ASSESSMENT OF ADHERENCE RESISTANCE DRAINING OF INDUSTRIALISED STRAINED MORTARS WITH THE INSULATION OF HYDRATION STABILISER

Elaine Manenti Soares [(1)]; Gabriel Cemin [(1)]; Humberto Ramos Roman [(2)]; Elaine Guglielmi Pavei Antunes [(1)]; Adriano Michael Bernardin[(3)];

[(1)] GPDEEC – Universidade do Extremo Sul Catarinense

[(2)] GDA – Universidade Federal de Santa Catarina

[(3)] UNESC – Ceramic Materials Group, University of the Extreme South of Santa Catarina, Criciúma, Santa Catarina, Brazil

1. ABSTRACT

Pathological manifestations in ceramic coatings are becoming more frequent in civil construction. Detachments are considered the most serious problems due to the high cost of repair and the risk of accidents. The performance of such coatings is mainly related to adhesion, which in turn is directly associated with planning, materials used and execution. The present work aims to evaluate the adhesion of ceramic plates seated with industrialised adhesive mortar with insertion of different percentages of hydration stabilising additive. Tensile strength tests were performed using an industrialised adhesive mortar type I (AC I), a ceramic plate of the BIIb group and a hydration stabilising additive in different proportions for the production of the system (substrate / mortar / ceramic plate) using the open time of 20, 25 and 30 minutes in normal healing. Results indicated that the insertion of hydration stabilising additives in the composition of industrially bonded mortar in normal curing time is impracticable.

2. INTRODUCTION

Façades of buildings (such as buildings, houses and other types) are more exposed to the elements (such as solar radiation, humidity, temperature, wind, rain, abrasion, impact and soil moisture), which have aggressive agents that reduce the life of façade coatings.

According to Pereira (2010), the protection of coatings is associated with the durability of structural elements and fences, since they avoid the direct action of aggressive agents on the surfaces of buildings. The protection promoted by the coatings has the basic feature of better preserving structural and wall-sealing properties.

The ceramic coating should be treated as a system, which includes the ceramic coating set (ceramic plate, adhesive mortar and grout mortar) and all layers prior to the base. Thus, it has the abilities of adhesion, mechanical resistance, and capacity to absorb deformations, among others.

Brazil is the second largest consumer of ceramic tiles worldwide and the second largest producer. Each day, the quality and variety of this material increases. In the same measure, the use of ceramics in Brazil grows to cover the floors and walls of all internal spaces of the house, as well as external spaces.

Ceramic coatings, in addition to their advantages and proven durability over the centuries, have those qualities that advanced technology has given them. They are suitable for small details, indoors or for large outdoor scales. They are offered in a way that satisfies the most varied tastes and textures.

One of the points that must be rigorously controlled during the execution of the ceramic coating system is the monitoring of the open time of industrialised sticky mortars, since overcoming this time can be a possible cause of less resistance, and thus cause displacement.

The objective of this study was to evaluate the adhesion strength of the type I - ACI adhesive mortar, added with a hydration stabiliser, in open times of 20, 25 and 30 minutes.

3. MATERIALS AND METHODS

For the tests, a type of adhesive mortar was used, more specifically ACI, and a type of ceramic plate. The ceramic plate belongs to the group BIIb, classification according to ABNT NBR 13817: 1997, according to the absorption group of the ceramic plates.

The tensile strength test is performed according to the specifications of ABNT NBR 14081-4: 2012, and for this, three mortar proportions are used. The first refers to the reference mortar (AREF) without additive, and the two other proportions refer to the proportions with insertion of the hydration stabilising additive, called A5 and A8 (0.5 and 0.8%, respectively, of the increased amount). The adhesion strength test was done for three open times: first at 20 minutes, second at 25 minutes and third at 30 minutes.

The materials and their respective characteristics are listed below in more detail.

Standard substrate was purchased from ABCP (Brazilian Portland Cement Association).

Parameters	Volume of Water Absorbed in 4 Hours	Surface Tensile Strength (MPa)
Specification of NBR 14082:04	<0,5 cm^3	≥2,0 MPa
Average value	0,45 cm^3	2,0 MPa

Table 1 *- Characteristics of Standard Substrate*

Board Type	Water Absorption (%)	Thickness (mm)	Mechanical Resistance to Flexion (MPa)	Expansion by Humidity (mm/m)
Semi-porous	6 to 10	7.4	>18	≤0.6

Table 2 *- Characteristics of Ceramic Plate*

Physical Appearance / Color	Recommended Dosage (%)	Specific Mass (g/cm^3)	Solubility	pH
Liquid, green colour	0.1 to 1.2	1.180 – 1.240	Fully soluble in water	11.5 to 13.5

Table 3 *- Characteristics of Hydration Stabiliser Additive*

4. PREPARING THE SYSTEM

Laboratory conditions during preparation were a temperature of 24°C and relative humidity of 56%.

The preparation of mortars followed the procedure adopted by technical norm NBR 14082: 04. After the quantitative measurement of the materials to be used, mixing was started by pouring the water into the mixer and then the dry material was added continuously in 30 s. The mixer was turned on at low speed to mix the components for another 30 s. The apparatus was disconnected and scraped from the blade of the mixer and its vessel in time intervals of 60 s. The container was put back into the mixer for another 30 s. The mixture was left in maturation time for 15 minutes with a damp cloth on top, and before using the mortar, the apparatus was turned on again so that it was mixed for another 15 s, obtaining a homogeneous paste, as represented in Figure 1.

