

## DURABILITY OF POLISHED GLAZED TILES

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### ABSTRACT

The production of glazed ceramic tiles with polished surfaces has increased considerably in Brazil. Such popularity is thanks to their high gloss and low roughness. However, glazes have closed pores in their microstructure that may not be removed during firing. The porosity of the glaze becomes naturally exposed at the surface during polishing. Despite many recent technological advances in polishing and surface finishing operations, we still have scant knowledge on how long surface treatments last and what influence the characteristics of the glaze play. The aim of this work was to develop a method to assess the durability of polished glazed tiles, and to compare how glazed tiles polished with different technologies perform and how the glaze characteristics influence lapping. The study was divided into two stages.

The first stage consisted of assessing 6 polished glazed ceramic tiles, three made of semi-stoneware and three made of porcelain stoneware. The polished surfaces were aged by chemical and abrasive degradation. Subsequently, the pieces were characterised by loss of gloss. The results showed that polished glazes are easily damaged by mechanical abrasion, especially semi-stoneware products fired at low temperatures. The second stage of the work sought to reduce mechanical degradation of the glaze on one of the porcelain stoneware tiles by adding different proportions of quartz to the glaze composition, in order to increase its mechanical durability and preserve its resistance to chemical attack. The study demonstrated that tile gloss loss from chemical and mechanical ageing is determined by the characteristics of the glaze used in the top layer.

## 1. INTRODUCTION

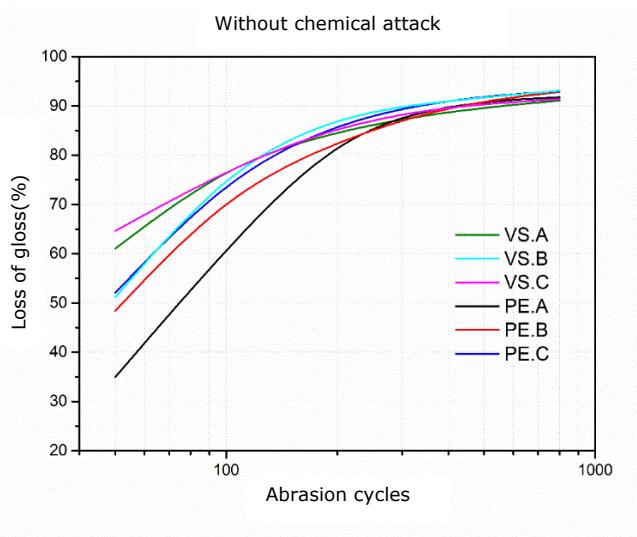
Polished glazed tiles are very popular among consumers for their high gloss and smoothness [1]. To achieve such aesthetic characteristics, the tiles are subjected to a lapping process. Although lapping improves their aesthetic characteristics, the closed glaze porosity that could not be removed by firing is exposed during that polishing process by the abrasion it undergoes. Therefore, polishing can affect both technical and aesthetic characteristics [1,3]. Some researchers have studied that effect on polished porcelain stoneware and the importance of applying a surface treatment to waterproof and protect those exposed surfaces [1,3]. However, in the case of polished glazed tiles, very little information exists as to the durability of the surface characteristics and the influence of the glazes. For that reason, the aim of this study was to develop a method that would allow the durability of polished glazed tiles to be assessed and the performance of glazed tiles polished with different polishing technologies and the influence of glaze characteristics in the lapping process to be compared.

## 2. MATERIALS AND METHODS

The research was divided into two stages: the first consisted of studying six different polished glazed tiles produced with different industrial polishing processes and surface treatments. Three were semi-stoneware glazed tiles (VS.A, VS.B, VS.C), and the other three were glazed porcelain stoneware tiles (PE.A, EP.B, EP.C). The durability of their polished surfaces was assessed under different conditions of accelerated ageing by chemical and mechanical degradation (UNE standard 138001:2008 [4]). The second stage of the research consisted of selecting one of the polished glazed tiles and adding different proportions of quartz to the glaze composition used in glazing it, and then, after lapping, to also assess test tile durability under varying conditions of accelerated ageing by chemical and mechanical degradation. Two amounts of quartz were added to the glaze, the first being 6% quartz #200 (PE.6Q) and the second 8% quartz #200 (PE.8Q). This was intended to increase resistance to abrasive wear.

