Characterization of materials formed by rice husk for construction

A M Portillo-Rodríguez

Aspiring Master Materials Science and Technology UFPS-Colombia

E-mail: asportilloro@hotmail.com

Abstract. This review article delves into the use of agro-industrial wastes, which in construction field provides alternatives for environmental problems with the use of them. This fact enables development and lower costs for new options in the brick, cluster, mortar and concrete industry, what represents benefits for environment, housing and generally everything related to construction, looking for sustainability. For that reason a literature review is made to support the theme focusing on the use of rice husk in its natural, ground or ash state for manufacturing elements with clay masonry, precast and optimization of concrete and mortars. The technique used is based on scientific articles and researches found in reliable databases that were analyzed and integrated into a synthesized structure, which summarized the objectives, analysis processes, the physical and mechanical properties and finally the results. The conclusions are focused on potentiality of elements production in the construction development based on the high effectiveness like thermal insulation, low density and various benefits offered by high silica content pozzolanic properties, etc.

1. Introduction

The excessive global population growth brings high demand for buildings with higher levels of comfort and to low costs, but it also appears the need to produce sustainable architecture in order to reduce energy consumption while lowering environmental impact. Around this, a worldwide interest in optimizing energy resources is growing as well as has the primary responsibility to promote comfort, it is also the most expensive component [6], therefore this brings the need for alternatives comprehensive address bioclimatic, economic aspects, material substitution technologies and environmentally friendly [10, 15].

Against this background it explores the use of rice husk that besides of being an agro-industrial by-product of big generation and accumulation of large producing areas around the world, it is emerging as an important alternative in the development of composite materials for possessing important features requirements for buildings such as thermal isolation, sound isolation, low density [5] force [15], porosity, in addition to its high potential as a source of SiO$_2$, which by their pozzolanic properties for strength and durability, important aspects in the manufacture of bricks, cement industry, paints, resins and plastics, among other applications [14, 18, 19, 21, 16].

This paper reviews the research on rice husk and its use in composite materials for construction, to provide an analysis of the results that will highlight the aspects studied and the results to guide future extensions and innovations in order to optimize processes and materials in the search for new applications and possibilities for development.
At Francisco de Paula Santander University it is generated a meeting point between architecture and materials science that provides wide space for common concerns, aimed at generating interdisciplinary exploration of new materials to help solve common situations needs of big part of population in search of low cost buildings, to optimize the characteristics of traditional materials, with ease of construction, and also with a reduced environmental impact.

2. Methods

The technique used for the development of this work lay in the review of scientific studies on rice husk oriented construction field in different countries of the world in the last 10 years, which were obtained in Science Direct, Redalyc, Publindex and Scielo, and other prestigious databases in science, determining factor in the definition of reliability criteria and inclusion of the results analyzed and synthesized.

3. Results and discussion

The results show that the development of composites with rice husk in different presentations is useful as an alternative to conventional materials substituent in construction and contributes to reducing the environmental impact caused by the waste products and of the respective burning [15].

It is reported that replacement of cement in a certain quantity by rice husk ash, primarily with chemical treatment improves the concrete, mortar and grout Portland cement, the characteristics of resistance to compression (see figure 1) [4] and flexural strength, durability and reduction of permeability [7, 11, 13, 14], appearance determined by the high content of amorphous SiO₂.

The obtained results show that the structure in concrete and mortars with added clay hull ash is different according to the fineness of the ash to be incorporated, where mixtures of rice husk ash ground are more homogeneous and compact for its amorphous state, as opposed to blends with rice husk ash naturally occur more open structures, and in addition to variables such as temperature and time, show changes in characteristics such as workability, compressive strength, water permeability and porosity [11, 12, 13, 18, 19].

Unlike the rice hull ash, the rice hull inclusion without incinerating in cement mixtures has disadvantages by its porosity, hygroscopy and organic content, which brings the water demand of the pulp segregation and consequently decreased strength [5]. But the use with or without pretreatment may provide interesting results in the incorporation of rice husk fibers in matrix composites with concrete, clay or synthetic non-structural applications because it provides significant characteristics of low density and high porosity that prominently located to produce building materials with thermal insulation properties (see table 1) and soundproofing. It is recorded that a greater amount of rice husk is obtained heat absorption [6], but their behavior is reversed related to particle size, which increases its conductivity by reducing its size [1].

