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Reusing the Coconut Clay (Brick) as Construction Material

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Abstract

With the aim of finding an alternative for the manufacture of concrete, based on the recycling of construction debris and demolition of works, in particular the reuse of the clay blocks (brick), a mechanism that will serve to improve the visual appearance within The city and to diminish accumulation of these in vacant lots and even in the municipal dumps the investigation was developed, through the method of observation and experimentation in laboratory, field, and documentary. Different samples of cylinders made in a conventional manner were prepared, the brick powder was prepared, after being crushed by using the angels machine and then sieved to use the material according to the particle size in the mixture substituting 5, 10 and 15% of the cement with brick powder, the same one that was designed to obtain a concrete of structural type, with a resistance of 210 kg / cm2 (21MPa) for this the techniques of observation and experimentation were used in laboratory. With the results obtained it was concluded that a structural type concrete can be made for the manufacture of beams, columns, slabs, only replacing up to 5% of the cement in a mixture of concrete; If 10 or 15% of the cement is replaced, it can be used for the production of non-structural concrete, for the manufacture of floors, sidewalks, and curbs, blocks, among others. These results demonstrate the reuse of the material and the reduction of the negative impacts that these produce in the environment.

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1. Introduction

In the year 2012 at the Pedagogical and Technological University of Colombia, studies were carried out for the reuse of bricks as coarse aggregate material, which consisted of replacing in percentages from 10% to 30% of the natural coarse aggregate by the recycled aggregate. In order to determine the percentage that would be convenient to use in a concrete mix, mortar was made by replacing 10%, 20%, 30% of the natural coarse aggregate, the results indicated that the resistance decreased between (2-6) % Of the design strength, obtaining as a conclusion that it can be replaced up to a maximum of 30% as coarse aggregate material in the elaboration of concrete for structures (Rojas Angela viviana Perez, 2012).

In 2015 at the Polytechnic University of Valencia, researchers from Spain and Brazil studied the preparation of concrete with ashes from sugar cane residues, resulting in a 30% decrease in Portland cement from this ash. In this same research, we have to study aspects such as the durability of mass concrete and reinforced concrete (Tashima & João Cláudio, 2015). In 2006, the National Technological University of Santa Fe, Argentina, at the Center for Research and Development for Construction and Housing (CECOVI), carried out an investigation that consisted of using recycled brick and debris as coarse aggregate for the production of concrete.

This same work was intended to replace all the aggregate coarse natural of a mixture of concrete with arid coming from the demolition of structures that contained debris and bricks the same that they had to be previously crushed. The results indicated that it is not very favorable to implement this technique for the preparation of concrete, since the results obtained for the calculated dosages give less than those of design, concluding that this type of element can be used for the elaboration of blocks for wall , Construction of sidewalks and curbs and counter-floors for homes (Suarez *et al.*, 2006).

The research aims to know the mechanical properties of cooked clay recycled from the bricks, when used as a component material of the concrete, aiming to reduce the pollution produced by the rubbish that is thrown in the municipal dumps and the exploitation of the raw materials Of concrete (cement, sand, and coarse aggregates). Concerned about the controllable exploitation of resources, and the care that must be given to the planet through the care of the environment and the environment around us, in order to obtain a better visual appearance without accumulation of debris in vacant lands. It has been decided to carry out an investigation in which the reuse of blocks of bricks that have been used in civil works is used, after a crushing process can be used as a component of the concrete, making a substitution to the percentage of cement That is used.

It is the reuse of building materials and demolitions, which can serve as raw material after being subjected to a physical-chemical or mechanical treatment. With the recycling it is intended to recover building materials, which can be given a new use or that would serve as a binder for the elaboration or manufacture of another material, thus making the respective reuse of the Construction and Demolition Waste RCD, Which would consequently economize the exploitation of raw materials, energy and water for the generation of new products and lower levels of environmental pollution. Ecuador is seeking the creation of new recycling techniques for waste generated by the construction and demolition of houses, buildings and concrete roads; Seeking to obtain in the future the development of a country with new standards for the use of RCD recycled in the elaboration of concrete used in the construction that will or will generate a less environmental impact and lower construction cost.

