SELECTION OF INDICATORS OF GLAZED CERAMIC TILE BEHAVIOUR UNDER ABRASIVE WEAR

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1. INTRODUCTION

The study of the behaviour of materials in service, given by their performances, has acquired increasing importance in the last decades. In the case of glazed ceramic floor tiles, the possible action of wear, caused by pedestrian traffic, is the result of an abrasive mechanism.[4] The loss of material through this process can have two different interpretations: as a modification of surface appearance and as material removal itself.[5] The approach proposed in this work is the consideration that it is the perception of the deterioration which conditions durability, and not the existence of the phenomenon in itself.

An object's appearance can be defined in terms of gloss, colour and texture of the surface. Gloss can be measured with glossmeters or spectrophotometers. It can also be measured by visual parameters under well-defined conditions in relation to geometry and illumination. Colour evaluation systems can be divided into those that operate by visual comparison and those that seek a numerical quantification. Given the good human capacity for differentiating colours and the simplicity of the qualitative methods in terms of their instrumentation, the systems that work on the basis of observation have been widely used. Roughness can be characterised by means of roughness meters, or by light scattering. Roughness meters characterise a surface geometrically through profiles.

2. RESEARCH METHOD

The experimental work consisted of subjecting samples of glazed ceramic tiles to abrasion, and analysing the variations they underwent in terms of appearance, relative to the original state. As this study is part of a larger work[1], in which it is desired to vary the charge and type of abrasive material, it was decided to develop an own abrasion tester. In this apparatus, the samples enter into contact with the abrasive material through a rotating disk that acts by sweeping. The abrasive material used is a suspension of quartz flour in water.

The study variables have been distributed across various levels as follows:

- colour of the samples: beige (B) and brown (M);
- gloss of the samples: with gloss (C) and without gloss (S);
- test loads (ca): 5N, 10N, 15N, 20N and 25N;
- abrasive concentrations (co), in mass: 5%, 10%, 15%, 20% and 25%.

The experiments form a matrix of 72 combinations. Three tests were conducted for each combination, for varying times. The specular and diffuse reflections were obtained with a Minolta CM 508 D spectrophotometer. CWF (fluorescent F2) was used as an illuminator. As an overall indicator of the variation in colour, the parameter Delta E (ΔE) was calculated. Tile roughness was determined with a Mitutoyo Surftest 211 roughness meter considering the parameters: mean roughness Ra, and mean roughness Rz. The visual observation of the colour and gloss variations was performed in an observation chamber built in accordance with the geometric and lighting conditions set out in standards ASTM D 4449[3] and ASTM D 1729[2], respectively.

3. SELECTION OF THE RESPONSE VARIABLE

The experimental data corresponding to each response variable have been modelled with the help of the SPSS (*Statistical Package for the Social Sciences*, version 8.0) software. Equations were thus obtained that describe the behaviour of the materials under analysis, throughout the abrasive process, as shown in table 1, for the case of the visual analysis according to gloss.

The selection of the models that best represented the behaviour of the ceramic tiles was based on two conditions: coefficient of determination (R^2) > 0,5 and relative error (ER) < 25%. Table 2 shows that visual analysis based on gloss constitutes the only response variable of wide use for all the studied samples. It may be noted that visual analysis based on the geometric conditions related to the observation of colour displayed no important variations. Few samples exhibited any change in colour after abrasion.

Group	Model	Statistical Parameters	
BS	$f(x) = 0{,}122.\ ca^{0{,}444}.co^{0{,}263}.t^{0{,}38}$	$R^2 = 0{,}631$	ER = 14,1%
		MAE = 0,09	SIGN = 0,0000
MS	$f(x) = 0{,}142.\ ca^{0{,}3108}.co^{0{,}453}.t^{0{,}449}$	$R^2 = 0{,}919$	ER = 6,0%
		MAE = 0,04	SIGN = 0,0000
BC	$f(x) = 0{,}108\ ca^{0{,}846}.co^{0{,}568}.t^{0{,}461}$	$R^2 = 0{,}745$	ER = 16,5%
		MAE = 0,08	SIGN = 0,0000
MC	$f(x) = 0{,}173.\ ca^{0{,}495}.co^{0{,}394}.t^{0{,}395}$	$R^2 = 0{,}599$	ER = 17,5%
		MAE = 0,10	SIGN = 0,0000

Table 1. Models and statistical parameters that describe behaviour in the visual analysis based on gloss as a function of abrasive load, concentration and test time

Group	Specular reflection	Diffuse reflection	Delta E	Ra	Rz	Visual analysis according to the gloss
BS	▨		▨	▨	▨	▨
BC						▨
MS	▨	▨	▨	▨	▨	▨
MC		▨				▨

Table 2. Indication (through scratching) of the models with $R^2 > 0{,}5$ and ER < 25%

4. FINAL CONSIDERATIONS

It may be concluded that gloss is the most sensitive characteristic among the properties that define surface appearance for indicating the transformations that occur in the surface of glazed ceramic tiles subjected to abrasive wear. Among the ways of evaluating gloss, the human eye is the best instrument for identifying surface variations.

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