EVALUATION OF THE POTENTIAL OF THE SLUDGE FROM THE PULP AND PAPER INDUSTRY IN FITTING BLOCKS.

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Abstract

A pulp and paper industry generate a large amount of industrial solid waste that which mostly, are sludge state, more moist, which has the basic composition or kaolin and cellulose. The National Solid Waste Policy, in force in Brazil, instituted an obligation of an adequate destination of this material in order to improve its costs with this process. The purpose of this work was to analyze the feasibility of incorporating sludge from the pulp and paper industry into blocks with soil-cement, reducing the amount of cement in the trace, which is 2: 1 (soil: cement). Blocks were prepared for the automated pressing process at different levels of incorporation (0, 5 and 10%) in mass of cement evaluating the mechanical protection and water absorption. The results showed that up to 5% of the incorporation of the analyzed blocks meet the requirements of the Brazilian technical standard and can be produced while providing an improvement of the destination process of its waste due to its environmental condition.

Keywords: *Waste, blocks, industry.*

Introduction

The environmental issue is increasingly important for the economic and social development of a society. Public policies that ally economic and industrial development together the environmental issue is a yearning for developed developing countries around the world [1]. In Brazil this issue has not gone unnoticed. Throughout the last decades, the country has prepared itself to face the environmental issue allied to the generation of solid industrial waste.

Through this effort, legislation has been implemented, such as the National Solid Waste Policy (PNRS) and technical standards for the characterization of these materials, correct or discard policies or even reinsertion policies of these products in other production chains [2]. An example of an industry that generates large quantities of solid waste is the pulp and paper industry, which generates a huge amount of sludge, basically composed of kaolin and cellulose, the wet end, which is generated in different stages of the production process, such as pressing and drying [3]. After generation these wastes are taken to settling tanks for a primary treatment process aimed at separating solid particulate material present in this sludge. Currently one of the major problems of these industries is the disposal of this material, which is done in landfills in a general way, which entails high costs the industries with the process of transport and disposal of it [4]. There are several studies around the world that aim to incorporate these residues into ceramic, cement or even road stabilization [5,6 and 7].

Another possibility of reinsertion, which has been studied, is the application of this residue in blocks of soil-cement, which are pressed structural blocks that do not need to be burned, being more sustainable than the traditional blocks burned, even with the use of the cement in its constitution [8].

The need for environmental preservation, coupled with the scarcity of natural resources, means that civil construction seeks new concepts and technical solutions aimed at sustainability in its activities. The use of soil-cement bricks in a construction project leads to a cost reduction of around 30%, since the investment in production is low, there is a facility in construction, it allows more aligned walls, being a simple and with a low number of professionals for the construction [9].

Therefore, the objective of this work is to analyze the feasibility of incorporating sludge from the pulp and paper industry into blocks with soil-cement, reducing the amount of cement in the trace, making it more economical.

Materials and methods

For this work the soil was collected for the confection of the blocks, this one comes from the municipality of Campos dos Goytacazes, from a deposit located in the district of São Sebastião to a depth of around one meter, being careful to remove organic material [7].

The pulp and paper industry waste were collected at Companhia Paduana de Papéis (COPAPA), located in the municipality of Santo Antônio de Pádua, in its decantation tank and transported to the dependencies of the State University of Norte Fluminense. The cement used was CPIII E32, Portland cement type III with addition of blast furnace slag, the choice of this cement is due to the fact that it is the most used in the region besides guaranteeing adequate properties in the soil-cement composition according to literature [10].

Sand was used in the mix for the purpose of improving the soil properties through particle size correction, this correction is fundamental to improve the compactness of the blend and to improve the mechanical properties of the composites [5].

For the confection of the blocks 5 traces of the soil-cement mixture were defined, which were molded in automated prey (Figure 1a) producing modular bricks (Figure 2b) of each trait, always with a pressing pressure of 15MPa. A minimum number of blocks were produced to ensure a minimum batch of representativeness for mechanical strength and water absorption tests.