Figure 1 *- Preparation of mortar - Criciúma SC.*
Source: Author

After finishing the preparation of the mortar, the consistency index test was carried out according to the norm NBR 13276: 2005. The reference mortar, added with 0.5% and added with 0.8%, obtained, respectively, the consistency index of 23 cm, 23 cm and 24 cm.

Figure 2 *- Consistency index - Criciúma SC.*
Source: Author

Ceramic plates with dimensions of 5 cm x 5 cm were seated in standard plates according to the determination of the technical norm NBR 14084: 04, which determines that ten clean and dry ceramic plates are placed on the mortar, extended in cords, so that there is a distance of 5 cm between them, and 2.5 cm between the edges of the plates and the edge closest to the standard substrate. Each plate was loaded and centred with a standard weight of 2 kg for 30 s.

Figure 3 *- Cord preparation - Criciúma SC.*
Source: Author

During 28 days, substrates were in normal laboratory cure, with an average temperature of 24°C and 59% relative humidity.

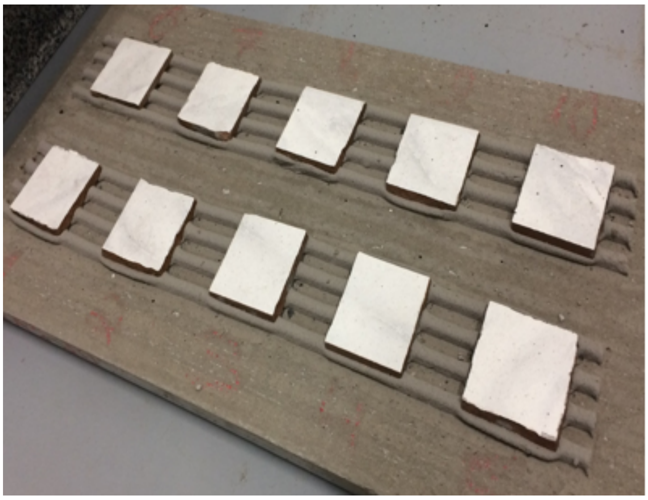

Figure 4 *– Seated plate*
Source: Author

Metal plucking pieces, which have the same dimensions as the ceramic plates, were glued to each plate distributed on the substrate. This was done three days (72 hours) before the tear-off test, making the bonding with epoxy adhesive so that their surfaces would overlap.

Finally, with the use of a dynamometer with a capacity of 5 kN and a speed of 250 ± 50 N/s, the tensile pull-out test was performed, following this step according to the technical norm NBR 14084: 04. In the test, the indicated value refers to the maximum tensile force exerted to start the plate, that is, at the moment of rupture.

During the test, the ruptures were analysed and classified according to their typology, being: A, rupture at the interface ceramic plate / adhesive mortar; B, rupture inside the adhesive mortar; C, interface mortar interface / substrate rupture; D, rupture inside the mortar of the substrate; E, substrate / base interface rupture; F, rupture inside the base; G, interface chip / glue rupture; and H, break in the glue / ceramic plate interface.

***Figure 5** – Test the ruptures analysed.*
Source: Author

5. RESULTS AND DISCUSSION

Data on the tests performed and their respective resistances obtained are bellow.

Assayed Mortar	Consistency Index (cm)	Open Time (min)	Medium Resistance (MPa)
Reference mortar	23	20	0.507
		25	0.411
		30	0.510
Mortar 0.5% additive	23	20	0.290
		25	0.318
		30	0.192
Mortar 0.8% additive	24	20	0.168
		25	0.252
		30	0.214

***Table 4 -** Test Data*

Analysing the obtained data, it is understood that the insertion of the hydration stabilising additive dramatically affected mechanical tensile strengths in most of the tests carried out, where a resistance ≥0.5 MPa is normally required.

In the reference mortar, there was predominance of type A rupture for open times of 25 and 30 minutes, and of type B for that of 20. For the mortars added, the predominance was type B rupture in all open times.

As for the reference mortar, we can see that the larger the open time, the higher the evaporation rate of the water on its surface, because it gave a smaller amount of water required for the later absorption of the ceramic plate.

As for the mortars added, the additive for the necessary amount of water for the late absorption of the ceramic coating, in contrast, drastically affected mechanical resistances. Such a problem can be derived from the chemical composition of the additives, which have high concentrations of sugars and organic salts in their composition. These compounds affect the hydration of cement, retarding it by virtue of being a plasticising additive, and resulting in a greater time for evaporation of the water contained in the mortar and thus, reducing mechanical resistance and incorporation of air.

6. CONCLUSION

With the data obtained in the tests, we can conclude that water evaporation, water absorption variation in a ceramic plate and the significant amount of chemical additives added during the preparation of a bonding mortar influence each mortar's tensile strength values in normal cure time.

However, these are not the only factors which influence mortar resistance change. There are several other factors that affect these properties according to the environment in which it is being prepared and exposed to the ceramic plate in the initial times of cure, such as the presence of water, drastic changes in temperature, air humidity, wind speed, and other intrinsic properties.

It is then understood by the study that the insertion of a hydration stabilising additive into industrialised sticky mortars became unfeasible, since it reduces mechanical tensile strengths due to the chemical reactions of the additive during the hydration of cement.

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