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LIFE-CYCLE EVALUATION OF THE CERAMIC BLOCK WITH A FOCUS ON SOCIAL INTEREST HOUSING

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ABSTRACT

This research creates an inventory of the production process of the ceramic block, using the methodology of Life-Cycle Assessment (LCA) as defined by ISO 14040. It is an experimental research conducted in three industries of the state of Pernambuco, Brazil, where the reference flow used is of 1 ton of clay, to quantify energy consumption (thermal and electrical) and estimate CO2 emissions. The analysis allows identifying that the ceramic block may be a viable alternative for the use in housing of social interest, besides clay being a raw material in abundance in the state, the production process can adopt measures to minimize environmental impact. The results can be applied to other buildings, and compared to products with similar function.

INTRODUCTION

Climate change, air and water pollution, destruction of nature, soil erosion, water scarcity and biodiversity loss are the most serious problems of developing countries, aggravated on low-income populations. The researches and applications of principles aimed at sustainability have shown that it is possible to promote a balanced economic growth, reduce poverty and ensure the quality of life of the society (IEG, 2008). This research mainly aims to use the LCA tool to identify energy consumption and CO2 emissions in the production process of the ceramic block, incorporated to the Social Interest Housing in the state of Pernambuco, Brazil.

INVENTORY OF THE LIFE-CYCLE OF THE CERAMIC BLOCK (LCI)

The LCI of the ceramic block was performed from the construction of an inventory of its own production process, with data referring to the consumption of materials and energy, and CO2 emissions. For the LCI to three industries in the state of Pernambuco: one located in Camaragibe, and two located in Paudalho, 40 km from the capital. It is important to stand out that this study is limited to the production phase of the ceramic block. For a complete demonstration of the scope of the research, a tree process of the ceramic block chain was created (Figure 1), based on studies from Soares Pereira and Breitenbach (2002), who delimits the cutting criteria and defines the inputs and outputs of the life-cycle of the ceramic block. The production process of the ceramic block is divided into three basic stages:

preparation of the raw material, molding the material and burning of the product, as shown in Figure 1.

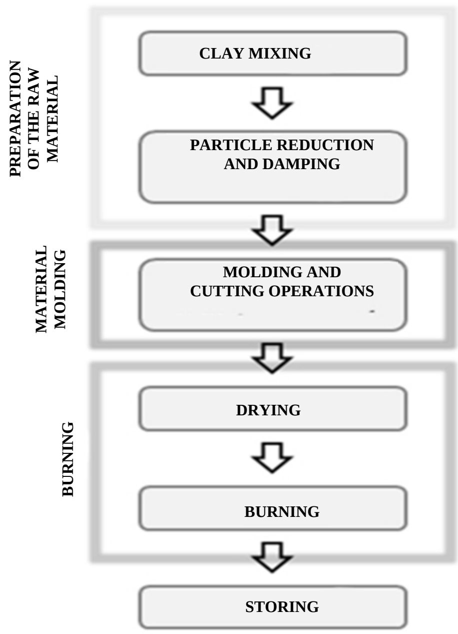

Figure 1 – Tree process of the ceramic block production process.

The preparation of the raw material is accomplished by mixing the clay with a loading shovel. After the raw material is reduced into smaller particles and moistened. The molding of the material is done by a mill, which compresses the raw material under vacuum and shapes the product. By means of a cutter, the blocks take its dimension for the beginning of the burning process. At all stages, there is electric or thermal energy consumption and only at the stage of molding the material there are no CO2 emissions.

DATA COLLECTION

A total of 18 industries informed by Sindicer, only 3 facilitated the access and data collection, whereas two are located in the Zona da Mata mesoregion (Paudalho) and one in the Metropolitan Region (Camaragibe). Data collection was based on the daily production of the industries visited. To survey CO2 emissions, a digital instrument was used, which measures the CO2 concentration in 30 seconds. Data were collected at a one-hour period and recorded every twenty minutes. For the collection of data of the consumption of natural resources, the information is provided by industries and for the values of other resources, information was sometimes provided, or sometimes measured onsite