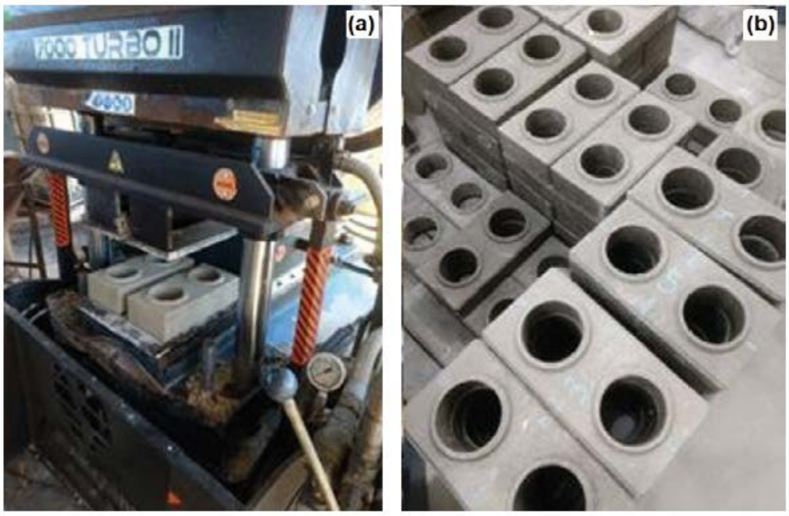

Figure 1a - Press for confection of blocks; 1b - Block models.
Source: France, B.R. et al. (2018).

After the blocks were made, they were cured in a humid chamber for a period of 28 days, time required for the occurrence of cement hydration reactions [11]. The blocks produced were submitted to compressive strength and water absorption tests in accordance with Brazilian technical standards. Table 1 below demonstrates the traits that were used.

Table 1 - Compositions used for molding the blocks.

Compositions	Compositions in mass	Compositions in percentage (%)
TR0	1:9:0:0	10:90:0:0
TR1	1:6.3:2.7:0	10:63:27:0
TR2	1:5.95:2.55:0.5	10:59.5:25.5:5
TR3	1:5.6:2.4:1	10:56:24:1
TR4	1:5.25:2.25:1.5	10:52.5:22.5:15

Results and discussion

Firstly, some characterization tests were carried out on the components used to make the blocks, Table 2 shows the granulometry present in each trait studied.

Table 2 - Granulometric composition, in percentage.

Composition	Sand (%)	Silt (%)	Clay (%)
TR0	23.0	28.0	48.9
TR1	51.7	19.2	31.2
TR2	47.9	20.3	31.7
TR3	47.8	22.9	32.0
TR4	42.5	24.7	33.1

It is observed in Table 2 that the reference trait (TR0) has a predominance of the clay fraction, whereas the other traces, where there is incorporation of the residue the sand fraction is predominant, due to the presence of sand in the composition of the mixture and the incorporated waste. Table 3 below shows the atterberg boundaries of the traits analyzed [12].

Table 3 – Atterberg Limits in compositions.

Composition	LL (%)	LP (%)	IP (%)
TR0	49.0	31.2	17.8
TR1	30.4	17.1	13.3
TR2	33.0	17.4	15.6
TR3	38.2	19.4	18.8
TR4	42.8	22.1	20.7

The values presented in Table 3 present a parameter for the determination of the capacity required for the execution of the course, the excess water can be used to build a block formula and generate pathologies in the buildings [13]. Table 4 shows compaction and density values of the compositions evaluated.

Table 4 – Density and humidity of each composition evaluated.

Composition	Density (g/cm^3)	Degree of humidity (%)
TR0	2.53	19.4
TR1	2.76	15.2
TR2	2.64	19.3
TR3	2.48	21.2
TR4	2.61	23.1

It is observed that the density of the traces studied are constant and are agents that facilitate the pressing process of the same. As for moisture, the increase observed is a reality of the high humidity present in the residue used, which has about 50 to 70% of humidity according to the literature on the subject.

