ADDITION OF DOLOMITE TO THE CERAMIC TILE COMPOSITION PROCESSED BY DRY GRINDING AND ITS EFFECT ON MOISTURE EXPANSION

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ABSTRACT

The expansion by moisture in ceramic tiles has been a problem that concerns both ceramists and the civil construction sector, since this is one of the main causes of the detachment of tiles in building façades. For this reason, several studies have evaluated the factors that affect moisture expansion. Some works have shown that certain crystalline phases can increase this expansion and lead to the detachment of

the tiles. Therefore, the aim of this work was to determine the effect of the addition of different amounts of dolomite to the raw materials and body compositions used for the manufacture of ceramic tiles by dry grinding on tile moisture expansion. The results show that the additions of 10 and 20 % dolomite significantly increase moisture expansion. However, the addition of 30 % did not modify the initial moisture expansion shown by the samples.

1. INTRODUCTION:

Ceramic tiles play a fundamental role in the performance of buildings, as they cover their façade and, consequently, are the main agents responsible for the protection of the walls and structures against environmental degradation agents. Consequently, they are also the construction elements most susceptible to degradation actions [1,2]. The systems that use these elements often show some early pathologies, one of these being tile detachment. One possible cause listed by technicians of the civil construction industry is the expansion by moisture of ceramic tiles [3,4]. Expansion by moisture (EPM) is related to the following factors: mineral phases of the ceramic components (amorphous, vitreous or crystalline), firing temperature and chemical composition [5]. Menezes et al. list the type of mineral phase as being the main one. The amount of amorphous and crystalline phases of a ceramic product can be determined during the manufacturing process, since it depends on the chemical composition and firing conditions [6].

2. MATERIALS AND METHODS:

The raw materials used in this work were three clays referenced A, B and C, used for the manufacturing of class BIIb ceramic tile by dry grinding. The clays were characterized by X-ray diffraction in a Shimadzu diffractometer (XRD 6000) with $Cu_{K\alpha}$ radiation, λ = 1.5418 Å, at 25 kV and 25 mA, 2θ between 3 and 80° and a step of 2°/min.

The work was carried out in two stages. The first one was the search for the best composition using the three clays and, simultaneously, the firing temperature that adequately complied with the firing shrinkage (LS), water absorption (BIIb class) and firing cycle. The second was the addition of dolomite in the compositions defined in the first stage and in the clays alone. The amounts added were 10, 20 and 30 % and the firing cycle used in these compositions was as defined in the first stage, in addition to performing a thermal shock test.

Two compositions were prepared starting from the clays, in addition to the clays alone. The first was a dry grinding composition referenced 'E' and the second a mixture with equal proportions of all three clays called 'M'. Both were used to determine the firing cycle. Composition 'E' consisted of 60 % A, 20 % B and 20 % C and composition 'M' consisted of 33.3 % A, 33.3 % B and 33.3 % C. After characterization, dolomite was added to the sole clays and mixtures in order to determine its effect on moisture expansion. In addition to the reference samples, that is, with 0 % dolomite, three amounts of dolomite were used, 10, 20 and 30 %. After firing and thermal shock testing, the samples were subjected to the moisture expansion test in accordance with the ABNT NBR 13818 standard.

3. RESULTS AND DISCUSSION

Figure 1 shows the diffractograms with the identification of the crystalline phases present in the clays. Figure 2 shows the water absorption and linear shrinkage after firing. The industrial standards for the production of semi porous tiles (*semi porosa*) used in this work are water absorption of 6-10 % and firing shrinkage of approximately 3-4 %. According to these limits, it was considered that a firing temperature of 1090 °C was suitable for both mixtures and for the sole raw materials.

