REUSE STUDY OF WASTE IN ECOLOGICAL BRICK

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Abstract

With technological advances, the creation and use of sustainable materials is increasingly sought. One of the most widely used sustainable materials in civil construction corresponds to ecological bricks, thus, the present work aims to carry out a brief bibliographical survey on the reuse of waste in the manufacture of ecological bricks, aiming at sustainability. In this research, the studies presented show exactly different recyclable components, such as: PET bottles, Styrofoam, rubber, etc., precisely to add ecological diversity and impose an appropriate purpose to these resources in a way that motivates sustainable development. This investigation in several materials in the verification of the applicability of ecological brick, in order

to submit and understand the behavior of these new materials.

Keywords: Ecological, Waste, Civil Construction.

1. Introduction

The market in terms of sustainability tends to show some advances in civil construction, since the term recycling does not correspond to something new, but very little discussed. Sustainability aims to reach the standard of living of future generations, so that they do not suffer irreversible impacts on the environment and that important resources are not lacking in the basic needs of the population (Lindsey, 2011). Recent studies show the importance of new materials that are not harmful to the environment, in order to add the value of sustainability to the product. For civil construction, the market presents numerous sustainable and viable alternatives for execution, but very little used, one of them corresponds to the soil cement brick or better known as ecological brick.

According to the ABNT NBR 8491/2012 Standard, ecological brick or cement soil (figure 1) presents in its composition of soil, Portland cement, water and additives (if necessary), however one of the fundamental components for masonry consists of soil, which must not present organic matter in levels harmful to its properties. Regarding the quality control of the brick, the standard makes very clear some questions such as the minimum compressive strength must be 2MPa, the absorption should be around 20% and cannot exceed 22% in tests.

Figure 1 - Ecological Brick

The cement soil brick or better known as ecological brick, because in addition to being mostly made up of soil, in its manufacture it does not present any burning process. According to ABCP (2000), the brick also has several advantages such as:

- The excavated soil of the work can be used for the production of bricks, reducing the cost of inputs for the work;
- The equipment used for its manufacture has low cost and easy rental, speeding up the construction phases;
- Due to its shape and regularity of the surface, there is no need to use a lot of mortar for laying or covering, generating savings in the final price, in addition to a thermo-acoustic improvement to the place;
- Because its manufacturing process is simple, it can dispense with specialized labor;
- It has a compressive strength similar to that of ceramic brick.

In Weber et al (2017), they highlight the use of ecological brick in civil construction, in short it is summarized in small and medium-sized works. Among some items mentioned by the authors, it is still evident that the brick allows aggregating residues in its composition, which positively points to the environmental issue. Thus, in addition to avoiding the emission of polluting gases, the ecological brick also allows the insertion of other materials (provided with study and foundation) in its formulations.

According to Law 12.305 / 2010, regulated by Decree 7.404 / 2010, solid waste can be defined as material, substance, object or discarded good resulting from human activities in society, the final destination of which proceeds, proposes to proceed or is obliged to proceed, in solid or semi-solid states, as well as gases contained in containers and liquids whose particularities make its release in the public sewerage network or in water bodies unfeasible, requiring technical or economically unfeasible solutions in view of the best available technology.

According to NBR 10004: 2004, waste is classified as hazardous as follows:

Table 1 - Waste Classification

TYPES	DESCRIPTION AND DISPOSAL	EXAMPLES
Class I waste (Dangerous)	Corresponds to materials with physical-chemical and infectious properties, causing risks to public health or the environment. These must present a correct disposal, since the accident rate and impact on the environment can be serious. **Main Disposal:** Incineration (total material destruction)	Paint and Oils: Paint sludge and paint cans, mineral oils, lubricants, thinner residues, oil-contaminated sawdust, oil filters, grease / oil-contaminated papers and plastics and sweeps, greases or chemicals, Others: Contaminated PPE (leather gloves and boots), salt residues from heat treatment of metals, tow, lead sludge, sludge from the washing ramp, hospital waste in general;
Class II-A waste (Not inert)	Materials with low risk, but still performing chemical reactions in contact with specific media. **Main Disposal**: Sanitary landfills (to occur due to the proper decomposition of solid waste that would be accumulated in the environment)	**Organic Matters:** organic materials from the food industry, sludge from water treatment systems and sludge from filters, **Papers, Glass and Metals:** iron filings, polyurethane, glass fibers, waste from cleaning boilers, plaster, cutting discs;
Class II-B waste (Inert)	They have no way of occurring chemical reactions, since their constituents are solubilized in concentrations higher than water potability standards. Main Disposal: Conditioned (temporarily stored to seek reuse or recycling)	**Rubble**: Wood, remnants of bricks and tiles (masonry in general), scrap iron and steel

Source: Brant, 2018

As for the origin, the residues can be classified as shown below:

