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CHARACTERIZATION OF MATERIALS USED IN THE MANUFACTURE OF CERAMIC TILE WITH INCORPORATION OF ORNAMENTAL ROCK RESIDUE

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Introduction

The minimization of the use of natural resources for the manufacture of ceramic products has been made from the incoporation of residues from other productive chains in the manufacture of ceramic products, as in the study of Vieira et al. (2016), in which ornamental stone residues were incorporated in ceramics in order to obtain contribution in the properties of the materials, as well as improvements in the final technological properties.

The incorporation of rock residue in clays allows the adjustment of plasticity in the ceramic mass, due to the coarse granulometry of the residue and an increase in dry density, in addition, in the study of Amaral et al. (2019), the increase in the residue content resulted in less linear shrinkage, decreased water absorption, which improves some properties of the ceramic mass.

The chemical and mineralogical composition of the clays depends on the formation deposits where they are located, and these compositions and the amounts of quartz, calcite, dolomite, feldspar and other organic compounds, can vary according to the level of these deposits. The composition can directly interfere in the properties of the materials to be manufactured, also influencing its final production cost (Tretjakova et al, 2018).

Thus, this study aimed to characterize the materials needed to make a ceramic tile with incorporation of ornamental rock residue (RRO), thus evaluating its main characteristics regarding the feasibility of this incorporation.

Materials and Methods

The clays used in the present work come from the municipality of Campos dos Goytacazes, State of Rio de Janeiro. The ornamental stone residue was in the form of mud, with natural humidity (in the range of 12 to 26%).

The industrial mass was made using clays locally called “strong” (AF) clay, that is, a more plastic clay and a mixed clay (AM), containing “strong” and “weak” clay. Both the mass, the clays and the rock residue were previously subjected to drying. For the preparation of the ceramic mass, 15% of ornamental rock residue was added for the weight of each clay.

The chemical characterizations of the clay and the residue were determined by X-ray fluorescence spectroscopy, with the SHIMADZU EDX-700 equipment.

X-ray diffraction determines the atomic and molecular structure of a crystal, it was performed using Rigaki MiniFlex 60 equipment at the Civil Engineering Laboratory - LECIV at UENF

The prototypes were made using an extruder of the Verdés brand, model BR-051. After extrusion, the prototypes went through a natural and artificial drying process. The prototypes were sintered at three different temperatures (850 °C, 950 °C and 1050 °C). The heating rate was 2 °C min^{1} with 120 minutes of stay at the threshold temperature. The cooling carried out natural convection until room temperature, when the oven was turned off.

Water absorption was analyzed according to ASTM C373 (1972).

The three point flexural strength of the prototypes was analyzed ccording to ASTM C674 (1977) with the aid of an EMIC hydraulic press, model CL 3000. The load application speed was 0.1mm min^{-1} and the distance between the cleavers was of 8.0 cm.

The confocal micrograph was performed in order to obtain enlarged images of the specimens and to distinguish details of the surface, using an Olymlpus microscope and LAMAV / UENF CGA model.

Results and Discussion

Table 1. Chemical composition of the raw materials used to make the prototypes.

Raw material	SiO_2	Al_2O_3	Fe_2O_3	K_2O	TiO_2	SO_3	CaO
AF	60,35	31,33	2,88	2,20	1,17	1,35	0,57
AM	56,46	34,01	3,31	2,26	1,42	1,78	0,66
RRO	86,22	7,15	0,26	2,15	0,10	1,59	2,34

Table 2. Average water absorption values observed in each ceramic mass composition.

