

IDENTIFYING, QUANTIFYING AND ESTABLISHING REQUIREMENTS FOR CHANGES IN COLOUR OWING TO THE WATERMARKS IN CERAMIC TILES

**⁽¹⁾ E. Quinteiro, ⁽¹⁾ A. P. Margarido Menegazzo,
⁽¹⁾ M. Dias Caridade, ⁽¹⁾ R. de Cássia Buissa Netto,
⁽¹⁾ C. Gibertoni, ⁽²⁾ J. O. Armani Paschoal**

⁽¹⁾ CENTRO CERÂMICO DO BRASIL - Santa Gertrudes (SP) – Brazil -
quinteiro@ccb.org.br,

⁽²⁾ INSTITUTO DE PESQUISAS ENERGÉTICAS E NUCLEARES – IPEN – São Paulo
(SP) – Brazil

1. INTRODUCTION AND METHODOLOGY

By using data history of technical consultations at the *Ceramics Centre of Brazil*, a determining factor has been identified in recent years in claims made regarding the use of ceramic tiles, namely a pathology known as watermarks (WM). Watermarks or stains are a change of hue detectable by the human eye on the visible surface of ceramic tiles, especially glazed tiles, and are caused by water in contact with the clay body. This change in surface appearance may be permanent or temporary (when it dries, the original hue returns) and it most significantly affects light-coloured tiles.

The appearance of the pathology can be classified by discovering the source of the water causing the change of hue: water used to prepare the mortar, water in the substrate solution (leaks in the water mains or failure in wall and floor waterproofing system), or water from the tile fixing surface (which reaches the bottom of the glaze and penetrates through the grouting, tile cut, or even holes in the glaze layer).

The aim of this study was to determine occurrence of the phenomenon both in terms of quantity and quality, to reach as a final outcome a procedure for measuring watermarks and for establishing tolerance parameters for the chromaticity coordinates used in the CIELab system. Simulations were also carried out of possible situations that represented non-compliance with good working practice when preparing materials to create the ceramic tile bedding (bonding mortar used for tile laying and grouting) and when installing ceramic tiles. In that stage, a correlation was found between each of the tile installation procedures used and the appearance of watermarks (quantitative method).

2. RESULTS

The L^* , a^* , b^* chromaticity coordinates of the CIELab system were determined to quantify colour and hue change in a large number of products liable to watermarking. Once the tiles had been immersed in water, the results were matched against the qualitative values (observers detecting a pathology or not). The results show that the ceramic tile is responsible, of course, for the appearance of watermarks in situations in which the glaze does not fulfil its waterproofing function (holes in glaze).

Our study also revealed that ceramic tiles may vary significantly in their sensitivity to watermarking depending on the manufacturing procedure used (owing mainly to the formulation of the engobe and total firing time). The quantitative analysis used in this study to determine changes in the CIELab ΔE hue proved to be an insufficient method of predicting whether a product was liable to watermarks. For more detailed analysis, the individual ΔL^* , Δa^* and Δb^* parameters need to be assessed.

Depending on the specific features of each decorative ceramic piece, the scatter of the measured ΔE values can increase. To do so, a procedure needs to be created to standardise selection of the areas to be measured.

A significant observation was made with regard to those pieces that were moistened before being installed and then, as expected, revealed high ΔE values compared to the original hue. However, these pieces tended to recover their original hue upon drying, with ΔE values comparable to other situations 24 hours after being installed.

The watermarks that appear on the surface during tile installation have irregular shapes, unlike when they are immersed in water, where the colour stain is uniform across the immersed surface. This fact may relate to the coating of grouting mortar on the side of the tile. In that case, rough grouts and cut pieces displayed irregular behaviour patterns with regard to the appearance of water marks. When the bedded surface was wet, watermarks were observed on all tiles and the appearance of the areas near the grouting changed, albeit temporarily until eventually they dried.

When the bedded surface is moistened, there is a greater tendency for watermarks to appear in those products where the grouting was prepared with excess water. This can probably be explained by the increased permeability of the grout when excessively moist.

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