BOND STRENGTH AND MICROSTRUCTURAL EVALUATION OF CERAMIC TILES INSTALLED WITH DOUBLE-FACE ADHESIVE SHEETS IN COMPARISON WITH DRY-SET MORTAR SYSTEMS

Otávio Luiz do Nascimento[1]; Alexandra A. Piscitelli Mansur[1]; Herman Sander Mansur[1]

(1) Federal University of Minas Gerais, Brazil

1. INTRODUCTION

There is in the Brazilian market an innovative product for installing ceramic tiles. This product is based on a double-face adhesive sheet. According to the manufacturer, it could be used for any type of tile and for interior and exterior environments. It is also recommended as an alternative for retrofitting. However, as it is a new product without any related Brazilian standard, there is a concern about its use, mostly because of the various pathologies observed when dry-set mortars were introduced in the market without any standards relating to product specifications, application and bond strength limits.

This work presents a comparative study of this innovative ceramic tile installation product with the traditional system with polymer-modified mortar. The main aim was to evaluate the performance and durability of the new system.

2. EXPERIMENTAL PROCEDURE

Pull-off tests were carried out in order to characterize the new system and the reference system (porcelain tiles installed with dry-set mortar) after curing in controlled laboratory conditions ((23±2)°C and 85% humidity), water immersion (7 days in laboratory conditions followed by 21 days immersed in water at (23±2) °C) and heat aging (14 days in laboratory conditions followed by 14 days at (70±2) °C) which simulates indoor and outdoor uses. Scanning electron microscopy (SEM) images were also obtained from failure sections for a better understanding of the failure modes.

3. RESULTS AND DISCUSSION

Bond strength results revealed that the adhesion strengths measured for adhesive sheets were lower than those obtained for dry-set mortar independent of the curing conditions (Figure 1). In addition, only for water immersion curing, the bond strength values obtained for the adhesive sheets were higher than the 0.30 MPa recommended by the Brazilian standards as minimum requirement for tiles installed on walls and floors. The failure modes for the polymer sheets were mostly adhesive at the tile/adhesive interface (Table 1). It could be observed that the tile back profile, so important for mortar adhesion, acted as a barrier preventing full contact between the tile and the adhesive sheet (Figure 2).

SEM images indicate adhesive flow due to the high temperature during the heat aging cure (Figure 3a). This suggests that the adhesive presents a glass transition above 25°C (average laboratory temperature) but below 70°C.

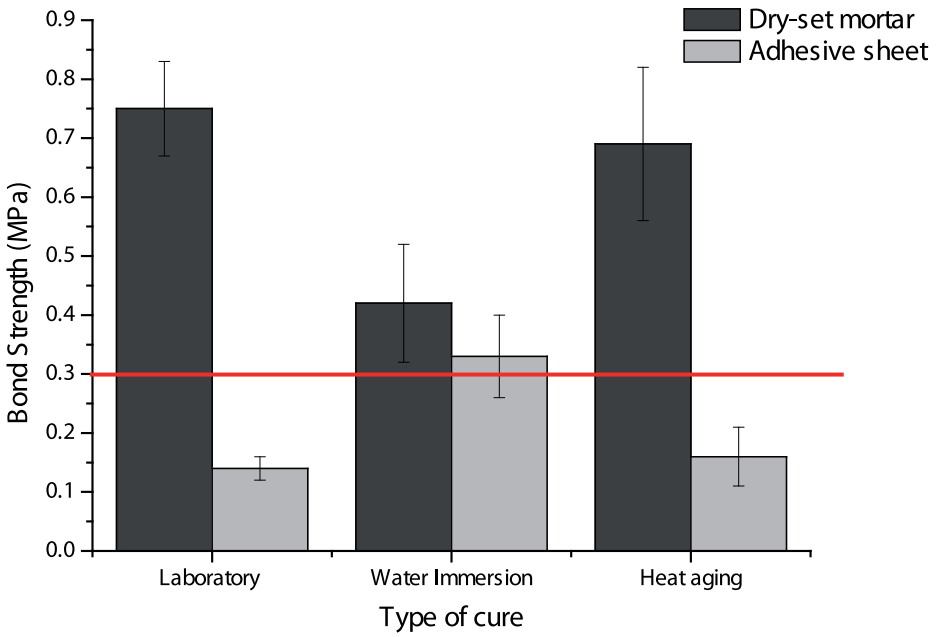
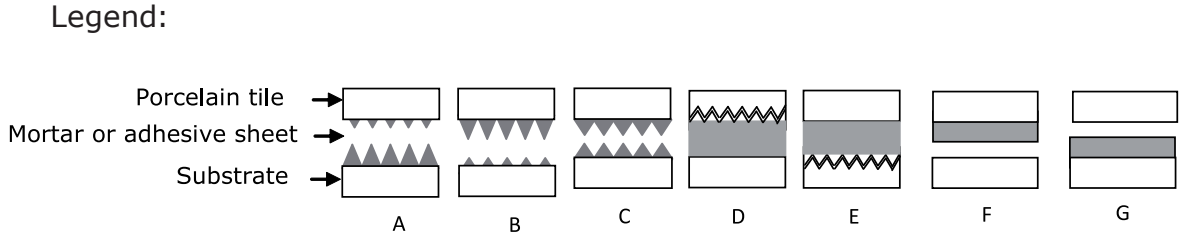


