

## EXPERIMENT OF RECYCLING AND USE OF SOLID WASTES ON BRICKS PRODUCTION TO CIVIL ENGINEERING (BRICKWORK)

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**Abstract.** *The reutilization of waste materials that by routine harm the collective health has motivated since 1990 a research about the recycling of domestic solid wastes with objective to produce bricks and blocks for brickwork to civil engineering build industry. The pieces are produced from organic and inorganic wastes from where recyclable wastes were removed (disentanglement), triturated, mixed with materials of aggregation and compressed. The tenor of this article concerns the presentation of the results from experiments of compression strength and water absorption computation on bricks that there are in its composition 73% organic compound, fertilizer of organic waste origin, prepared only by handmade energies, from the disentanglement of wastes, sifting, treatment and compressing (pressure done by manual equipment). After compression each piece goes through a cold process and crystallization, into cover ambient and on natural way. The results of experiments that, in spite of revealing water absorption at 29% level, sustained the average 1,9 Mpa compression strength, reaching demanded levels at ABNT Patterns for ceramic materials (NBR 7170 and 6460). The research would also contribute to the decreasing of serious environment problems originated from antropogenic pollution inside the filled lands and sewers of wastes in urban areas.*

**Keywords:** *Brickwork materials, Recyclin, Solid wastes administration.*

### 1. Introduction

At United Nations Human Environment Conference, in 1972, accomplished in Estocolmo, the scientists had revealed worried about the exhaustion in a next future, of some natural resources that will not be renovated, such as oil and copper. The first report of the Club of Rome, called "the Limits of the Growth", divulged in 1971, foresaw a uncontrollable loss of life of the population in 2050, provoked for the exhaustion of the natural resources, as consequence of the increase of the industrial production and foods to assist the exponential growth of the population.

The great dividing landmarks of the process of ecological awareness that are influencing in the change of attitude of the society and, in this way, contributing to lever the pressures for the environment responsibility of the companies, are: the United Nations Human Environment Conference, realized in Estocolmo in 1972; the Brundtland Report, in 1987; and the United Nations Conference for Environment and Development, accomplished in Rio De Janeiro in 1992, when it was presented by the World Business Council for Sustainable Development - WBCSD, the proposal of ecoefficiency: "production of goods and services with competitive prices, that bring satisfaction and quality of life to the consumer, at the same time that it reduces the generation of pollutants and the use of resources, considering their total life cycle, at a level that could be supported by the Earth".

The world-wide average of residual productions in the last two decades exceeded the mark of 2.190 million tons/year, mainly organic residues, from anthropogenic and natural sources, that by the handling modalities, display these materials to the physical-chemical inclemencies, provoked by lixiviation. (SCHALCH, 1984) and (SCARLATO et al, 1992).

The exploratory research of these environmental problems caused by the urban and agricultural garbage deposits, guided experimental research of Civil Engineering since 1990, and specifically the laboratorial experiments performed in FEUERJ - College of Civil Engineering of the University of the State of Rio de Janeiro in 1999, (Soil Mechanics and Concrete Laboratories).

For such experiment in 1999, prototype bricks had been produced using a quaternary mixtures of organic compound (composed of organic waste origin stabilized by process of natural aeration or mechanics) - quicklime (CaO) - Kons 1 and 2 Kon stabilizers - cement of the Portland type (CP II), trying to get a material with performance and with mechanical strength properties and durability, evaluated for parameters of water absorption and compressive strength following the Brazilian norms. As it has supported to the experiment, had been also executed soil mechanics assays emphasizing the Characterization, Compacting, CBR and Sand Equivalent, using binary mixtures of waste origin composite and residues of workmanships (stucco).

And it was the perspective of reutilize residual materials that routinely harm the collective health, has motivated from 1990 a research on the recycling solid waste domestic products with the intention to produce bricks and blocks for the masonry construction for the industry of the civil construction. The parts are produced from organic and inorganic

wastes from where are removed the recycling wastes (disembarrassment), triturated, mixed with materials of aggregation, compressing.

This article presents the results of the experiments calculation of compressive strength and water absorption in the bricks that has in its composition 73% of organic wastes natural fertilizer, and only confectioned through manual activities, since the disembarrassment of the residues, passing for sifting, treatment and compressing (molding with manual equipment). After compressing each part goes to a process of drying and cold crystallization, in covered and natural environment.