Table 2 - Types of waste according to origin

WASTE	ORIGIN
Household	Originating from domestic activities in urban residences.
Urban cleaning	Originating in sweeping, cleaning of streets and public roads and other urban cleaning services.
Urban Solids	It includes household waste and urban cleaning waste.
Commercial establishments	The waste generated in these activities.
Public basic sanitation services	Waste generated in this basic sanitation activity.
Industrial	Those generated in production processes and industrial facilities.
Health services	Those generated in health services, as defined in regulations or standards established by the bodies of Sisnama and SNVS.
Construction	Those generated in the construction, renovation, repair and demolition of civil construction works, including those resulting from the preparation and excavation of land for civil works.
Agrossilvopastoris	Those generated in agricultural and silvicultural activities, including those related to inputs used in these activities.
Transport services	Those originating from ports, airports, customs, road and rail terminals and border crossings.
Mining	Those generated in the activity of exploration, extraction or processing of ores.

Source: Brazil, 2010.

The State of Piauí through State Law No. 6,888, of October 6, 2016, in its Art. 2, legislates that all civil constructions executed by the State of Piauí, directly administered by the state government or through contracted agents, be public buildings or housing estates, should have the obligation to employ criteria of environmental sustainability, energy efficiency, quality and origin of materials. Thus, this law aims to determine the use of sustainable techniques of civil construction in works carried out by the State of Piauí or with financial resources in any capacity linked to the state treasury.

In view of the growing evolution of the civil construction sector in Brazil and in the world, nature has been suffering from this evolution, the destruction of the environment happens more and more with the expansion of the urban area. With this scenario, there is an urgent need for improvements in the management of construction waste combined with the preservation of the environment, since the importance of the application of assertive policies and more intense inspection with regard to the management of this generated waste.

In Brazil, it is estimated that about 6.3 million tons of solid waste has inadequate final destination, thus showing that the country still has much to improve on the issue of waste. This research aims to show how these residues can be used in civil construction by being applied directly to ecological bricks.

This work is organized in the following sections: section 2 shows the procedures for conducting a bibliographic study; section 3 portrays the results of this study, addressing the opinion of authors, in order to show the relevance of the study and, finally, in section 4 presented to the appropriate conclusions of the research.

2. Methodology

For the development of this study, data already concluded through bibliographic research were analyzed, being them applications of different materials in ecological brick formulations. The research has a qualitative approach and a descriptive nature. The articles were collected in the Google Scholar database, from the capes journal portal and the master's thesis database at the Federal Institute of Education, Science and Technology of Piauí, as shown in the table below.

Table 3 - Summaries of Related Works

REFERENCE	TITLE
Carvalho (2019) Gomes (2018)	Feasibility study of the use of babassu coconut fiber in soil-cement brick formulations Brick-Ecological Development with Incorporation of Tire Rubber Waste
Pinto (2015)	Study of cement soil bricks with addition of civil construction waste.
Rodrigues et al (2019)	Development of the soil-cement mixture with replacement of 5 and 10 percent of soil with styrofoam
Sena et al (2016)	Mechanical Evaluation of Solid Brick Soil-Cement containing PET Waste
Sousa et al (2019)	Ecological brick, with the addition of PET fibers
Souza (2020)	Sustainable brick is made with sand and reused plastic

Source: Author, 2021

3. Results

Research in the area of reuse of waste increases as the acts of sustainability develop in certain regions of the world, making the benefits to the environment profitable, effective and exploratory, through the reduction of waste. As a result, some studies work entirely on recyclable materials or sustainable methods with the intention of observing behavior and reducing the impact on nature.

Therefore, the studies analyzed below show exactly the perspectives of other authors in the requirement to compose a new product and due to the fact that it is a recent analysis, it determines how profitable this relation of ideas can provide when verifying its application in the market.

To work with the compositions, the use of organic materials can harm the final product due to the fact that it decomposes after a certain time, in Carvalho (2019) presents in his research the use of babassu coconut fiber (figure 2) as an addition to make analysis of the resistance parameters, and found with the addition of 1.5% there is an increase in the mechanical resistance over the curing time being propitious for commercialization in the market.

Figure 2 - Ecological Brick with Babaçu Coconut Fiber

The fact of inserting other materials in the composition of the brick, in order to provide sustainability, does not necessarily have to be only recyclable materials, but reusable like the fact of tire rubber, where it is usually used in the preparation of the asphalt, however Gomes (2018) applied rubber residues to the brick (figure 3) proving the decrease in resistance when adding 9% compared to the initial material, in addition to having a very significant deformation due to this increase and recommending the use of clay soils, with the intention of facilitating the control of compaction in the mold.

Figure 3 - Ecological Brick with Tire Residue
Source: Gomes, 2018

Another alternative for handling ecological bricks corresponds to the reuse of construction waste, as it can be added in its line, in order to eliminate practically any and all debris, according to Pinto (2015) the addition of the construction waste (figure 4) , shows unsatisfactory results due to few resistance and water absorption indices, not corresponding to the normative limits, this fact must have occurred because of the amount of increase incorporated in the line, damaging it or as a result of the porosity of the material, decreasing from its final characteristics significantly, but the study makes a beneficiation to Civil Construction Waste.