The possibilities are evident that rice husk provides according to the various states in which they present, and in its natural state, ground, ashes, ground into ashes, ashes with different treatments and generally in different combinations; and according to this, it provides a variety of options for improving characteristics matrix composites with clay, cement or synthetic agglomerates, such as low thermal conductivity, low density, durability and resistance to degradation [1, 2, 5, 15, 17, 22, 24].

The results show that the main variables in determining efficiency and application possibilities of the material are determined at the process temperature, the heat treatment time and the presentation and the percentage of inclusion of rice hulls [1, 15].

There has been research that lead to generating more energy potential environmentally friendly sustainable obtaining rice husk ash, from the idea of taking advantage of the process in an integral way. The heat produced in combustion creates thermal energy that can be harnessed in different production processes, capturing flue gases including carbon dioxide (CO₂), Calcium Carbonate (CaCO₃) and other agricultural uses [9, 10, 23, 20, 21].
4. Conclusions and recommendations
This work shows that research is defined cost reduction versus conventional products, which determines that the use of rice husk provides many options in the field of construction, and well outlined the possibility to meet the demand in and increase accessibility to the entire population [7, 14, 16].

Materials with concrete, clay and polymer may be produced by using rice husk to satisfy needs durability, thermal and acoustic insulation, and low cost, even if not fulfill high quality standards in resistance, but possible for smaller buildings specifications [1, 6, 15].

It is clear that rice husk has drawbacks such as high organic matter content and moisture content, which requires treatment and controlled processes to optimize results, which provides that for the development of rice husk, technology and technical feasibility studies, economic and environmental, mainly in the case of the ashes should be introduced because the burning and grinding processes are major sources of pollution [9, 14].

References
[1] Gökhan G and Osman S 2013 Construction and Building Materials ScienceDirect vol 40 390
[2] Cruz J C, González J, Perdomo L, Rodríguez P 2012 Ingeniería Mecánica vol 15 115
[3] Calero F and Vásconez L 2012 Scientific Articles – Carer Mechanical Engineering
[4] Salas A, Delvasto S, Mejía de Gutiérrez R and Lange D 2009 Cement and Concrete Research 39 773
[5] Serrano T, Borrachero M, Monzó J and Paya J 2012 Dyna rev.fac.mynas 79.
[6] Sisman C, Gezer and Kocaman I 2011 Bulgarian Journal of Agricultural Science 17 40
[7] Memon S, Shaikh S and Akbar H 2011 ScienceDirect. Construction and Building Materials 25 1044
[8] Pineda P, Bedoya C and Rosales A 2011 Dyna 165 207
[9] Prada A and Cortes C 2012 Orinoquia 14 155
[10] Martinez J, Pineda T, Lopez J and Betancurt M 2010 Revista Facultad Ingeniería Universidad de Antioquia 51 97
[11] Alireza N, Suraya A, Fara H and Mohamad M 2010 ScienceDirect. Construction and Building Materials 24 2145
[12] Batic O, Giaccio G, Zerbino R and Isaia G 2010 VI International Congress on Pathology and Recovery Structures (Argentina: Córdoba)
[13] Rashid M, Molla K and Ahmed T 2010 European Journal of Scientific Research 40 471
[14] Mafla A 2009 Inventum 6 74-78
[15] Bedoya C, Pineda P and Rosales A 2010 Ingeniería y Ciencia 5 155
[16] Behak L, Peres W 2008 Revista Ingeniería de Construcción 23 34
[17] Aguila I and Sosa M 2008 Revista de la Facultad de Ingeniería 23 55
[18] Solarte S, Ospina M, Aperador W and Mejia de Gutierrez R 2007 Scientia Et Technica XIII 443
[19] Arcos C, Macias D and Rodriguez J 2007 Revista Facultad de Ingeniería Universidad de Antioquia 41 7
[20] Valverde A, Sarria B and Monteagudo J 2007 Scientia Et Technica XIII 255
[21] Ahumada L and Rodriguez J 2006 Rev. Acad. Colomb. Cienc. 30 581
[22] Cadena C and Bula A 2002 Ingeniería y Desarrollo 12 1