Sustainable Development of Panel Products in Wood Technology: A Way out of the Global Economic Meltdown

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Abstract
The high cost of building materials in Nigeria brought about the concerted efforts by replacing conventional ceiling products with wood cement boards. This paper introduces the principle of sustainable development of wood based panel products as one of the ways to reducing the global economic meltdown. It also indicates that with the use of indigenous materials for the production of panel products like ceiling board, a reasonable reduction in the price of conventional asbestos for ceiling installation will be achieved. The study further shows that the use of wood wasted from a variety of sources for value added products and employment generation expected reduce the pressure on the timber exploitation thereby providing a way out of the current globa economic meltdown.
Keywords: Wood technology; sustainable development.

Introduction

The global economic meltdown and the dire need of affordable buildings for the teeming masses call for sustainable development of wood based panel products which would serves as alternative and better competitor to the conventional asbestos, which is highly expensive. The future holds a great promise for the use of cement-bonded particleboard as a sheet element in the building construction industry.

Urban centres are growing at a faster rate with high demand for shelter coupled with increase in population even at the rural areas. The population growth poses a lot of problems and challenges to all tiers of government. Several attempts to ameliorate these challenges are evident from the various housing policies of both State and Federal Government in Nigeria and in fact in the entire world at large.

In Nigeria, it has been reported that global inflation and foreign exchange problems have led to frequent difficulties being encountered in the production of resin bounded particleboards, because the resin adhesives used are either imported in finished forms of in raw components (Badejo, 1983). For these reasons, resin binder has been indicated to account for about 65% of raw material input cost of particle board production in Nigeria (Omoluabi, 1982). Due to these factors mentioned above, increasing research interest has focused on the development of alternative source of binders for wood based panel production in Nigeria. One attractive area which is more widely looked into is wood-cement board manufacturing since the cement binder required can be locally sourced in Nigeria. The

development of wood cement particleboard should aim at achieving a combination of the advantages of the properties of wood which include its relatively low density, toughness, high tensile strength and elastic properties and those of cement such as high stiffness, its resistance to moisture and bio deteriorating agents.

Wood-Cement Board.

Wood-cement board has been defined as composite panel products made from wood or other lignocellulosic raw material, an inorganic binder such as cement, chemical additives and water (Simatupang et al. 1978). As reported min literature, cement became an important binder for panel products in the 70s when prices of petroleum sky-rocketed in the developed nations thereby affecting the activities of the petrochemical industries which manufacture the organic resin used in the panel products manufacturing industries(Moslemi, 1974; Gracia, 1981). The acceptance of wood-cement board can be associated with its high potential as a constructional material for building of low cost houses. The boards have lots of advantages over resin bonded particleboard in that they are highly resistant to fire, fungus and insect attack. They are also resistant to moisture uptake and are highly dimensionally stable under fluctuating relative humidity.

Wood-cement boards are usually produced in a variety of forms, which include plain board or well designed board with various patterns. Therefore, urgent attention is needed on the use of wood-cement board as building material for low housing because of the high cost of resin binder and that of conventional asbestos. The following reasons justify the use of wood-cement board as one of the materials for building construction as against conventional asbestos.

- The two major components (sawdust and cement) can be found locally compare to the resin adhesives used for particleboard, which is being imported.
- This will conserve the foreign based and stimulate export earnings.
- It will encourage the utilization of any form of wood residues, lesser utilised timber species and other lignocellulosic biomaterials.
- It will provide various grades of building materials for future needs in construction works and residential buildings.
- It can be engineered to be more dimensionally stable than any other common wood products.
- It is environmentally suitable and friendly, as it does not leach harmful chemicals or gases.