Cement is a finely ground inorganic material which is kneaded with water, forms a paste that sets and hardens through reactions and hydration processes and, once hardened, retains its strength and stability even under water (IECA, 2016). Is usually used in construction works, using them to cover, plaster and fill holes, among others. The final stage of cement production ends in Clinker crushing with 5 - 7% gypsum, this varies in the range according to the type of cement to be manufactured, the function of the gypsum is to retard the setting time of the cement. Cement roller mills contain metal balls which, as the mill rotates the balls, perform their grinding function by means of friction with the material (Clinker composite and gypsum) resulting in the fine powder called cement (Sanjuán Barbudo *et al.*, 2014).

2. Materials and Methods

In order to carry out the investigation, debris was selected at different sites in the city of Portoviejo, including waste landfills. Different samples of cylinders were prepared, some of them manufactured in a conventional way and others were added brick powder (cooked clay). The same one that, after being crushed by the use the machine of the

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Angels was sieved, and was replaced by the cement in proportions of 5, 10 and 15% according to the obtained dosage.

To determine the cement content in the dosage, the apparent volume of the coarse aggregate was calculated, the weight of the aggregate was determined, the volume of cement, water, coarse aggregate and the volume of trapped air was established, then the volume of Fine aggregate taking into account its weight and volumes for a m3. Different tests were carried out to know the moisture content of the fine and coarse aggregate; As well as procedures for collecting data from the trials performed.

The tests of the fine and coarse natural aggregates were made, according to the Technical Standards of Ecuador (NTE), among the tests carried out are: Granulometry (NTE INEN 0696), Density (NTE INEN 0858), Specific Gravity and Absorption (NTE INEN 0856 - 857), Moisture content (NTE INEN 0862), clay was tested for specific weight and saturated and compacted unit weight, for fresh and hardened concrete, Determination of settlement (NTE INEN 1578), Elaboration of concrete cylinders (NTE INEN 1576), Compressive strength of concrete cylinders (NTE INEN 1573).

3. Results and Discussions

According to Barranzuela (2014) as described by (Rhodes *et al.*, 1990), the granulometric distribution is an important variable for the physical characterization of the clays, since it will depend on the degree of packing of the particles and, therefore, the properties Physical-mechanical properties of clay elements such as porosity, water absorption, flexural strength, among others. Because the size of the clay grains can vary greatly depending on the type of clay being referred to, the physical properties of the clays also vary, their properties depend on their mineralogy, physical state and geological history of the clays, The plasticity that is the main property of the clays, which refers to the ability to maintain in the form given, with a certain amount of water added, the contraction that produces a decrease in the dimensions of what is Is molding to lose moisture, the refractoriness that is the resistance to temperature increases where the chemical content of alumina and silica intervene the more percentage of these the greater will be this. Another of the properties is porosity and color; if the clay has a large grain size the porosity will be greater than that of clay with a small grain size, these are presented with varied colors, being the purest clay, but in general they are more or less gray, sometimes blue or black, and often yellow, red or brown. The different shades depend on their chemical content but in this case, it is not determined by the silica and alumina content, but the causes of the coloring are determined by the impurities of both mineral and organic origin, mainly: iron oxide, cobalt oxide, Copper oxide, vanadium pentoxide, cobalt, and manganese oxide (Barranzuela, 2014).

Based on these concepts, the experiment was designed that will allow knowing the properties of the construction residuals collected for its investigation. For the preparation of the concrete cylinders, the molds of 10 cm in diameter by 20 cm in height were selected, afterwards the mixtures were elaborated and then the settlement test was carried out for each one of them, according to how it (NTE INEN 1578), the filling of the Abrams cone was done in three layers, compacted with 25 strokes each, filled the mold and removed it within 5 seconds proceeding to measure the settlement of the mixture. The values of settlements obtained in each mixture are described in Table 1, as it can be seen, with 5% of the clay powder, a settlement is obtained close to that of conventional concrete, and it can be observed that it can be replaced without any significant change in its settlement.