INVENTORY EVALUATION OF THE LIFE CYCLE OF THE CERAMIC BLOCK

During the production process, the preparation of the raw material and the molding are the steps of greater electricity consumption due to the use of high power equipment, such as the laminator and the mill. The step of burning, is characterized by being the phase of greater environmental impact due to the combustion of biomass. It is noteworthy to say that industries B and C use mesquite wood as a component for combustion. Industry A presents the highest value in relation to energy consumption and CO2 emissions, which indicates the use of equipment with high power engines and use of more polluting biomass than other industries. Machines run daily for nine hours and the furnace for 24 hours in the production of ceramic blocks. Although it is presented as the most polluting material, the cane briquette is a byproduct, a feature that minimizes the environmental burden generated by emissions. Industry B showed lower results concerning energy consumption - due to the use of equipment with low power engines, even with hours of operation equal to industry A - and CO2 emissions. Industry C, on the other hand, in order to reduce the consumption of electricity, replaces the matrix by a generator that works on burning diesel for four hours, contributing to gaseous emissions.

The Table 1 presents a summary of the data obtained, corresponding to a ton of clay.

Table 1 - Data obtained referring to a ton of clay.

		Ind. A	Ind. B	Ind. C
INPUTS	Electric power consumption (kWh/t)	23	11	12
	Thermal power consumption (MJ/t)	356	465	77.000
OUTPUTS	CO_2 Emission (kg/t)	0,0053	0,0032	0,0042
	Blocks (unit/t)	333	333	354

INTERPRETATION OF THE RESULTS

The data regarding the biomass show that the cane briquette (industry A) has lower calorific value and energy than firewood and sawdust (industry B) - however, as a byproduct, it can achieve better results and be used along with products of high calorific value, such as vegetable oil, used in industry C. The consumption of biomass in industry C is superior to other industries because of the use of the two methods of burning. Despite not showing lower results, it is possible to consider that industry C consumes less energy and has a lower amount of emissions by making more products with a ton of clay. In the phase of preparation of the raw material, the power consumption is very important and this can lead to the study of alternatives with positive contribution to the environment. The burning phase is relevant for the study of consumption of thermal energy for being the only step that uses biomass combustion. Performed by all industries analyzed, the use of firewood to start the fire in the furnace can be replaced by continuous briquette cane and fueled with vegetable oil, as both showed low CO2 emissions throughout the study.

CASE STUDY - SOCIAL INTEREST HOUSING

The typologies most commonly found in the state of Pernambuco are performed in ceramic block masonry for sealing - often used with structural function in the dimensions 9 x 19 x 19 cm, with eight holes horizontally, and concrete blocks with dimensions 9 x 19 x 39 cm. and built with area of 40 m². The masonry by ceramic blocks with eight holes horizontally (9 x 19 x 19 cm), settled and grouted with cement mortar and sand in 1:3 ratio. Considering 1 m² of masonry as a functional unit, it is possible to identify CO2 emissions and energy consumption for any building that uses the ceramic block as sealing material. For the construction of a social interest housing with 40 m², a total of 3.125 units of ceramic blocks were necessary.

Therefore, to construct a 40 m² house, it is necessary to consume approximately 139.15 kWh of electricity and 271.50 kg of biomass - which results in the emission of 0.038 kg / Nm ³ of CO_2.

FINAL CONSIDERATIONS

Preparation of the inventory from the LCA methodology allowed us to identify the inputs and outputs of the production system to qualify and quantify consumption and CO_2 emissions. It is an important tool for the study of environmental impacts for they may enable the realization of a diagnosis to make decisions that can define environmental quality and therefore, the quality of life of the society.

The ceramic block is the most used product in civil construction in Pernambuco characterized by low cost, easy access and use of unskilled labor. However, the intense use of this material affects the environment, either solid or gaseous. The value of CO_2 emission may seem meaningless if used for manufacturing 340 ceramic blocks, however, when adapted to every house in housing complex; it is possible to scale its influence on global warming. Experimental research has allowed to identify that the utilization of biomass in the burning of the product may be a feasible alternative if used as a byproduct, such as the cane briquette. Firewood, although appears effective with high calorific value, may be replaced by cane briquette and also by vegetable oil. The use of furniture and vegetation residues may also be a viable alternative to the process of burning, in addition to contributing for the elimination of residues.

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