Wood-Cement Boards Production: Board Formation and Conditioning

Preparation and treatment of materials should be in accordance with a modified Technical Association of Pulp and Paper Industry method (2002) standard. Water soluble extractives should be removed by soaking wood fibres in hot distilled water in an insulated container to maintain constant temperature at 80^{o}C for 4 hours. Thereafter, the wood residue should be air dried in the laboratory environment at room temperature for 20 days to attain 12% moisture content. The air-dried sawdust should be screened with a 2 mm sieve to remove fine dust, while the coarse particles should be stored in sealed polythene bags to minimize changes in moisture content.

Ordinary Portland cement could be purchased at Ado-Ekiti from a fresh consignment. I n order to prevent the cement from absorbing atmospheric moisture, it should be packed and sealed in polythene bags. The process to be used for board production are cement-sawdust ratio of 3.0:1, nominal board density of 1200 kg/m^3 and additive concentration of 3% of cement weight (Weight/weight basis) in each board produced. The amount of distilled water to be used could be calculated based on the formula developed by Simatupang (1979).

Water in litre = 0.35C + (0.30-MC) W
Where C = cement weight (g)
Mc - Moisture content of wood (%)
W Wood weight (sawdust weight)(g)

The quantity of cement and sawdust required for each board must correspond with the desired board density and dimension. The quantities of those materials required will be weighed using triple beam balance.

The weighed sawdust would be placed in a mixer and a solution of $CaCI_2$ would also be sprayed uniformly on it while stirring. The predetermined quantity of ordinary Portland cement would be added and the slurry thoroughly mixed until homogenous sawdust, cement and water is formed. The mixed composite would be distributed evenly into a wooden mould of 600 mm x 600 mm on a caul plate that would be covered with cellophane (to prevent sticking of the board to the plate). Another caul plate would be placed on the felted mattress and compressed until the upper plate closed up to 8 mm "steel stoppers." On reaching the 8 mm "steel stoppers" the caul plates would be held in a position with bolts and nuts to keep the mattress under pressure for 24 hours. Thereafter, the boards would be removed from the moulds. After removing those boards from the press, they would be conditioned by stacking them in the laboratory for 28 days (curing period) in order to allow for full curing of the cement binder. Thereafter, the boards will be trimmed and either be packed for sale or some samples be cut into test specimens to monitor the quantity. The test specimens should be kept under laboratory environment at relative humidity of 65 ± 2% prior subjecting to various tests.

Table 1: Board Production Matrix

Cement	**Sawdust**
Density: 1200 kg/m^3 Treatment	Ratio: 3.0.15
Total	5

Test on Cement-Wood Based Particleboard

After 28 days curing, standard test board samples of 8 mm x 50 mm x 150 mm should be tested on a Hounsfield Tensionmeter machine. Load would be applied at the rate of 0.1mm per second on the centre of each board sample until failure of the test sample occurs. The load at which each board sample fails should be recorded and the data obtained be used to calculate modulus of rupture (bending strength) while modulus of elasticity (stiffness) would be calculated from the values obtained from the load-deflection graph plotted on the same machine. Another boards specimen of 50 mm length x 50 mm (width) x 8 mm (thickness) should be tested for thickness swelling and water absorption. Water absorption would be calculated from the increase in weight of the specimen, while the thickness swell would be computed from the change in dimension prior and after water soaking. Cyclic water-soak and oven-dry experiment would be carried out to determine the thickness changes of cement-bonded particle board made from cement and sawdust following cyclic exposure to oven drying and 48-hour water soaking while another set of these boards would be subjected to termite infestation in a termite prevalent environment at College of Education, Ikere-Ekiti in Ekiti State. Periodic inspection would take place while the level of degradation would be assessed based on American society for Testing and Materials Standard.

The cement-wood ratios of commercially produced cement bonded boards (CBBs) range from 2.73… to 3.0:1 on a weight basis (Anonymous 1977). Oyagade (1990) also reported that the density of commercially produced cement bonded boards' ranges from 1100

to 1300 kg/m^3. So, high weight is one of the few problems that can affect wood cement bonded boards, therefore, decreasing the cement/wood ratio and density of the cement bonded boards can reduce such problem. Reduction in the high weight of cement bonded boards becomes necessary as it will enhance easy handling and application in situations such as ceiling installation.

