APPLICATION OF THE NORIE-LACER-LOPP MODEL FOR THE ESTIMATION OF THE USEFUL LIFE OF GLAZED CERAMIC TILES SUBJECTED TO ABRASION

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1. INTRODUCTION

The purpose of the NORIE-LACER-LOPP[1] model is to estimate the useful life of glazed ceramic tiles subjected to abrasion through accelerated tests. The model refers to the abrasion caused by freely moving pedestrian traffic, which corresponds to walking without a braking effect, and expresses wear based on the visual observation of gloss[2]. The model has been obtained from tests performed in the laboratory and measurements in the field, modelling the data with the help of the SPSS (Statistical Package for the Social Sciences) software. The real environment on which the field study has been based is a fast-food restaurant whose ceramic floor tiles showed wear. An abrasion tester1 has been used in the laboratory, in which abrasive load (ca) and concentration (co) values were set of 25N and 15%, respectively, representative of the aggressiveness of the restaurant. These values correspond to the indices ca = 1 and Co = 0.6 in the models.

2. DEFINITION OF THE EXPONENTS ASSOCIATED WITH ABRASIVE LOAD AND CONCENTRATION

In order to establish the influence of the abrasive load and concentration in the model, experiments were designed on 2 levels of colour, 2 levels of gloss, 5 levels of load and 5 levels of abrasive concentration. Table 1 details the numerical representation of the models obtained, the coefficient of determination (R^2), the mean absolute error (MAE), the relative error (ER) and the significance of the model (SIGN). Group BS corresponds to beige samples without gloss; BC, beige with gloss; MS, brown without gloss and MC, brown with gloss.

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

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

Assuming that the influence of the aggressiveness parameters is the same in any type of ceramic tile, the exponents to which load, concentration and time are raised must be the same for any group of ceramic tiles. Thus, the models presented in table 1 were fitted in the SPSS program, raising t to 0,5, taking into account the behaviour identified in the fast-food restaurant[1]. After the models had been fitted, the respective mean values obtained for the four groups, shown in table 2, have been adopted as exponents for the abrasive load and concentration.

Group	Model	Statistical Parameters	
BS	$\Delta Vis_l = 0{,}06017.Ca^{0{,}6}.Co^{0{,}5}.t^{0{,}5}$	$R^2 = 0{,}543$	ER = 23,3 %
		MAE = 0,10	SIGN.= 0,000
MS	$\Delta Vis_l = 0{,}0766.Ca^{0{,}6}.Co^{0{,}5}.t^{0{,}5}$	$R^2 = 0{,}847$	ER = 15,2 %
		MAE = 0,07	SIGN.= 0,000
BC	$\Delta Vis_l = 0{,}0951.Ca^{0{,}6}.Co^{0{,}5}.t^{0{,}5}$	$R^2 = 0{,}697$	ER = 18,0 %
		MAE = 0,08	SIGN.= 0,000
MC	$\Delta Vis_l = 0{,}132.Ca^{0{,}6}.Co^{0{,}5}.t^{0{,}5}$	$R^2 = 0{,}563$	ER = 16,8 %
		MAE = 0,10	SIGN.= 0,000

Table 2. Fitted models and statistical parameters that describe wear behaviour in the visual classification for groups BC, BS, MC and MS

3. APPLICATION OF THE MODEL TO GROUPS: BS, BC, MS AND MC

Replacing the variables ca and co in the models in table 2 with the values corresponding to the different aggressiveness conditions representative of actual service conditions yields the variation of the resulting appearance of wear in the laboratory, for each group. When *t* is replaced with *tr/0,0132*, which is the acceleration factor of the fast-food restaurant[1], the behaviour in the field can be estimated for freely moving pedestrian traffic, measured in million people.

When the behaviour of the tiles corresponding to the case study and the behaviour of the tiles belonging to the studied groups are compared, a significant difference can be observed. Figure 1 shows the evolution of wear for the aggressiveness condition of the fast-food restaurant. For example, after 60 minutes' testing or the traffic of 792,000 people, the tiles belonging to the case study are expected to reach the visual class 0.19, whereas the tiles belonging to groups BS, MS, BC and MC undergo greater wear, reaching, respectively, visual classes 0,36; 0,46; 0,57 and 0,79.

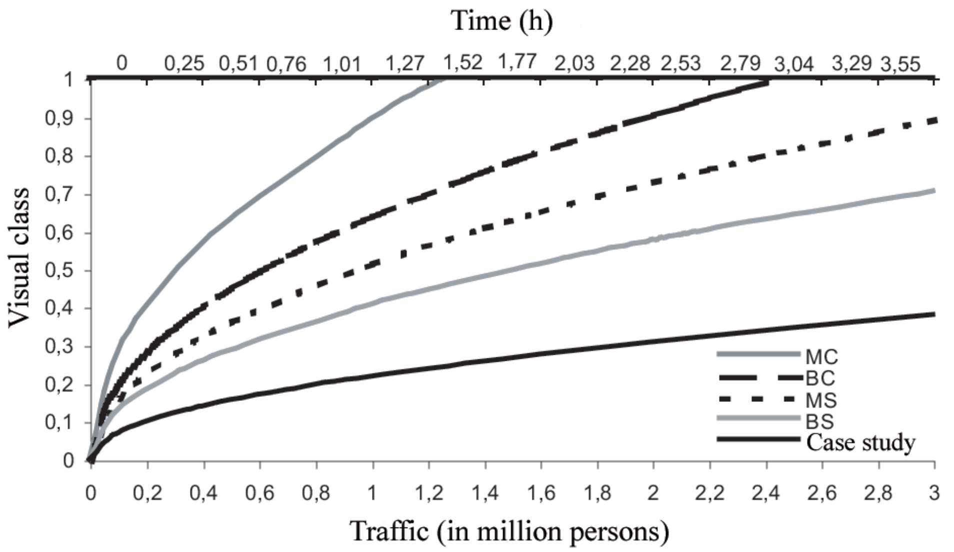

Figure 1. Plot of the behaviour of the tiles of the case study and of groups BS, MS, BC and MC

4. FINAL CONSIDERATIONS

In this study, it has been demonstrated that the useful life of glazed ceramic tiles, subjected to abrasive wear by pedestrian traffic, can be estimated by a mathematical model. The model has been developed based on the characterisation of the aggressiveness conditions found in a real environment and on the visual analysis of the pieces that underwent wear, in comparison with the results obtained in the laboratory from accelerated tests.

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