Pdr	R										
PRU 9 Pdr	O										
PRU 9 Pdr	R										

When it comes to ED's lower than 1, the human eye cannot percept the differences. Even if the colorimeter had captured it, it wouldn't be noticeable, which means that a colour doesn't need to have and ED equal to zero to show a good result.

The overall aspect it is also influenced by the original lack of uniformity - result from the production and different levels of susceptibility to agents of alteration, which appear in different tiles or even within the same tile - and the base colour, that is the most relevant to the general reading.

3.1 Glaze

Overall, the colour of the glazes turned out good (Fig. 6), with all of them with ED lower than 10. The one with the biggest difference (PRU 2 Fr) has much more luminosity in the reproduction, but the opposite still occurs, existing no rule for the differences.

Fig. 6 – *PRU 1 Pdr, the.glaze and brown with lower ED.*

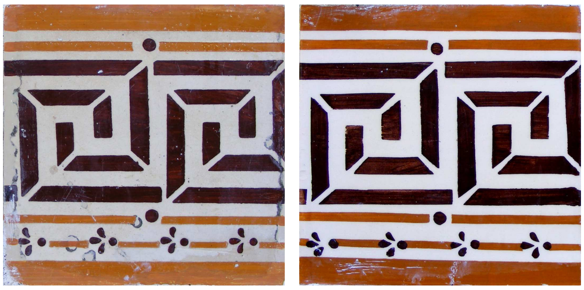


Fig. 7 – *PRU 2 Fr, the. glaze with higher ED.*

3.2 Brown

The browns of the reproductions have a medium quality. While some are good (Fig. 6), in others the variations are high, with an average between 5 to 10 ED. The worst result (Fig. 8) shows to much luminosity, and it's more yellow (higher L and *b values), in a tendency that remains, with the exception of PRU 6 (less luminosity and yellow) and PRU Fr (less luminosity).

Fig. 8 – *PRU 2 Pdr light, the brown with higher ED.*

3.3 Ochre

This is the most difficult colour to achieve, from the theoretical point of view. With the exception of PRU 9 (Fig. 9), all the reproductions present values between 12 and 18 (Fig. 10). The luminosity varies in an inconstant way (more or less), but they generally are more yellow and more red (higher b* and *a values than the original. Even though this difference is perceptive visually, overall it doesn't shows too much in the big picture.

Fig. 9 – *PRU 9 Pdr, the ochre with lower ED.*

Fig. 10 – *PRU 8 Pdr, the ochre with higher ED.*

3.4 Blue

The light blues are good (PRU 1 Pdr is the best), while the dark ones are harder to achieve (PRU 1 Fr is the best - Fig. 11 – and PRU 1 Pdr is the worst). They're generally less luminous, greener and less blue than the originals, with the exception of PRU 8 Pdr, that became more intense than the original. Pru 9 Pdr isn't taken in consideration for the analysis once the measuring point was very narrow and the measurement was contaminated by the adjacent colour of the glaze.

Fig. 11 – *PRU 1 Fr, the dark blue with lower ED.*

3.5 Red and pink

These are generally good, especially the reds (Fig. 12). The colour pink is usually less luminous, redder and less yellow, but with good visual results (PRU 9 Pdr). The red show less luminosity than the original.

Fig. 12 – *PRU 6 Fr, the red with lower ED.*

3.6 Green

The green is also a difficult colour to approximate in terms of numeric values, with DE between 7 and 13 (The best is PRU 6 Pdr - Fig. 13 – and the worst is PRU 6 Fr), but there is no standard in the way they differ, with all the values going up or down in the various combinations. However, visually, this is one of the colours with the best visual results, while integrated, even though the differences are perceptive.

Fig. 13 – *PRU 6 Pdr, the green with lower ED.*

3. CONCLUSION

From this analysis it is passible to conclude that even though the colours were achieved through empiric knowledge, this has proven very good results.

The easier colour to approach in numeric value is the glaze and the reds/pinks, along with the light blues, while the ochre is the hardest. The most different colour is the brown in PRU 2 Pdr light, with an ED of 22, and the most similar is the glaze in PRU 1 Pdr, with and ED of 3. Visually, the green in PRU 6 Pdr is probably the one who differs the most, appearing very dark. However, when we look at the reproductions the differences almost look insignificant once they're integrated in the façade since the original presents themselves variations in their colours, due to the quantity of ink applied, its dilution or the position of the tile in the oven during the firing.

The browns need to lose luminosity and to become bluer, the ochres need to lose warmth (becoming more blue and green) and the blues need to become bluer, while the reds and pinks could use more luminosity. The greens were the ones where no solid conclusions could be taken as a whole, but where the individual analysis can also brings directives to approach the colour of the reproduction to the original.

The biggest conclusion to withhold from this article is the possibility to improve the colours used to the reproductions through the theoretical analysis, understanding which way to go, regarding the luminosity (dictated by the amount of ink used and the dilution), and the range of colours from green to red and yellow to blue, adapting the colours to the closest result.

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5. REFERENCES

[1] RIBEIRO, Liliane Sardo. *Azulejaria de Fachada de Ovar - Formas e Agentes de Alteração.* Tomar : Instituto Politécnico de Tomar, 2011 [Master dissertation].

[2] FERREIRA, Luís Mariz. *El azulejo en la arquitectura de la ciudad de Oporto [1850-1920] Caracterización e Intervención.* Bilbau : Universidad del País Vasco, 2009 [Doctoral thesis].

[3] FERREIRA, Maria Isabel Moura. *Azulejos tradicionais de fachada, em Ovar, Contributos para uma metodologia de conservação e restauro.* Ovar : Câmara Municipal de Ovar, 2009.

[4] SCHANDA, János. *Colorimetry: Understanding the CIE System.* s.l. : John Wiley & Sons, 2007.

[5] WIDDEL, Heino, POST, David L. *Color in Electronic Displays.* s.l. : Springer, 1992.

[6] AGUIAR, José. *Cor e cidade histórica: estudos cromáticos e conservação do património.* Porto : Faculdade de Arquitectura da Universidade Porto, 2002.