Contribution of wood-cement board production to knowledge

- The use of sawdust and cement for the production of ceiling board will facilitate optimal utilization of wood residues and industrial lignocellulosic wastes.
- the production of the wood cement boards will provide fundamental knowledge of the inherent ability of cement bonded boards to withstand insect attack, solar radiation and other severe weather conditions in the tropical region of West Africa.
- It will also provide information on systematic approach for further research on the level of wood waste and cement combination for future development of cement bonded boards.

Contributions of wood-cement board production to employment generation

The production of wood cement boards will enhance job opportunities to unemployed graduate and the youths. According to Osuntuyi (2002), empirical survey has confirmed that a production unit will employ between eight and ten workers where five hundred boards will be produced per day.

Most of the tools required for cement bonded boards production are: wheel barrow, spade, trowel frame and caul plates (depending on the size of boards to be produced); and materials required are cement and wood waste (e.g. sawdust). The production process requires unskilled labourers with minimal capital investment. Therefore low income earners can easily embark on the production of cement bonded boards. Cement bonded boards made from cement-wood wastes, are advantageous to the users as they can last for over seventy years.

Conclusion

The development of wood based panel products serves as an alternative and better competitor to commercial asbestos in the low-cost housing units and in the construction industry in Nigeria. Panel products made of cement and sawdust are dimensionally stable under varying humidity environment and the unit cost is much less than that of commercial asbestos. The price of commercial asbestos in Nigeria today ranges between ₦850 and ₦950 due to the sophisticated equipment and machines involved in its production whereas the unit price of cement bonded board is between ₦350 and ₦400. This is because sawdust which constitute about 20 to 40% of the product can be abundantly found nearly anywhere in the southern zone of Nigeria. Despite the present global economic meltdown, more houses will still emerge on the basis of naira differential between commercial asbestos and cement bonded particleboard.

Large quantity of sawdust generated in Nigeria are normally burnt off in the sawmills of dumped in landfills, while the remaining part is used as fuel. Burning of this sawdust in an open air is likely to cause environmental pollution with the emission of carbon-dioxide (CO_2) and carbon-monoxide (CO) as a result of insufficient oxygen in the heap of the sawdust. The release of those gases into the atmosphere changes the climate, thereby resulting in global warming, which is now one of the greatest threats to our world. Therefore, the use of wood wastes will serve as an environmental management system; it will also contribute positively to the economic growth of our society. Finally, apart from solving the problems of

partitioning, flooring, shuttering and cladding, the use of indigenous materials in the production of panel products for ceiling installation will create job opportunities for rural dwellers and unemployed youths.

Recommendations

As a way of achieving economic freedom and reducing the effects of economic meltdown in Nigeria and Africa, it is imperative to embrace technical education and development of appropriate technologies in the production and fabrication of value-added products using indigenous materials like sawdust, coconut fibre, veneer and sugar cane baggasse in the production of cement bonded particleboard. Based on the potential of wood based panels, the following measures are further recommended:- Government and private individuals must as a matter of urgency be encouraged to engage in the production of cement boarded particleboard production in order to complement the commercially available asbestos.

Those in the area of wood science, technology and other engineering discipline should be adequately rewarded to ensure absolute commitment on their job performance.

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There is no sustainability in a mere economic survival and to ensure sustainable economic growth and development, there must be adequate funding of technical education and other vocational training like agriculture since most indigenous materials for the production of cement bonded boards are by-products of agriculture.

Seminars, conferences and workshops should be organized for the producers of cement bonded particleboards while research grants be made available to those in academics to carry out various tests so as to ensure quality of cement bonded particleboard.

Under entrepreneurship education, students should be giving some vocational training in schools for gainful self-employment in recognized occupations as semi-skilled or skilled workers after graduation. This type of education prepares individuals to handle their own business affairs and function intelligently as cap able workers in business economy hence, reduces the problem of unemployment.

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