Figure 1 – Bond strength results.

Sample	Failure mode		
	Laboratory	Water immersion	Heat aging
Dry-set mortar	30% cohesive A 70% cohesive C	80% adhesive G 20% cohesive B	60% cohesive A 40% cohesive C
Adhesive sheet	15% cohesive A 85% adhesive G	100% adhesive G	30% cohesive A 70% adhesive G

Table 1 – Summary of failure modes.



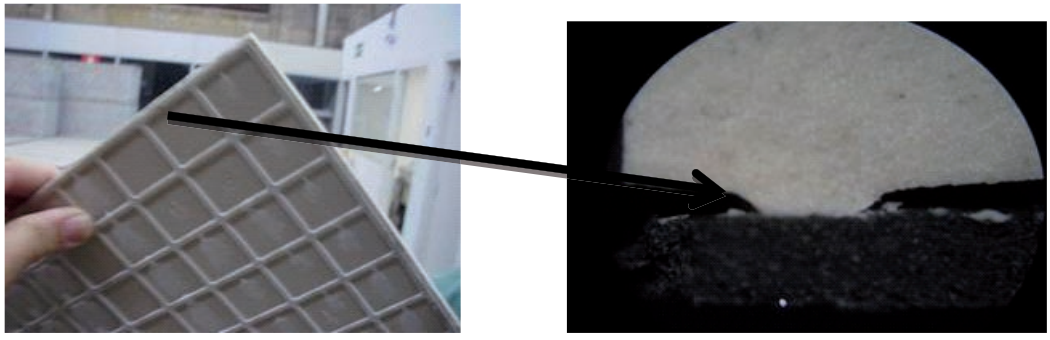


Figure 2 – Detail of the tile back profile, which acts as a barrier preventing full contact between the tile and the adhesive sheet.

During heating, it is possible remove the tiles without resistance (Figure 3b). When the temperature is lowered, the adhesive penetrates deeply into tile surface roughness and the strength is recovered. Under immersion curing, redispersion of the adhesive was detected. While the system is soaked, the bond strength is almost null, but this is recovered after drying. The SEM images show that the re-dispersion of the adhesive promoted even spreading of the adhesive on the tile surface (Figure 4).