Temperature (°C)	Water absorption (%)			
	AM0	AM15	AF0	AF15
850	15,4	15,8	20,3	18,1
950	20,4	19,4	18,4	14,9
1050	11,3	11,4	14,3	13,3

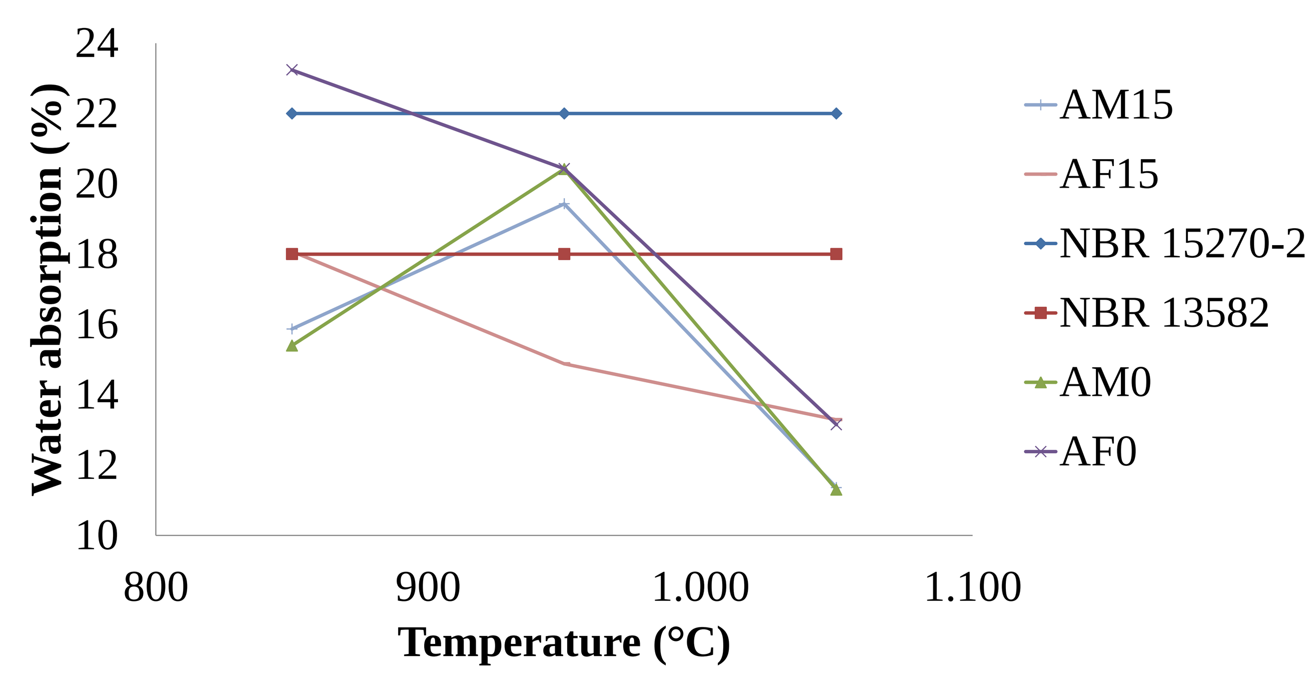

Figure 1. Average water absorption values for ceramic masses compared to standards

Table 3. Average values of linear retraction observed at home ceramic mass composition.

Temperature (°C)	Linear retraction			
	AM0	AM15	AF0	AF15
850	1,39	1,02	1,42	1,54
950	2,11	2,01	2,36	2,52
1050	3,50	3,17	3,99	4,17

Table 4. Average flexural strength values found in each ceramic mass composition.

Temperature (°C)	flexural strength (Mpa)			
	AM0	AM15	AF0	AF15
850	5,21	7,14	6,73	9,35
950	5,19	7,16	6,04	5,87
1050	8,35	12,5	8,58	9,40

Conclusions

The ceramic mass composed of the clays and the residue present after the sintering properties expected from the raw materials due to the chemical composition and the x-ray analyzes, which indicated the reddish color, the presence of free quartz inert to sintering and the increased formation liquid phase which contributes to the densification of prototypes.

The sintering temperature that resulted in the best results was 1050 °C.

It is possible to conclude from the results found in the technological tests carried out, that the incorporation of 15% of ornamental rock residue in both clays did not affect the tile properties, indicating the feasibility of incorporating this residue in civil construction, minimizing the impacts generated.

Acknowledgements