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## **RESEARCH EFFORTS OF NBRRI IN THE AREA OF BUILDING MATERIALS DEVELOPMENT – THE CHALLENGES AND PROSPECTS**

**PAPER PRESENTATION**

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## **Fore notes**

The chairman of this session, members of high table, noble members of press, honorable ladies and gentlemen. I thank you all very much for giving me the opportunity to present this paper at this unique gathering with the THEME; **BUILDING MATERIALS: RESEARCH, CREATIVITY AND DEVELOPMENT**. This theme cannot be more auspicious than now considering high cost of building materials due to weak global economy and their subsequent effects on building construction in Nigeria.

### **1.0 Introduction**

A significant component of urbanization is the presence of modern infrastructural facilities needed to support urban life. These include housing, public buildings, commercial, educational, health, telecommunication, road, recreational, etc. Realization of these facilities demands a huge input of a variety of construction resources, especially the materials.

In most urban areas of Nigeria, the above mentioned infrastructural facilities have been found to be inadequate. One of the major reasons for this inadequacy is the high cost of conventional materials currently favoured in the construction industry in Nigeria. For instance, housing which is considered a basic human need, construction materials alone constitute over 70% of the cost of housing delivery, especially where low income households are concerned. It is therefore, expected that any cost reduction strategies targeted at construction materials will considerably bring down cost of project delivery thereby creating opportunity for provision of more facilities.

It is generally expected that locally sourced materials and the technologies for its application in the above mentioned areas will not only be more climatically and environmentally suited to the particular locality, but also cheaper and more affordable. It is in the light of this that there has been a call to look inwards in the sourcing of materials, especially those for construction, used in the country.

It has been estimated that Nigeria requires about 850,000 housing units annually for the next 20 years to solve her housing needs, a deficit estimated at 17 million units. It is estimated that

about =N=120 trillion is required to fund this housing deficit. In response to this challenge, some individuals and organizations have ventured into the development of locally sourced materials and technologies for construction purposes. Unfortunately, impact of such ventures has not been felt in the country due to the harsh environment and non-acceptability of the technologies developed. It may be pointed out here that what may be local to one locality, may indeed be considered imported in another.

## **2.0 BUILDING MATERIALS**

### **2.1 Types of Building Materials**

There are different types of building materials used in the country. These can be broadly classified as imported and locally sourced building materials.

#### **2.2 Imported Building Materials:**

These are materials or components which come into the country in their finished form. These will include certain brands of cement, iron mongery, sanitary fittings, electrical fittings, wall and floor tiles, ceiling materials, paints, doors and windows, plumbing accessories, roof covering materials, etc.

#### **2.3 Locally Sourced Building Materials:**

Locally sourced building materials are building materials or components which are manufactured or assembled in the country. Local building materials in the country can be classified into three as follows: i) conventional building materials, ii) traditional building materials and iii) alternative building materials.

##### **(i) Conventional Building Materials:**

Conventional building materials are building materials which are either manufactured or assembled in the country. They are the most popular and widely used of building materials in the country. Standards for the use of many of these materials are available and have thus encouraged their acceptance by professionals and public alike. Many of them are readily available. Although they are generally considered expensive, they are considered as symbol

of modernity and therefore convey enhanced status to their users. They include steel, plastics, timber, etc.

**(ii) Traditional Building Materials:**

Traditional building materials are building materials whose raw materials are wholly sourced locally and the products produced locally, usually by rural dwellers using local means of producing walling and roofing materials which are indigenous to them. In Nigeria, these methods have evolved over time, and labour-intensive. The materials may require frequent maintenance. Presently, there are no standards evolved for their use. Therefore, they are no more used in urban areas. Materials in this category include mud, thatch, grass, corn stalk, etc.

**(iii) Alternative Building Materials:**

These are materials which have evolved through research and development activities in the country. The raw materials for their use are locally sourced. Some of these materials have successfully undergone the various stages of research and development (including testing and field trials) and have been found suitable for use in the country.

As a result, standards are currently being evolved for them and their uses have been endorsed by the new National Building Code. These include the stabilized bricks and fibre reinforced concrete roofing materials. There are several other building materials in this category which are at different levels of research and development.

A compendium of local building materials available in Nigeria has been compiled at the Institute for use by practitioners and stakeholders in the Nigerian construction industry.

### **3.0 NBRRI'S EFFORTS IN THE DEVELOPMENT AND PROMOTION OF ALTERNATIVE AND SUSTAINABLE CONSTRUCTION MATERIALS**

The Nigerian Building and Road Research Institute, (NBRRI) is one of the public institutions involved in research and development in the country. NBRRI was established in 1978 to conduct integrated research and development in the broad areas of building and road. Over the years, however, the Institute's mandate has been expanded to include research and development in the engineering materials sector.