Figure 4 - Ecological Brick with Civil Construction Waste
Source: Pinto, 2015

Access to recyclable materials is highlighted in participating in the formation of the soil-cement brick, through addition or replacement, as can be seen in the research by Rodrigues et al (2019), in which the work carries out an analysis of the soil-cement through the Styrofoam replacement (figure 5) in percentages of 5 and 10%, with the interaction between the materials for the final product, it is very difficult due to the existing empty spaces, in addition to higher percentages of Styrofoam, segregation and exudation occur.

Figure 5 - Samples with Styrofoam
Source: Rodrigues, 2019

Unlike styrofoam, there is another polymer that has better results, PET (figure 6), as can be seen in the work of Sena et al (2016) whose replacement in percentages of 5, 8 and 11%, in order to highlight the resistance of the ecological brick and compare with the normative limit, in order to determine which ones are more suitable for civil construction, in which the only satisfactory corresponds to the norm corresponds to 11%, however the research standard shows a resistance below 1.5 MPa proving that all percentages are adequate.

Figure 6 - Crude PET waste
Source: Sena et al, 2016

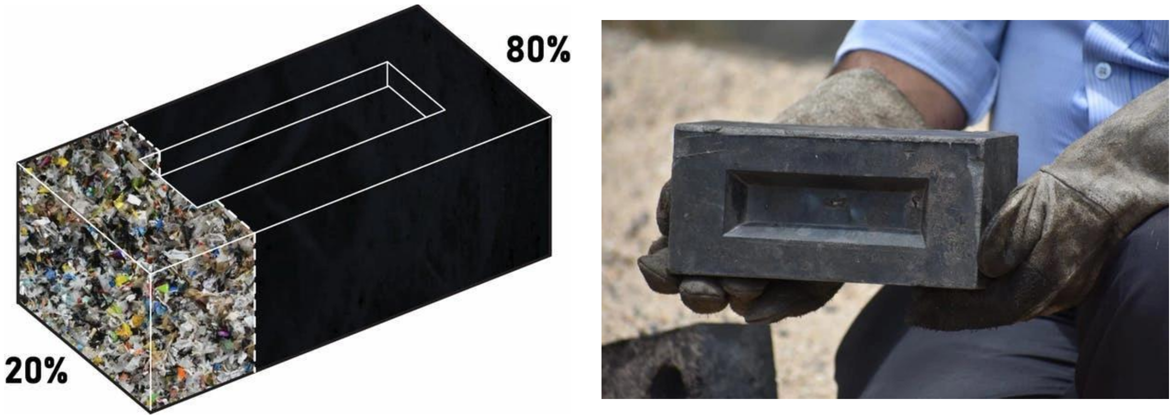
Thus, the substitution contains acceptable results and the addition also, according to Sousa et al (2019) based on the addition of PET with percentages of 10 and 15% to discover the final strength of the ecological brick with recycled PET, with acceptable results for 10%, because with a percentage of 15% the resistances were well below 2 MPa, one of the normative and essential criteria to determine the viability in civil construction.

(a) 10% de PET (b) 15% de PET

Figure 7 - Ecological Brick with Recycled PET

Source: Sousa et al, 2019

A company in India conducts tests to create an ecological brick using reused plastics (20%) and waste sand / foundry dust (80%) to reduce the amount of dust wastage, presenting a propitious purpose in addition to improving the pollution in the region, the figure below shows the model of this brick (Souza, 2020).



(a) Percentages of Materials (b) Final Product

Figure 8 - Ecological Brick with Foundry and Plastic Dust Residue

Source: Souza, 2020

5. Conclusion

The relevance of observing the perspective of other authors shows exactly evidence of such fundamental factors for the development of the creation of the material: physical and mechanical characteristics, making it possible to manage it in different alternatives by replacing or adding some element in its composition, provided that be performed with an ideal percentage in relation to the other fundamental elements of the composition.

Several applications of materials were studied in the production of ecological bricks: addition of babassu coconut fibers, tire waste, construction waste, Styrofoam, recycled PET and plastics. Each material to be inserted must be guided according to some study, but as can be seen, the ecological brick in fact allows for several variations of materials incorporated in its composition. According to some authors cited, in addition to being able to insert a residue in the brick, this material can also generate a positive factor in the physical and mechanical characteristics of the final material, enhancing its use in civil construction.

Finally, highlighting the comments regarding the authors' opinion together with the evidence of applications of different residues shows exactly a way to provide several alternatives to the market, providing partial requirements in the generation of the brick, since the residue of these new bricks could be used in its own composition, in addition to showing how important it is to attribute another purpose to waste through conventional ones, thus guaranteeing a cleaner environment and advances in research determining more functionalities for the products for the works.

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