STUDY OF WATER ABSORPTION BY PREPARATION OF CERAMIC BODIES WITH DIFFERENT CLAYS FOR PORCELAIN TILE MANUFACTURE

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ABSTRACT

Several types of clays can be part of the formulation of bodies for fabricating porcelain tile. The main objective of this study has been to verify the influence of different clays, originating from the north-eastern region of Brazil, on the final properties, with particular emphasis on water absorption, in relation to the obtainment of materials used in BIIb class ceramic floor and wall tiles. The samples were produced on a laboratory scale, using a traditional porcelain tile production methodology. The clays used were of different mineralogical and chemical composition, added to a porcelain tile body composed of phyllite, kaolin, talc, and calcite. The results indicate that the requirements of standard NBR 13818:1997 of the Brazilian Association of Technical Standards (ABNT) for class BIb materials were met by some of the bodies, under certain firing conditions, providing in some of the formulations, materials with low water absorption, high mechanical strength and good aesthetic characteristics.

1. INTRODUCTION

Ceramic clays, also termed commercial clays, are those that serve as industrial raw material for the manufacture of construction materials. These clays are among the most important mineral resources for the manufacture of ceramic floor and wall tiles, in terms of the exploited volume and the value of the production costs.

Among ceramic floor and wall tiles, porcelain tile is one of the most important materials, in which the quantity and the quality of the clay that the body contains plays a key role in the final properties of the materials.

The present study was intended to evaluate the influence of different types of clays, originating from the north-eastern region of Brazil, on the final properties, with particular emphasis on water absorption, in relation to the obtainment of materials used in BIIb class ceramic floor and wall tiles.

2. EXPERIMENTAL PROCEDURE

The materials used for this research were ceramic clays (clay 1, 2, 3, 4, and 5) originating from the north-eastern region of Brazil, between the States of Paraíba and Rio Grande do Norte, and an industrial porcelain tile body composed of phyllite, kaolin, talc, and calcite.

The body formulations were developed with 36 % by weight of different clays mixed in five formulations (M1-M5), added to a porcelain tile body, designated PGP.

Test pieces of 60x20x6 mm were prepared by dry pressing from a powder of the formulations. Approximately 7.0 % moisture was added to the powder (by weight, dry basis) and a pressing pressure of 50 MPa was used. After drying in an oven a 110ºC, the test pieces were fired in electric kiln. For all firings the heating rate was 10ºC/min, between 35 and 600ºC, and 20ºC/min, between 600 and 1150ºC or 600 and 1160ºC. The residence time at peak firing temperature was 3 min. The properties analysed were: drying shrinkage and dry bending strength, bulk density, bending strength, linear shrinkage, and water absorption.

3. RESULTS AND DISCUSSION

Table I details the values of water absorption and linear shrinkage of the formulations studied at 1150ºC and 1160ºC. Together with these values, the table includes the fired bulk density and bending strength. It can be observed that the fired bulk density of the pieces displayed close values, independently of the clay used. On the other hand, the water absorption displayed a significant variation among the formulations (1.5 % - 8.8 %). The more refractory behaviour of formulation **M3** can be observed, due to its more kaolinitic clay mineral. In the **M5** formulation, since it contains the clay minerals, illite and montmorillonite, and in the **M4** formulation, since it contains a high proportion of potassium oxide, the water absorption with temperature was much smaller than in the foregoing formulation. The linear shrinkage displayed moderate values, in which the lowest values of the formulations **M2** and **M3** were due in both cases to a larger free silica content in clays 2 and 3, respectively. Finally, the greater mechanical strength of formulation **M3** (1150ºC) was possibly

associated with the larger quantity of mullite formed due to the highest Al_2O_3 content among the clays.

As it may be observed, in the firing at 1150ºC, that in none of the studied formulations were results obtained within the standard NBR 13818:1997 of the Brazilian Association of Technical Standards (ABNT) for class BIb materials (porcelain tile). Only formulation **M1** achieved properties for the manufacture of semi-stoneware-type ceramic materials. On the other hand, in view of the results obtained in firing at 1160ºC, the formulations M1, M4 and M5 can be considered class BIb materials, of the porcelain tile type, because they display water absorption and mechanical strength within the values of standard NBR 13818:1997. Possibly, at temperatures above 1160ºC, the **M3**, formulation, which has the largest quantity of kaolinitic clay, would have values within the specifications for porcelain tile.

	BULK DENSITY (g/cm³)	BENDING STRENGTH (MPa)	LINEAR SHRINKAGE (%)	WATER ABSORPTION (%)
1150ºC				
M1	2.1 ± 0.0	26.2 ± 2.4	4.4 ± 0.4	5.3 ± 0.6
M2	2.0 ± 0.0	17.6 ± 1.9	2.6 ± 0.6	7.5 ± 1.2
M3	1.9 ± 0.0	24.1 ± 2.4	2.8 ± 0.4	8.8 ± 1.4
M4	2.1 ± 0.1	21.8 ± 3.0	4.1 ± 0.7	3.7 ± 1.5
M5	2.1 ± 0.0	21.7 ± 2.5	4.6 ± 0.4	3.5 ± 0.5
1160ºC				
M1	2.2 ± 0.0	32.8 ± 2.2	6.1 ± 0.1	3.0 ± 0.1
M2	2.0 ± 0.1	23.8 ± 3.5	3.6 ± 0.1	5.3 ± 0.6
M3	2.0 ± 0.0	27.5 ± 3.2	3.8 ± 0.3	7.3 ± 1.4
M4	2.2 ± 0.0	30.7 ± 3.3	5.0 ± 0.1	1.5 ± 0.1
M5	2.2 ± 0.0	30.2 ± 2.2	5.7 ± 0.2	2.0 ± 0.2
BIb*	-	> 30	-	< 3
BIIa**	-	> 22	-	< 6
* NBR 13818:1997 - porcelain tile; ** NBR 13818:1997 - semi- stoneware.				

Table I. Firing properties at 1150ºC.

4. CONCLUSIONS

The results obtained allow the conclusion that the different clays had a significant influence regarding the requirements of standard NBR 13818:1997 of the Brazilian Association of Technical Standards (ABNT). Class BIb materials were obtained for some of the bodies (**M1, M4** and **M5**) under certain firing conditions (1160ºC), in some of the formulations providing materials with low water absorption, high mechanical strength, and good aesthetic characteristics.

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