

Preparation and characterization of masonry units, lightweight concrete based and agro-industrial wastes: a review

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Abstract. Discussion about the new composite materials that integrate agro industrial residues for the masonry unit's production, which are directed towards its implementation in projects of affordable housing, is a subject of interest to the public and productive sector of the country. For this reason, it presents a descriptive review of primary and secondary sources, which support the project under study. The methodology consisted in finding research articles in databases supported by the scientific community, which are ordered, integrated and prioritized, creating a matrix synthesis, which condensed the objectives, type of material, studied properties and main results found. It was found that the composite materials for masonry use mainly clay or cement as matrix and as reinforcement, agro waste like paper fibers, bamboo, rice husks, among others are used. Moreover, the properties that determine its potential use are low density, stress resistance and low thermal conductivity. Comparing the results with traditional specimens as the block of clay, concrete, adobe vs. experimental models made of the compounds analyzed, favorable results were obtained in the case of integrating waste materials into its composition, optimized their properties. Thus, science and architecture converge through recognition of the properties of materials that expand the alternatives of building spaces, economic and environmentally sustainable.

1. Introduction

Technological developments and the gradual progress in society have deeply impacted the environment becoming more visible its gradual decline coupled with increased energy consumption and emissions of the same product. According to the work done by Vargas Robles [1], the construction sector is one of the fields that degrades faster emerging territory hence the need to develop and use materials that are more easily integrated into the environment at the end its useful cycle [1-7, 11, 12, 15-22]. This paper seeks to publish the results of the development of two composites used as source added agro-industrial wastes. The results of such materials for possible use in masonry pieces where optimum performance is essential for its mechanical and thermal properties were analyzed [5-7].

Concerns about which are reflected in this study are based on discussions raised in the master of science and technology of materials and architectural plan of the University Francisco de Paula Santander where two aspects of great significance converge: material innovation [10] and the need to design a product that would facilitate the development of low-cost building systems for housing of priority and in emergency situations. All framed in constitutional rights of access to adequate housing [8-9].



This work will allow the architecture curriculum form a line within a research group that plans to consolidate in the field of advanced materials applied to construction.

2. Materials and methods

The methodology used was a descriptive review of articles, books and works published in scientific grade which were obtained through databases such as Redalyc and Science Direct among others, the reliability criteria whereby it was determined that the items and the works selected were appropriate, at the same time were endorsed by the publishers of such committees and databases highly regarded in the scientific.

3. Results and discussion

It was reported that masonry units made from lightweight concrete matrices with reinforcements hydrated lime and alum as well as lightweight concrete, silica and paper sludge, showed low thermal conductivity, high mechanical strength and lower density than unreinforced units. [1-4]. that in accordance with ASTM C 168 (ASTM, 1995,s.p), [11, 15, 16] over the standard terminology related to thermal insulating materials, where the cellulosic fibers act as insulators, usually derived from paper, cardboard or wood with or without binders for bonding. Thus as required by the ASHRAE [14], as the studied composites may be in the following classifications: a) As insulating cement, which can be a mixture of binder, reinforcing and dry additives, which when incorporating water could be applied in wet surfaces; b) As rigid material, by its possibility to be fabricated in block, panel or sheet.

Masonry samples prepared from clay and rice hulls and lightweight concrete specimens and paper sludge (1 to 5.22), reported a significant decrease in weight due to lower density of the material; in addition when comparing with the properties of common brick, block and concrete block adobe, its qualities were superior to yield better behavior by low thermal conductivity which places them at an advantage versus traditional materials (See table 1 and 2), obtaining as added value the reuse of agroindustry residuals which affect reducing costs and environmental impact.

Table 1. Density and thermal properties of brick adobe and silica mixture + paper sludge^a.

Properties	Brick	Adobe	Silica-Paper Sludge	Concrete Block
Density (kg/m ³)	1800	1620	855	2300
Thermal conductivity (W/m °C)	0.72	0.49	0.383	1.08
Specific heat (J/kg °C)	829	1240	1513	920
Thermal diffusivity (m ² /s)	*1.7x10 ⁻³	*8.7x10 ⁻⁴	1.02x10 ⁻³	1.84x10 ⁻³
Thermal Delay (h)	*4h 38'	*6h 32'	6h 28'	4h 31'
Thermal buffer (%)	*30	*18	18	*30
Thermal resistance (m ² °C/W)	*0.208	*0.306	0.391	0.138

^a Source [2].

Table 2. Compressive strength and density of local materials^a.

Material	Mechanical Strength (Kg/cm ²)	Density (Kg/m ³)
Common Brick	18	1800
Adobe	8	1620
Silica + paper sludge	34	855
Block	40	2100

^a Source [2].

4. Conclusions and recommendations

It was shown that there are now growing agro-industrial waste reuses as fly ashes, paper sludge, bamboo, rice husk, silica and others. Thus is raised the constant need for alternatives to conventional materials, offering opportunities in terms of their characteristics, and properties that allow the applicability in the design and construction of living spaces.

It was evident a significant cost reduction due to the utilization of industrial wastes as aggregate in foundation for its low volumetric mass and energy consumption for its artificial acclimatization. It further reported that Latin American countries like Mexico and Brazil are leading such research while in Colombia disclosure is still nascent.

It was evidenced that these studies are not made of materials analysis using techniques such as x-ray diffraction, scanning electron crystallography, which would allow a better understanding of the internal structure of the material.

These are used most commonly property evaluations known as physical mechanical strength, thermal and acoustic conductivity.

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