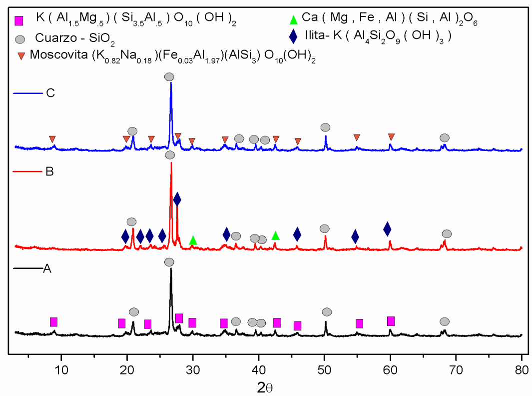

Figure 1. *Diffractograms of the clays*

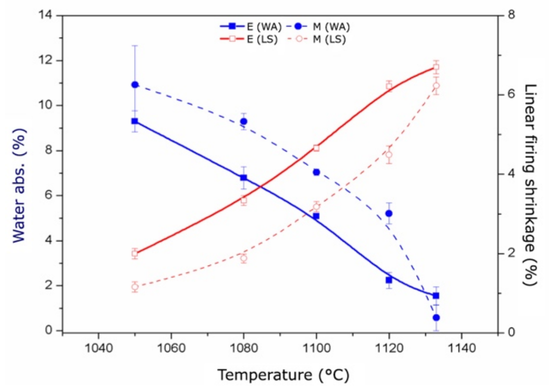

Figure 2. *Water absorption and linear shrinkage of mixtures E and M*

The results for the samples subjected to the moisture expansion test are shown in Figure 3. There is a trend for moisture expansion to increase as dolomite was added up to 20 %. At 30 % addition of dolomite there is a decrease in moisture expansion compared to 10 and 20 % addition. According to the ABNT NBR 13755 (2017) standard, the expansion by moisture in ceramic tiles should be limited to the maximum value of 0.6 mm/m and in some cases this value may be excessive [7]. Therefore, most of the samples do not comply with the standard regarding the EPM. Samples A, B and C are the clays alone (Figure 3). Clay A shows EPM values > 0.6 mm/m. When dolomite was added to it, clay A showed the highest values of EPM. On the other hand, clay B presented the lower EPM values and a lower standard deviation. Mixtures E and M showed a similar trend regarding the EPM results.

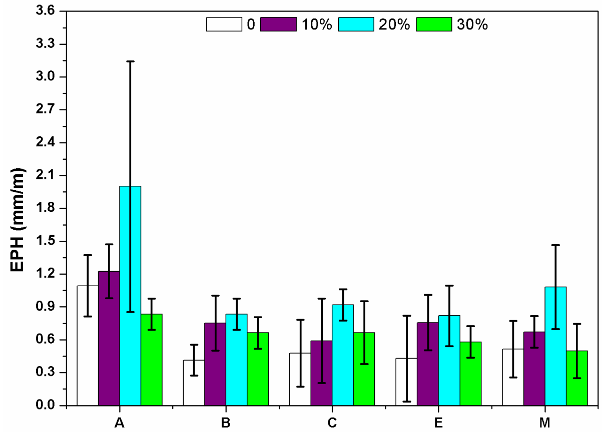

Figure 3. *Moisture expansion (EPM) of the sole clays and mixtures with dolomite addition after firing*

4. CONCLUSIONS

The results show that the addition of up to 20 % dolomite strongly affected the moisture expansion behaviour of the compositions. At higher amounts of dolomite addition, magnesium and calcium phases tend to form, which are more stable and help to decrease the EPM.

If the starting raw materials are made up of significant amounts of oxides such as magnesium and calcium, depending on the firing cycle used, they may present a high EPM. Therefore, an adequate control of raw materials and firing cycles is always necessary since they strongly affect the EPM that, in many cases, will only be detected after the tiles are already in use. Higher firing temperatures and slightly slower cycles can lead to the formation of stable mineral phases that could avoid the EPM and could result in higher strength.

5. REFERENCES:

[1] CICHINELLI, G. Patologias cerâmicas: por que ocorrem os desplacamentos e trincas em edificações revestidas com cerâmicas e quais as recomendações dos especialistas para evitar problemas. Téchne: a revista do engenheiro civil, São Paulo, n. 116, p.12-13, Nov./2006.

[2] SILVA, A.; BRITO, J.; GASPAR, P. L. Methodologies for service life prediction of buildings: with a focus on façade cladding. Lisboa: Springer, 2016

[3] BARBOZA, N.; Loturco, B.; Besana, M; Santin, E. Construtoras de todo o Brasil se mobilizam para encontrar saídas para o descolamento cerâmico. Téchne: a

[4] BOWMAN, R. La necesidad de establecer un convenio sobre la dilatación por humedad para el análisis de fallos en los sistemas de colocácion de azulejos. CSIRO Division of Building. Constrution and Engineering; In: WORLD CONGRESS ON CERAMIC TILE QUALITY (QUALICER), 2, 1992, Castellón, p. 461-473.

[5] CHIARI, L., OLIVEIRA, C.J., MONTEIRO, C.S., FORJAZ, N.V. e BOSCHI, A.O., Expansão por Umidade – Parte I, Cerâmica Industrial, 01 (03/04) 06 (1996).

[6] MENEZES, R. R.; CAMPOS, L. F.; NEVES, G. de A.; FERREIRA, H. C. Aspectos fundamentais da expansão por umidade: uma revisão: parte 1: aspectos históricos, causas e correlações. Cerâmica, v. 52, p. 1-14, 2006.

[7] ASSOCIAÇÃO BRASILEIRA DE NORMAS TECNICAS. NBR 13755: Revestimentos cerâmicos de fachadas e paredes externas com utilização de argamassa colante - Projeto, execução, inspeção e aceitação - Procedimento. 1 ed. Rio de Janeiro: Moderna, 2017. 57 p.