In line with her mandate, the Institute has conducted several researches both tangible and intangible. It has also made and is still making significant achievements by pioneering the development of various local construction materials and the equipment required for their use. However, this paper focuses on the tangible aspects of research developments. These include:

#### **i. Improved Sun-dried Bricks (adobe)**

In many rural settings in the country, use of sun-dried bricks is common. The bricks are characterized by irregular shape and dimensions. They also have low compactive effort. To improve the quality of this local construction material, NBRRI designed and fabricated a machine which ensures that sun-dried bricks have regular shapes and dimensions as well as improved compactive effort.

#### **ii. Cement Stabilized Bricks/Blocks**

To further take advantage of laterite, which is in abundance in most parts of the country, and in order to further improve the quality of the materials for construction purposes, the Institute researched into stabilization of laterite. Various stabilizing agents were found suitable. However, the ordinary Portland cement, OPC, was adopted because of its wide availability. NBRRI's stabilized bricks have dimensions of 290x140x100mm. They have been found suitable and indeed have been used in construction of low and high rise buildings in different parts of the country. It has also been found to be about 25 to 30% cheaper when compared to conventional walling materials and it has better thermal comfortability. The bricks produced

have compressive strength of 1.64N/mm<sup>2</sup>. A 1m<sup>2</sup> wall requires 35 bricks of the size mentioned.

### **iii. Interlocking Laterite Blocks**

Unlike the stabilized laterite bricks, the interlocking laterite blocks are designed to avoid the use of mortar during laying. This further reduces cost of construction. They are made from the same materials as the stabilized laterite block: laterite, cement and water and compressed in an interlocking block making machine. The machine comes in different types, semi-automated, electro-hydraulic and diesel engine operated. These machines are being fabricated by NBRRI. The block has dimensions of 240x230x110mm and requires 40 numbers per square meter of wall. It is interesting to note that houses built with interlocking blocks stand on a special class of their own, requiring no external finishes, as they are beautiful and aesthetically appealing. Typical houses of this form can be found at the premises of Nigerian Building and Road Research Institute Ota, Abuja, Owode, Ayetoro, Bocos, Uyo, Nnewi, Awolowo Road Ikoyi, etc. The Institute has various machines for the making of the blocks.

### **iv. Burnt Clay Blocks**

Burnt clay blocks are also used as alternative materials for walling in low cost housing. They were the common walling materials in colonial Nigeria. They were abandoned when the cost of cement and sandcrete blocks became cheap. Nevertheless, with the escalating cost of cement, serious attention is now directed to using burnt clay blocks. Furthermore, with the development of various burning methods with improved kilns, it is expected that the price of burnt clay blocks will be affordable for low cost housing. Various kilns, which make use of firewood, rice husk, kerosene and black oil, can be used during firing. Production of burnt clay bricks and blocks using simple presses and fired in vertical shaft kilns using kerosene as fuel can give rise to cheaper burnt clay bricks.

## **v. Clay Roofing Tiles**

Clay roofing tiles are produced from suitable clays. The moist clays are moulded into the required shape (plain or corrugated) using the mould designed for this purpose. They are air dried for about two weeks and then fired in a kiln. A simple clamp kiln can be designed to make use of agro waste materials such as corn stalk and rice husk. A kerosene-fired kiln has also been constructed in some parts of the country for the burning of clay bricks and tiles. When produced at the cottage level, the materials can be suitable materials for low cost housing due to their maintenance free nature.

## **vi. NBRRI Brick/Block making Machines**

NBRRI's first brick making machine produces bricks in the dimensions of 290x140x100mm. It has compactive effort of 3N/mm<sup>2</sup> and produces two bricks per operation using human efforts. For effective operations, the machine requires a three-man team. It is manual operated, potable, hence can be used either on or off site.

## **vii. Machines Developed at NBRRI**

In addition to this machine mentioned, the Institute in recent years, has designed and fabricated other machines for effective production of alternate and sustainable building materials. These include:

- Electro-hydraulic brick making machine (single and double moulds).
- Electro-hydraulic interlocking block making machine (with interchangeable moulds).
- Semi-Automated interlocking block making machine.
- Laterite grinding machine.
- Construction tools like end frames, internal and external corner finishing gadgets, improved trowels, etc.
- Laterite mixing machine.
- Manual paving stone machine.
- Electrohydraulic paving stone machine
- Roller compactor,
- Mador Tiles Vibrating Table, etc.

It is also worthy to note that most of these machines are gender friendly and have taken into cognizance the low literacy level of those expected to operate them.

### **viii. Fibre Cement Roofing Materials**

NBRRRI has also developed the technology for the production of different fibre reinforced cement roofing materials in the country. These include the sheets, tiles and semi-sheets. The roofing materials are basically made from a composition of coir fibre, sand and cement in appropriate mixes. In order to ensure quality control, vibrators for the production of the sheets and tiles (Mador tiles) were designed and fabricated. Moulds for the semi-sheets have also been designed and produced.

