DETACHMENT OF CERAMIC TILES: FACTORS WHICH INFLUENCE ADHESION

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1. ABSTRACT

Detachment of ceramic tiles occurs when stresses which appear in the system are greater than the adhesion capacity of the layers. The aim of this paper was to assess the main factors responsible for detachment. The results showed that the bedding method was the most predominant variable.

2. INTRODUCTION

One of the pathologies of ceramic tiles is detachment. Detachments are characterized by a loss of adhesion of ceramic tiles to the gripping mortar. This pathology occurs when the stresses which arise in the system exceed the adhesion capacity for the connections between the tile and the mortar and/or the wall plaster. There are several factors which cause detachment of ceramic tiles, within which are to be found structural problems and/or the use of unsuitable ceramic tiles.

The aim of this paper is to evaluate the main factors responsible for the detachment of ceramic tiles after being installed in internal environments and to propose solutions to minimize this pathology.

3. MATERIALS AND METHODS

Ten commercial products were selected which were classified according to water absorption, moisture expansion and chemical and mineralogical composition. These products were then installed on pattern concrete substrates with approximate dimensions of 50 x 25 x 4 cm^3: The variables assessed were the mortar, bedding method and accelerated ageing.

- Nature of mortars: bedding was done with three commercial ACI, ACII and ACIII.
- Nature of bedding: pieces were bedded using two different installation procedures: simple and double bonding.
- Accelerated ageing: tensile adhesion strength measurements were conducted after 28 days from the curing of the mortar and after 30 and 90 days of accelerated ageing.

Bedding using simple bonding seeks to simulate installation practices used in the field. The test pieces were place on the spread mortar and a pressure of 20 gf/cm^2 was applied for 30 s. Bedding using double adhesive was carried out in accordance with ISO 13007-2:2010 standard and its objective is to promote greater interaction between the substrate, the mortar and the ceramic tiles. The mortar is spread on the pattern substrate and on the back of the test pieces of ceramic tile. Then these were bedded on the strips of mortar applied to the substrate and a pressure of 80 gf/cm^2 was applied for 30 s. The difference between the two methods used goes from the minimum to the maximum possible adhesion performance, when scarcely the technique/quality of installation was changed.

The pull-off tests were carried out using a traction test, with a speed of load application of approximately 250 N/s and using metal devices which do not deform the adhesive on the surface of the ceramic tiles. After pulling-off and separating the ceramic tiles, the tensile adhesion strength values were calculated using as a basis the force applied in the test and the dimensions of the test pieces used. Furthermore, in each case, the contact surface of the system on which the breakage occurs was recorded. Tensile adhesion strength measurements, performed using the procedures described, were conducted after the following curing/ageing conditions:

- 28 days after bedding: the tiles remained in a horizontal position during this period of time at laboratory ambient temperature.
- 30 days after accelerated ageing: when the 28 days of curing described had elapsed, a part of the substrate sets (mortar, ceramic tile) was subjected to a cyclical procedure of accelerated ageing comprising the heating to 70 °C in an electric oven for 24 hours, followed by immersion cooling in a tank of water at ambient temperature for 48 hours. This first set was subjected to 10 cycles of this kind, resulting in a period of accelerated ageing of 30 days. The ageing procedure seeks to accelerate the degradation process of the mortar as well as the moisture expansion process of the ceramic tiles.
- 90 days after accelerated ageing: another part of the ceramic tile-mortar-substrate set was subjected to a total of 30 cycles of heating/ cooling under

the same conditions described earlier, which makes a total of 90 days of accelerated ageing.

4. RESULTS AND DISCUSSION

The sampling of products carried out was quite wide, considering that variations in water absorption between 5.6 % and 15.3 % were found. All the products presented moisture expansion values (EPH_{ISO}) lower than the limit recommended by the standard of 0.60 mm/m. The average pull-off strength values of the ceramic products installed using simple and double bonding (considering the three mortars used) were 0.12 and 1.8 MPa, respectively. Although products with different porosities and technical characteristics were employed, the results were little influenced by the nature of the ceramic products. In the case of the bedding using the simple bonding method, tensile adhesion strength of the products bedded with ACIII mortar was, on average, 600 % higher in comparison with the strength obtained by the other two mortars. However, in no case was a tensile adhesion strength greater than 0.5 MPa using the simple bonding procedure after 28 days from curing. The average value of the products bedded using double bonding with ACI mortar presented a tensile adhesion strength 2500 % greater compared to the products bedded using simple bonding. This number is even higher (5800 %) in the case of the products bedded with ACII mortar and also quite significant (730 %) in the case of products bedded with ACIII mortar. A summary of these results is presented in figure 1. The accelerated ageing method used caused an average reduction of 20 % in wrenching strength of the products bedded with ACI and ACII mortars and 15 % in the wrenching strength of the products bedded with ACIII mortar. Apparently, moisture expansion of the plates did not seem to be a determining factor for the reduction of adhesion experimented by the system as a function of ageing.

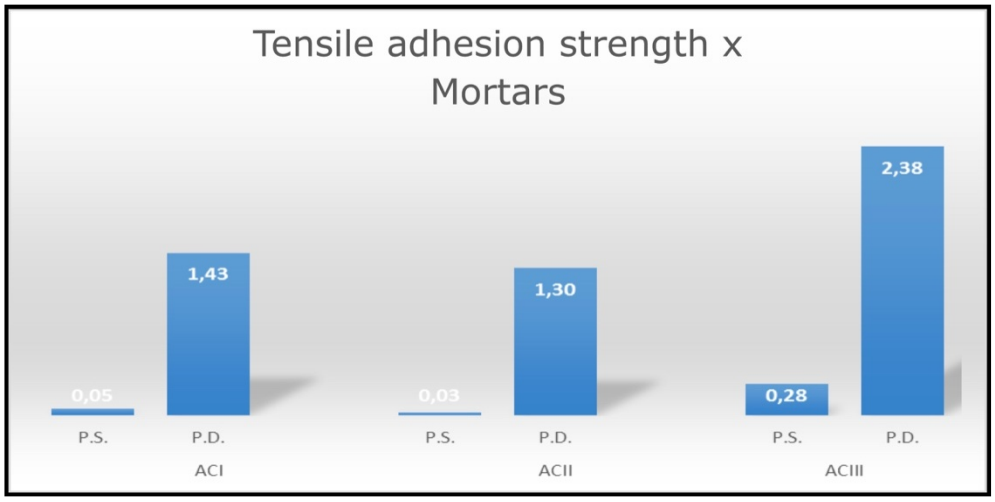

Figure 1. *Tensile adhesion strength 28 days after curing.*

5. CONCLUSIONS

Among the variables studied bedding conditions significantly affected adhesion. After 30 days of accelerated ageing, the products presented significant average reduction in tensile strength and that reduction is even more considerable after 90 days of accelerated ageing. The results obtained indicate that moisture expansion of the tiles was not a decisive factor in adhesion reduction experimented by the system as a function of ageing. This statement is based on the fact that the reductions found in the average adhesion strength values are relatively homogeneous for the same accelerated ageing times, that is, they were not affected by the different moisture expansion of the products assessed.

6. BIBLIOGRAPHICAL REFERENCES

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