Table 1
Settlement tests with different clay results

Type of mixing Set in mm	Type of mixing Set in mm
Conventional concrete	80
5% clay powder	80
10% clay powder	50
15% clay powder	50

At the end of the settlement test, the filling of cylinders was performed, where 24 specimens were selected, according to (NTE INEN 1576) where each was filled with two layers, each layer was compacted with 25 strokes using a rod Of 10 mm of diameter of hemispherical tip and with 15 blows distributed in the outside of the cylinder with a hammer of rubber, in order that the mixture is well compacted and leaves all the air trapped in her. After the filling was completed, the cylinders were roughed and allowed to set for 24 hours, after the decoupling was performed and placed in the curing pool.

For the preparation of cylinders, six samples were selected for each of the samples, with different components, starting from a standard sample with natural aggregates and the other cylinders with the different percentage of material as shown in Table 2.

Table 2
Component of the test specimens for the preparation of the cylinders

Number of cylinders	Design
6	Cement + water + coarse and fine aggregate
6	Cement replaced 5% with clay powder + water + coarse and fine aggregate
6	Cement replaced 10% with clay powder + water + coarse and fine aggregate
6	Cement replaced 15% with clay powder + water + coarse and fine aggregate

According to what was established in (NTE INEN 1573), the compression test was performed at 3, 7, 14, 21, and 28 days, with the cylinders to be tested on the selected day to be removed from the curing pool And then let them drain for a period of 15 minutes and thus carry out the test corresponding to each day. To obtain the results and graphs required of the test with the mixtures carried out in a conventional way, with 5, 10 and 15% of clay powder. In Figure 1, the results obtained from conventional concrete are observed, in the 28 days, they show greater resistance than the requested one, being able to be used as structural concrete.