## 2. Natural Composite Fertilizer Justification

The initiative of the use of this natural fertilizer there was on it the fact of perspectives in the bricks and blocks manufacture with binary and ternary mixtures of soil-cement and soil-cement-silica. The natural fertilizer is what could be called as a after-soil material or as a material that is the dust of the Earth. This product of the nature and the anthropogenic activities presents in its chemical and mineralogical composition the same elements found in soil, to wit, the layers and profiles of the terrestrial crust located in the horizon A (AZAMBUJA, 1979). And through the growth and vegetal reproduction, as a dynamic cycle hydrated silicate of aluminum, solar energy, photosyntheses and absorption of minerals on the soil fractions, transforming these mineral elements into the nutritional culture of societies, that after the partial consumption rejects parts in which will enter in process of deterioration and modification for friable particles (BRAGA, 2002).

As activity of improvement and reconstitution of soil, especially in agriculture and gardening, parts of the urban or agricultural solid wastes are lead the stabilization (natural fertilizer), through manual or mechanical handling emphasizing the oxygenation, and with the objective to speed up the natural process of these dejections. It is an activity in the cycle of the dust to the dust.

In the experiment in 1999 - FEUERJ, the natural fertilizer yielded for the COMLURB (Urban Cleanness Company of the City of Rio de Janeiro), presents particles with similar forms found on soil used in the mixture the soil-cement, that is, flattened forms, lamellar, angular and of needles, however with superficial area varying between 30 and 1700 m<sup>2</sup>/ kg.

And to form criterion of comparison with argillaceous materials, in face of characterization, had been executed assays of soil mechanics, esteem with binary mixtures of natural fertilizer - stucco, a comparative degree with the grit, widely used on reinforcement of sub-roadbed and sub-base of flexible road ways. In these layers, the reinforcement of sub-roadbed and sub-base, it is configured the grit compacting up to 3 layers with maximum height of 90 cm (total 270 cm), adjusting the soil base only when necessary, and locating them below of the final layers with asphalt.

In the evaluation of behavior in these assays, two binary mixtures with the following characteristics had been used:

- Mixture A – natural fertilizer 70.3% / stucco 29.7%, and
- Mixture B – natural fertilizer 80% / stucco 20%

Table 1 presents the comparative parameters that had stimulated the use of this natural fertilizer assays with massive bricks destined for packing walls, as NBR 7170.

TABLE 1 – SOIL CRITERIA

CHARACTERISTICS	MIXTURE A	MIXTURE B	GRIT
GRANULIMETRIC INDEX (NBR 7181)			REQUISITE (%)
Bolter n° 4 - 4,8 mm -	98	99	100
Bolter n° 200 - 0,075 mm -	26	29	10 A 50
Plasticity Index - NP			
Soil Classification (HRB) - A2-4			
CALIFORNIA SUPPORT INDEX (NBR 9895)			
Blows for layer (5 layers) -	26	26	26
Especific mass apparent soil maximum (Kg/cm <sup>3</sup> ) -	1.382	1.286	1.670
Optimum humidity (%) -	27,3	29,5	20
California Support Index – CBR (%) -	18,8	12,7	20 *
Expansion (%) -	0,68	0,87	< 1 *
SAND EQUIVALENT (%) - Average (3 test tubes) -	50,0	53,2	40 *

Source: LMS - FEUERJ - Certificate nº LMS - 043/CB-01 \* Minimum requirements for use in reinforcement of sub-roadbed and sub-base of flexible road ways, as method DNER-ME 049 and General Norms of the DNER - volume III/IV - flexible pavements.

### 3. Experimental Development

With the proper parameters of support, the assays had been planned for the verification of the possibility of anthropogenic residual material use, in the form of natural fertilizer, for completion of blocks / bricks for packing walls in compliance with norm ABNT NBR 7170 - Ceramic massive brick for masonry, and the verification of the engineering assays had been based on norm ABNT NBR 6460 - Ceramic massive brick for masonry - Verification of compressive strength. Thus the date of molding, i.e., lots 7d, 14d, 21d and 28d had been established as lots of prototype bricks according to dates of cure of the cement.

Even the natural fertilizer being a product with lesser incidence of bigger parts that 3mm, the material was lead to one disembarassment and manual sifting, followed by calcinations and the interaction process.

#### 3.1 Materials and Composition of the Mixture

The materials used in this quaternary mixture in this study, with destination to manufacture massive bricks, had presented for all test units the composition of 73% of natural fertilizer (the same volume yielded for COMLURB), and 27% of stabilizers, as mentioned, with optimum humidity of 26% at the molding moment, in relation to the total mass.

