International Journal of Sustainable Development, Volume 4, Number 8, 2011

POTENTIALS OF AGRICULTURAL WASTE COMPOSITES AS BUILDING MATERIALS IN NIGERIA

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ABSTRACT

The quest for sustainable building design, materials and construction has resulted in the creation of more awareness about the use of agricultural waste and natural fibre composites as building materials. There had been efforts by many research and development organizations and other funding agencies to provide the much needed thrust for the transfer of available knowledge and product to the end users. Rich agricultural waste can be found in most countries especially the underdeveloped ones. A large part of these waste composites are either used as fuel or allowed to decay in the farm land. In Nigeria over 100 million tonnes of agricultural waste are produced annually. These agricultural waste fibres have properties that can be harnessed and utilized more effectively as composites building materials. This study provides an overview of agricultural waste composites used as building materials. Also, the advantages of using these composites and their potential growth in the future are also discussed.

Keywords: Agricultural Waste, Building Materials, Composites, Sustainable Development, Fibres

INTRODUCTION

The over dependence of many nations including Nigeria on petroleum based materials have had so many impact on the environment. The development of an alternative to these materials offer opportunities for environmental gains and reduced energy consumption. Non-renewable materials such as fossil fuels and minerals have dominated the goods manufactured industry. However, the utilization of these products is associated with problems such as increasing costs, environmental degradation due to extraction, processing and disposal.

The construction industry including the building sector contributes majorly to the degradation of the environment through different means. All nations of the world are face with the challenges of the deforestation of the natural resources, atmospheric pollution, energy consumption and waste generation. As the population of Nigeria increases, the demand for wood fibre is also expected to increase. Agricultural waste fibres can replace or assist in satisfying the need for wood fibre. The benefits of utilizing agricultural waste as building materials include developing a value-added product from fibre source that is currently not well utilized as well as decreasing demand for conventional building materials.

Globally, building construction is responsible for the current consumption of 25% of wood and 40% aggregates, 16% of water and 40% of the energy annually spent (Braganca et al, 2002). The high demand for building materials in Nigeria and over dependence on the importation of building materials resulted into high cost which has also led into haphazard development of the housing sector. Locally sourced building materials in Nigeria, which would have facilitated sustainable development, remain underdeveloped to a socially and economically acceptable level owing to the low level of development of the economy (Adedeji, 2007). In recent times, there had been demand for the development of new technologies that will harness available sustainable materials such as agricultural waste into composites that will substitute other building materials. This new technology is to also allow for the reduction of labour, time and cost.

Agricultural wastes have been used in various types of applications which include building materials, fuel, animal feeds, farm manure etc. Agricultural waste composites in form of bio-composites are today emerging as the replacement to glass fibre reinforced composites. These are environmentally friendly and help in eliminating the high cost of using petroleum-based materials. In India, organic boards have also been developed. In addition, researchers have developed a variety of building material utilizing industrial and agricultural wastes that integrate cement and cementitious materials as binders. These combinations are utilized to make composition boards, flooring tiles, roof sheathing and water proof coatings (Mohan, 1978). A study carried out by Adedeji and Ajayi (2008) reveals that, it is possible to produced dimensional kernel fibre with Portland cement-bonded particle boards using Palm Kernel fibre with Portland cement binder after hot water treatment.

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This study is therefore aimed at providing an overview of agricultural waste composites which can be successfully use as sustainable building materials to improve on sustainable development in the building industry.

AGRICULTURAL WASTE COMPOSITES IN NIGERIA

The Nigerian nation with huge arable lands devoted to grains and other annual crops can be seen as both a forest and agricultural nation. The main objective of farming is the growing of grains and other seeds. There is therefore a great interest in developing uses for residues that are currently burned or ploughed back into the ground. In Nigeria, many people have explored the possibilities of using natural fibres from different plants which can be use in the production of hard boards and particle boards. Some of these agricultural wastes have been used as pozzolanic materials as mineral admixtures in the production of concrete.

Agricultural waste fibres are abundantly available locally in Nigeria and extracted from renewable resources. The most promising sources of agricultural waste fibres for composites products in Nigeria are wheat straw, corn stalks, jute, bagasse, rice husk/stalk, saw dust, bamboo, palm kernel and other grain straws/stalks. Rice straw which is used to produce fibre board is the most important lignocellulosic material.

Agricultural waste such as wood fibres, jute, sisal etc as natural fibres can be combined to form bio-composites. These offer many advantages such as renewability, recyclability and biodegradability. The advantages of agricultural fibre composites include;

1. They are renewable resources and required low energy during production.
2. They are natural organic products with no dermal issue for their handling.
3. Agricultural fibres are non-abrasive and exhibit great formability.
4. They of light weight.

Composites are fibrous materials derived from agricultural waste, trees, and plant or shrubs sources. They contained fibres usually seen as natural fibres as wood, bamboo, wheat, jute, sisal and cotton stalks. Due to lightweight, high strength to weight ratio, corrosion resistance and other advantages, natural fibre based composites are becoming important composite materials in building and civil engineering fields (Amit and Jha, 2009). Agricultural waste can be used in the production of pozzolans and agro-fibre composites as materials for building construction.

AGRICULTURAL WASTE COMPOSITES AS MINERAL ADMIXTURE (POZZOLAN) IN CEMENT

Agricultural waste fibres have been used in the production of fibre cement composite. Among different fibres that can be used in cement based composites, agricultural waste fibres offer various advantages such as availability, renewability, low cost and dimensional stability. The application of agricultural fibres in cement composition improves the toughness and post cracking of the matrix. Fibre cement composites can be used to substitute asbestos cement productions. According to Matawal (2005), the workability of concrete blended with the shell and fibre ash of oil-palm waste has good workability and setting time well within the requirements of international codes.