Figures 2 and 3 show the water absorption and mechanical resistance to compression respectively. Also set are the limits that the Brazilian technical norm imposes on each property.

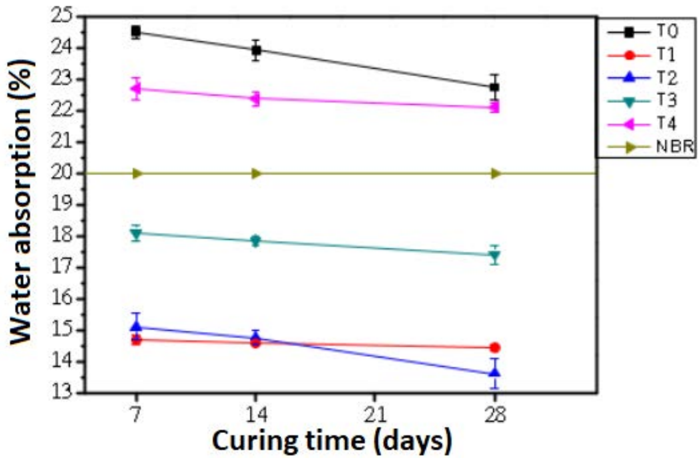

Figure 2- Water absorption by curing time.

In the Figure 2 shows the result of the baseline and traces with partial replacement of the soil by the residue. The result indicates the average value of the water absorption obtained from the test of six bricks of each trace. It can be noticed that the substitution of the residue by the soil in the proportions of 5% and 10% by mass, meets the requirement of in relation to the water absorption, since the average value of water absorption at 28 days of age in these proportions was below the maximum allowed, of 20%. The high moisture content of the paper residue contributes significantly to these composite properties [14].

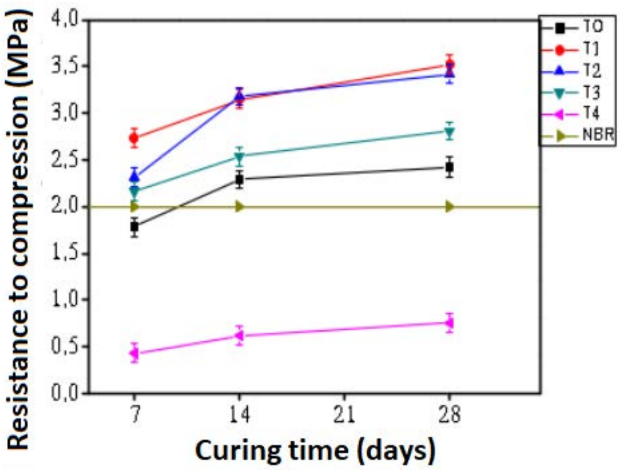

Figure 3- Resistance to compression by curing time.

The resistance result shown in Figure 3 indicates the average value of the compressive strength obtained from the six block test of each composition. It is observed that the substitution of the residue by the soil in the proportions of 5% and 10% by mass, meet the requirement of in relation to the compressive strength, since the average value of compressive strength at 28 days of age Bricks in these proportions was higher than the allowed minimum of 2.0 MPa [11].

Conclusions

According to the obtained results it can be concluded that:

- According to the physical characterization of the soil, it was possible to verify that the soils suitable for use in the manufacture of soil-cement bricks without granulometric stabilization;
- It was verified that the soil in the natural state and the mixture with 15% of residue did not to the physical requirements of the soil and obtained values above that allowed for water absorption;
- It was found that the traces of soil stabilized with sand and incorporation in up to 10% of papermaking reached 7 days after curing values higher than the resistance to minimum compression required by the standard;
- The blocks composed of natural soil only reached the values of resistance to compression minimum at 14 days of cure;

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