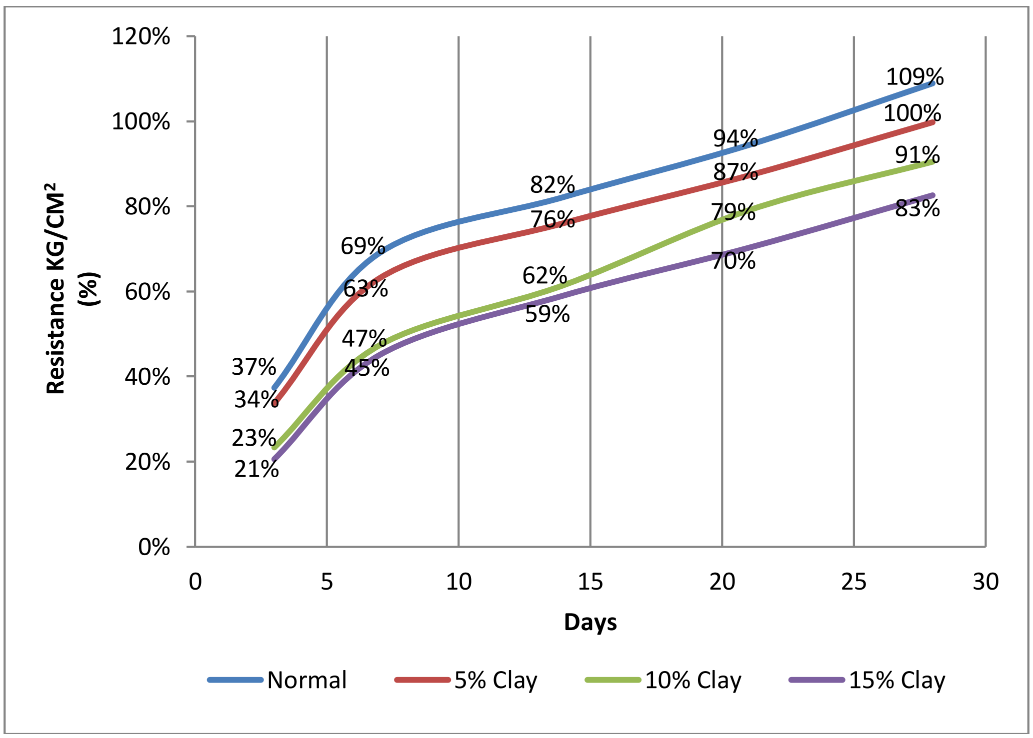

Figure 1. Compression results with different components

The first results obtained can be shown three days after the curing, where the concrete resistance with a percentage of 5% is close to the values of conventional concrete, according to ASTMC23M (INEN 1572). At 28 days after the cylinders were prepared, the results of the compression test determined a resistance of conventional concrete 228.62 kg / cm2 (109%) and concrete with 5% of clay powder 209.36 kg / cm2 (100%), obtaining The expected strength (21Mpa), although the other results do not reach similar values, can be used as a non-structural concrete that can have different uses such as the replant, blocks, underlayment among others with mixtures of concrete based Of 10% clay powder 190.10 kg / cm2 (91%), of the concrete based on 15% clay powder 173.35 kg / cm2 (83%).

It can be considered that with the obtained values other results could be obtained using super plasticizing additives that would enhance the resistance of the concrete from RCD since the clay absorbs more water in the setting process. In Figure 2, the physical appearance of the collected material (debris) (A), the treated (B) and the final result in the concrete (C) can be observed.

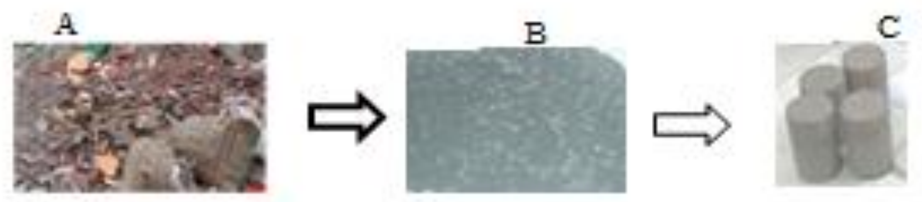

Figure 2. Physical appearance of the material

Provide a statement that what is expected, as stated in the "Introduction" chapter can ultimately result in "Results and Discussion" chapter, so there is compatibility. Moreover, it can also be added the prospect of the development of research results and application prospects of further studies into the next (based on result and discussion).

The research made it possible to reduce the levels of pollution caused by demolition or reconstruction waste in the city of Portoviejo, even more so after the earthquake in the province of Manabí, with many of these materials being relocated to areas where they were reused Reducing the pollution, the visual and aesthetic appearance of the various sectors affected by the debris. At present, it is proposed to reuse blocks of cooked clay (bricks), to limit the production of these residues in municipal dumps or in vacant lots and even to reduce the use of natural resources in the preparation of concrete, achieving a better Ecological balance, reusing a discarded construction material and producing in the future a sustainable and profitable society with the use of this mechanism.

It is also possible to produce more economical concrete, through the reuse of the blocks of cooked clay, with this reduces the consumption of cement and the costs that this entails, since the concrete is the most used material in the constructions of houses, buildings, Bridges or in any civil works, recycling RCDs will help members of the community to generate new sources of employment that help improve the economy of a given society.

This research analyzed several strategies for the reuse of cooked clay (brick) as a building material, among them were the availability that is linked to the volume of existing material as well as the places of production, processing of the product, which Take with them the technology used to transform waste into a new material with added value, another factor is the economic feasibility of obtaining the recycled material and the cost-benefit analysis that it represents, and the disclosure that would be in society to increase Interest and use.

4. Conclusion

According to the results of the compression tests obtained at 28 days, it is established that the blocks of clay can be reused (bricks), replacing up to 5% of the cement with clay powder in a mixture of concrete of a structural type. The residues studied can be reused in nonstructural concrete in proportions of 10 and 15%. The reuse of these materials helps to mitigate the environmental impact generated by the exploitation of the raw material in the manufacture of cement, also improving the quality of the people going.

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Statement of authorship
The author(s) have a responsibility for the conception and design of the study. The author(s) have approved the final article.

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