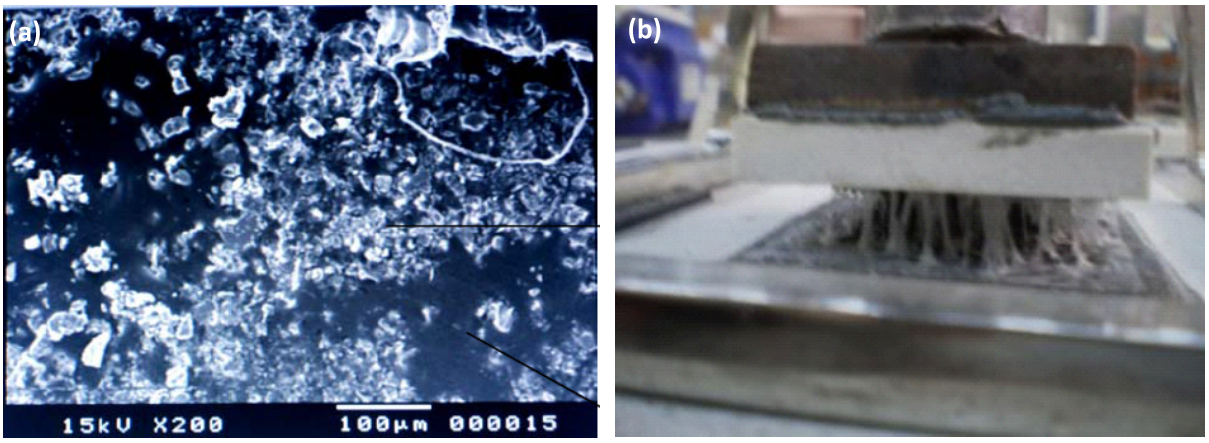


Figure 3 – (a) SEM image showing the effect of adhesive flow into the engobe layer due to heating (adhesive side). (b) Molten state of the adhesive during heat aging.

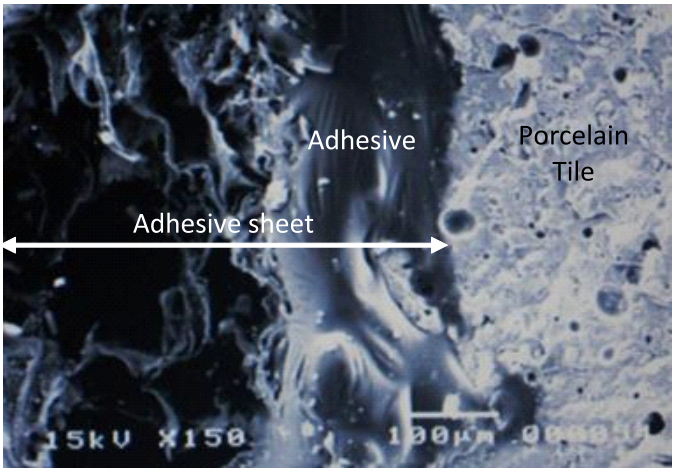


Figure 4 – SEM image showing increased adhesive spread on the tile surface due to adhesive redispersion during water immersion.

4. CONCLUSIONS

Based on these results, the use of this product should be evaluated in each case considering the environmental conditions that it will be subjected to. High temperatures and wet conditions should be avoided. More studies should be carried out in order to guarantee a better understanding of the behaviour of this new product in order to avoid the development of pathologies.

ACKNOWLEDGMENTS

The authors acknowledge the financial support of CNPq, CAPES, and FAPEMIG.

REFERENCES

[1] A.A.P. Mansur; O.L. Nascimento; H.S. Mansur in Proceedings of Qualicer 2006, V.1, 107.

[2] Brazilian Standard. ABNT. NBR 14081. Rio de Janeiro, 1998.

[3] A. A. P. Mansur, PhD Thesis, Universidade Federal de Minas Gerais, 2007.

[4] P. Schossler, Master Dissertation, Universidade Federal de Minas Gerais, 2001.

[5] Brazilian Standard. ABNT. NBR 13755. Rio de Janeiro, 1996.

[6] A.J.S.I. Fiorito. Manual de Argamassas e Revestimento, Editora Pini Ltda. São Paulo, 1993.