### 3. RESULTS AND DISCUSSION

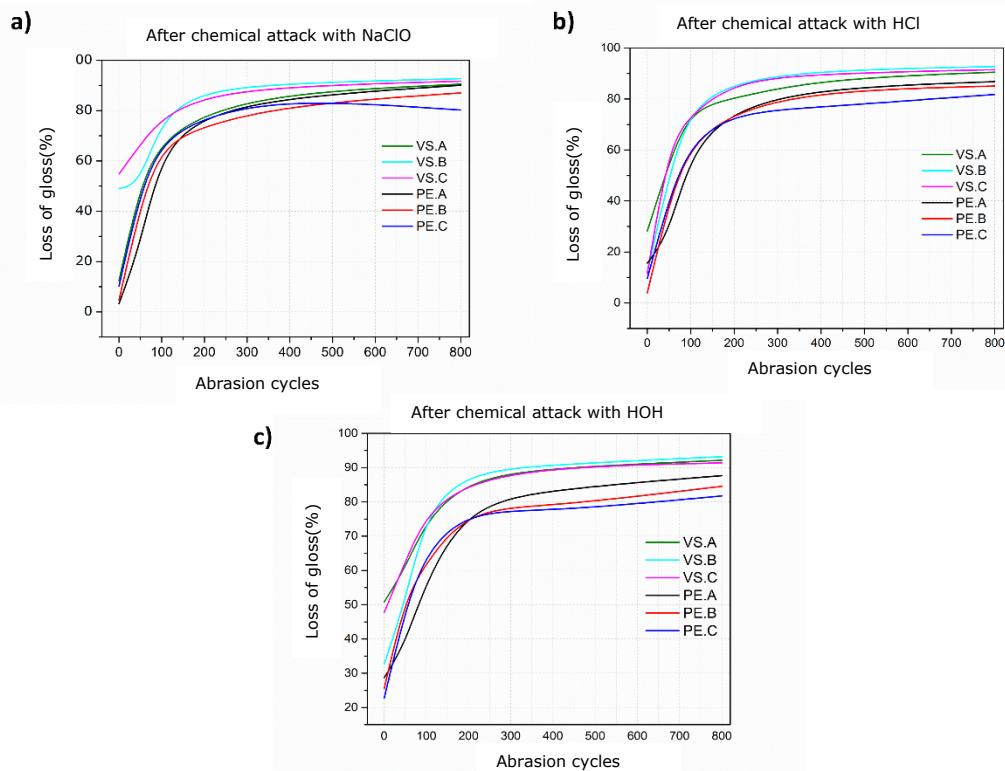
Figure 1 shows the resulting loss of gloss on the surface of the glazed semi-stoneware and glazed porcelain stoneware tiles subjected to abrasive wear and assessed in the various cycles.



**Figure 1.** Loss of gloss due to abrasive wear

At  $\leq 100$  cycles, the glazed porcelain stoneware surfaces were seen to exhibit better mechanical performance than the semi-stoneware tiles. As the abrasion cycles increased, the loss of gloss on both types of surfaces becomes more similar.

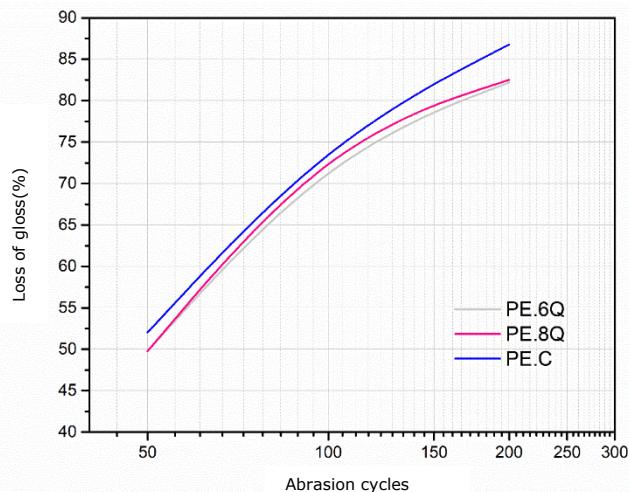
Figure 2 depicts the loss of gloss on glazed semi-stoneware and porcelain stoneware surfaces subjected to abrasive wear and chemical attack using different chemical solutions. At 0 abrasion cycles, the curves reflect the loss of gloss due exclusively to chemical attack. From the results of chemical attack without abrasion, a significant difference can be seen between the polished glazed surfaces of the semi-stoneware tiles compared to those of the porcelain stoneware tiles. This result is closely related to the physical and chemical characteristics of the glazes used in the two types of ceramic tiles. In the tests with combined mechanical and chemical degradation, the loss of gloss seen on the semi-stoneware surface from the different chemical reagents - NaClO (Figure 2a), HCl (Figure 2b), and KOH (Figure 2c) - is significantly higher than that for the porcelain stoneware tiles, and the effect of the KOH solution was seen to be the strongest.



**Figure 2.** Loss of gloss due to abrasive wear and chemical attack with:  
a)  $\text{NaClO}$ , b)  $\text{HCl}$ , and c)  $\text{KOH}$ .

For the second stage, the PE.C porcelain stoneware tile was selected, since of the three porcelain tiles tested, it was the one with the highest loss of gloss due to abrasion. When only mechanical degradation was applied, the number of work cycles was only up to 200.

Figure 3 shows the loss of gloss on porcelain stoneware surfaces with the quartz additions to the glaze and the original PE.C with no quartz addition. PE.6Q and PE.8Q exhibited the lowest loss of gloss compared to that of the PE.C tile, with the biggest difference being found at 200 cycles.



**Figure 3.** Loss of gloss from abrasive wear on porcelain stoneware tiles PE.6Q, PE.8Q and PE.C.

#### 4. CONCLUSIONS

Glazed porcelain stoneware tiles perform better in terms of mechanical and chemical degradation than ceramic tiles of the semi-stoneware type, made with glazes fired at lower temperatures and faster cycles. When the porcelain stoneware tiles were compared with each other under combined chemical and mechanical degradation tests, the loss of gloss noted on all three products was similar amongst them. When the full set of results is assessed, the PE.C tile is seen to perform very well in terms of chemical resistance. However, with regard to abrasive wear, there is room for improving this tile's ability to preserve its gloss against mechanical degradation. For this reason, the microstructural characteristics of the glaze were altered. The results obtained when quartz was added to the porcelain stoneware glaze show that gloss loss decreased, assuring greater durability of the polished glazed tile. In view of the results of resistance to abrasive wear and chemical attack, it is fair to say that one of the main variables to be considered or analysed when assessing the durability of polished glazed tiles is the glaze, since the top coat is the one most directly affected by use.

## REFERENCES

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