The performance of the stabilizers in this assay, says respect:

- Quicklime (CaO) – It is registered its interaction with the present humidity in the composition, raising teperature and developing bactericidal actions to the material, besides the cementant characteristic;
- Stabilizers Kon1/ Kon2 - for inherent reasons in the research, the concise description of the performance of this composition registers cementant factors and to wrap up the grains;
- Cement Portland type (CP II) - widely produced and used in function of its stabilizing characteristics.

#### 3.2 Confection of Test Units

They had been confectioned according to NBR 7170, 7 test units for dates 7 and 28, and 5 test units for dates 14 and 21, as demonstrated in figures 1 and 2 and 3. The dimensions executed in the molding had been 110 of width, 58 of height and 230 length mm, shaped in available equipment on Concrete Laboratory, being a rudimentary manual press without explicit mark. Despite the press having capacity to produce 3 parts for time, it was used unitary production.



Figures 1 and 2 – Molding of Bricks

Figure 3 - Massive Brick

#### 3.3 Drying

The modality of bricks drying chosen for this mixture is not forced, observing only the deposit of the bricks in aired place and on the shade.

#### 3.4 Assays

The assays for the evaluations techniques in agreement with NBR 6460 - Ceramic massive brick for masonry - Verification of the compressive strength, had followed the programming presented in table 2., having as analysis parameters the established boundary-values in NBR 7170 divided by categories, as represented in table 3.

TABLE 2 - Assays Program

ASSAY	PROCEEDING	AGE OF BRICKS (days)	N° of BRICKS FOR ASSAY / LOT
Dimensional verification	Individual measure	7, 14, 21, 28	5
Compressive strength	NBR 6460	7, 14, 21, 28	5
Water absorption	NBR 6460	7, 28	2 (total 4)

TABLE 3 – Minimum compressive strength divided by wall category

Category	Classification	Compressive strength (Mpa)
A	packing wall	1,5
B	packing wall	2,5
C	structural wall	4,0

Source: 7170 NBR jun/1983 p 4

Obs: The categories A and B qualify bricks for the confection of packing walls. Category C qualifies the structural function of the bricks, not being necessary the structure in concrete for the masonry.

With the use of this method, it was esteem to determine profits of compressive strength in relation to the time of cure of the cement. In the same way the referring assays the water absorption, carried through for the test units with dates of 7 and 28 days after the molding.

#### 4. Results and Discussions

Through this physical-chemical stabilization process, there was esteemed a organize resultant from the interaction and orientation of solid particles of the material (after-soil) with cementant and agglutinant substances, operating intergranularly and with granular confinement.

##### 4.1 Individual Measure

It was registered that the water absorptions and the dehumidify of test units, had not produced important volumetric variations, <2%, in compliance with the wet (48 hours immersion) and drying (oven) cycle.

##### 4.2 Compressive Strength

The presented average resistance in the lots (table 4) was configured in the category A, registering the average of 1,9 Mpa, with shunting line standard of 0,30. In compliance with NBR 6460, the test units had been immersed for 24 hours before the assay of compressive strength.

Table 4 - Results of Compressive Strength Assay (Mpa)

Lots	7d	14d	21d	28d
Lot average	1,76	1,91	2,0	2,03

Compressive strength average : 1,9 Mpa

##### 4.3 Water Absorption

The provoked humidity esteem the optimum humidity in the compression time, and promotes the necessary lubrications to the type of equipment, and presents relation with the humidity represented in the soil assay,

characterizing a capacity of maintenance of the stabilization of the material despite the average volume of 29% of humidity registered in the assays of water absorption.

## 5. Conclusion

The differentiation relative to NBR 7170 was configured in two of the main references. The first one mentions the composition of ceramic massive brick to be made of clay, and the second pointed the necessity of fire the brick. If not configuring in this experiment none of these two references. This norm however, was chosen as line of direction having itself the fact of in that laboratory habitually using as bedding on civil construction and then to be one that more adjusted to the type of recycled residual organic material in question.

The adequacy of this experimental stabilization esteem to provide factors as: economic viability, that will be able to contribute in the reduction of serious environmental problems, resultant of anthropogenic pollutions of filled lands and garbage sewer in urban areas.

In this experiment two requirements had been verified:

- the material in study can be characterized by not deteriorate when submerged in watery way; and
- presents coherent permeability with the necessary durability as the products for masonry.

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