Study on the possible utilization of the agricultural waste materials Rice Husk Ash (RHA), as a filler composite in the construction industry has been experimented by different researchers. Some of the results obtained reveal that, RHA could be used in partial replacement of cement as an active addition, or pozzolana, in mortar and concrete production. Saw dust ash (SDA) has also been used as admixture in concrete. However, a study conducted by Matawal (2005) on the partial replacement of cement with saw dust ash (SDA) indicated that there is a gradual loss of concrete strength with increase partial replacement percentages and it may not be necessary to use replacements beyond 10%.

Bagash (sugar cane fibre) ash had been used as a partial replacement of cement at up to 50% level. Bagash ash in concrete actually enhances imperviousness of concrete while reducing it workability and increasing the setting time. A study conducted by Aigbdion et al (2010), shows that the presence of oxides and carbon in the ash of bagasse will make it suitable for refectory and ceramic products such as insulation, membrane filters and structural ceramics. Other agricultural waste fibre used as pozzolanic materials includes groundnut husk ash (GHA), Acha husk ash (AHA) and ashes from other agric-waste stalks/fibres. Experiments carried out on these agricultural waste stalk/fibres proved that, they can be viable options as admixture to mortar and concrete, which can be apply in the construction of pipes, sandcrete blocks and mass concreting.

AGRICULTURAL WASTE COMPOSITES AS BIO-COMPOSITES PANELS

The performance of bio-composites depends on the properties of the natural fibres used in them. However, using natural or agricultural fibres in building materials has also some disadvantage such as low modulus of elasticity, high moisture absorption, decomposition in alkaline environment or in biological attack, and variability in mechanical and physical properties.

Straw is also used in particle boards. Due to their low density, panels produced from straws are resilient and more likely resistant to earthquakes. Wheat straw has potentials for the manufacture of a number of board products, including a substitute for high quality interior particle board, medium density fibre board type product, and structural particle board (Bach, 1999). Rice husks are quite fibrous by nature and required little energy input to prepare. It has been used for the manufacture of particle boards. However, particle boards from rice husks have not found commercial acceptance because of substantially higher quantities of adhesives required to yield board with acceptable properties (Chung and Todd, 2002). The residue fibres from sugar cane processing (Bagasse) is also utilized in the making of particle boards and composition panel production.

Jute composites provide an economic alternative to wood for the construction industry. It can be use as face veneer on wood ply boards or as natural fibre reinforcement panel boards. Jute composite boards and panels can be use for partitioning, surface panelling, roofing, furniture, wardrobes etc. Palm Kernel fibre, a by-product of palm kernel has been used for composite panel technology. Composite panel technology wall panel have been experimented in a number of projects in major cities in Nigeria and particularly for students' accommodation in Ambrose Alli University, Ekpoma, Nigeria (Adedeji and Ajayi, 2008). This system is cost efficient, less labour dependent and also faster.

In Peru, bamboo and wood fibres have been used in prefabricated panellized construction. In this kind of construction, low technology methods are used for prefabricated panels of bamboo and wood fibres. In the Northwest region of the United State, wheat and ryegrass straw fibres are utilized for the production of panels (Loken et al, 1991). Bamboo is well known in the tropics as a popular construction material which possessed excellent physical and mechanical properties. In India for instance, bamboo mat boards, bamboo mat veneer composites and bamboo mat corrugated sheets are manufacture in commercial quantities. These composites have been used as excellent eco-friendly roofing products.

AREAS FOR FUTURE RESEARCH AND DEVELOPMENT

Building components made from agricultural materials fall into the same product categories as other wood based composition products. Low density insulation boards, medium-density fibre boards, hard boards, particle boards and other building components such as walling and roofing can be manufactured using agricultural fibres. Binder used may be synthetic, thermosetting/thermoplastics, resins, modified naturally occurring resins like tannin or lignin, starches and other organic and inorganic binders, or no binder may be required at all. There seem to be little restriction to what has been tried and what may work. However, the availability of agricultural fibres in large-scale in different regions of the world suggests that a lot of research and development work is required for proper utilization of available natural fibres.

The major problem that may be associated to the utilization of these agricultural fibres is related to knowledge of the technology involve in the extraction of fibres, chemical and physical characterization, possible modification of the fibre interfaces and the processing techniques. Agricultural waste composite research should focus on the development of structural exterior grade materials in order for them to play a larger role in housing and infrastructure development. As a result, more research and development is required for the extraction and characterization of the basic materials for the up scaling of technology from laboratory scale to commercial level. This will go a long way in enabling sustainable development.

CONCLUSION

The environmental loss suffered by the society due to the pollution generated during the production and recycling of certain building materials especially synthetic based materials has drawn attention towards the use of natural and agricultural fibres as composites in building materials. Different studies conducted on agricultural and natural fibre has established that the fibres are versatile materials for application especially in rural areas than to high-tech application. These naturally available materials are supposed to be used in order to save the environment and energy consumption which is required in the processing of man-made synthetic composites.

Despite volumes of wood residues for the composites industry, there is increased interest in use of agricultural residues for composites panel manufacture. Different ways in which agricultural waste fibres are modified and used in so many parts of the world have brought it to be at par and in some instance superior to

synthetic fibres and other admixtures. This study provides a new direction in achieving sustainable building materials and development, and new technological innovation for the usage of agricultural waste fibres to improve on the environment.

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