### **ix. Stonecrete Blocks**

For areas where there are abundant stones, NBRRRI has developed the stonecrete technology. Use of stonecrete cuts down on quantity of cement used in block wall as little cement is used. It is strong ( $7 \text{ N/mm}^2$ ) and can be used for load and non-load bearing walls

### **x. Development of Pilot Plant for Production of NBRRRI Blended Cement(Pozolana) from Clay and Volcanic Ash Plant**

The problem of high cost of building materials and inadequate housing provisions in developing countries, including Nigeria has become a very critical one. Due to the increasing population and high cost of production of cement, many could not afford to have a house on their own. There are also high utility charges due to cost of petroleum products and power expended for production/tons of cement; as well as inadequate capacity utilization of cement factories leading to high cost of importation of cement.

The price per bag has been fluctuating to end users ranging from N2,500 to N2,700/50kg bag, which translate to N50 to N54/kg; and even N3,000/bag at crises situations. *There is need to find alternative binding materials to supplement the Portland cement, which will go a long way in reducing the cost of building.* The project, one at Ota that is using clay and other

agricultural waste products is 100 per cent completed and has already started production, while another one at Bokos is using volcanic ash for production of pozolana.

Blended and other hydraulic cements are gaining popularity because of their ability to improve concrete characteristics and provide a means of reducing carbon dioxide emissions in the cement manufacturing process. Thus, such volcanic ash that occurs in some parts of Plateau State, Bokos Local Government with previous volcanic activities is being used in production of the blended cement (Pozzolana) in various percentages to provide supplement in the building industry over the use of wholly standard Portland cement to reduce cost of buildings.

All the above clearly show NBRRI's commitment to her mandates and her concerted effort at reducing construction cost in the country via development of alternative and sustainable local construction materials and technologies which simplify and accelerate the construction process.

### **3.1 Popularization**

NBRRI is making serious effort to popularize her innovations and technologies as they evolved. These have been through various means which include participations at various exhibitions, fairs, workshops, conferences, radio and television programmes, etc. Information on these innovations has also been documented in technical reports, information leaflets, NBRRI Newsletter, etc. In addition, pilot projects utilizing some of these innovations have also been constructed.

To consolidate on the above efforts, the Institute has put in place an Extension Service Unit, and currently has a web-site, where the public can hopefully obtain information on her activities, etc. Another noteworthy effort of the Institute in the development and popularization of local construction materials is the Institute's involvement in formulation of relevant standards for such materials. NBRRI has served and continue to serve on several of Standard Organization of Nigeria's (SON), Technical Committees, which make vital contributions to the formulation of standards in the country. Training is an important

component of the Institute's activities. Periodically, the Institute organizes training programmes in the form of seminars, study tours, conferences, and workshops with the objectives of creating awareness for her R&D results and transferring the skills needed for the application of these R&D results to interested person(s).

### **3.2 Problems Hindering Promotion of Local Building Materials in Nigeria**

There are several problems hindering smooth operations of the local building materials sector. These are:

**i) Inadequate Production:** Nigeria is a vast country, and the demand for housing is enormous. The local building materials industry has not been able to meet the demand for their products due to several reasons. The epileptic supply of electricity and high cost of diesel, etc., required for daily operation have also negatively affected production capacity of these industries. On the other hand, entrepreneurs appear reluctant to invest in mass production of alternative building materials, albeit at the cottage industry level. Those who are willing to engage in this line of business may not have the required capital for setting up. As a result, shortages in the production of local building materials continue to persist, as demand cannot be met.

**ii) Continuous Importation of Building Materials:** Building materials have continued to flood the markets. Some of these materials have been smuggled into the country for their application in various construction industries. The appetite of Nigerians for foreign goods, which are enormously considered to always have superior quality over their local counterparts, is not helpful.

**iii) Lack of Standards:** Standards play a vital role in the widespread acceptance and use of a building material. Unfortunately, many local building materials do not have standards. Where the standards exist, especially for conventional ones, they are imported.

**iv) Lack of Awareness:** Many of the conventional local building materials have been used over a long time and therefore, people are familiar with them but for alternative building materials, the story is different. Unfortunately, manufacturers or promoters of these new materials have limited funds which cannot support the high cost of media advertisement in the country. When people are not familiar with products, it is most unlikely, they will venture into using them, especially, for building purposes, considering the expected life span of a building and the huge outlay of resources that go into its realization.

## **4.0 Conclusion and Recommendations**

### **4.1 Conclusion**

Sustainable building materials technologies can greatly curtail economic and resource inputs, improve labour productivity of building inhabitants, and reduce environmental impacts. This promise presents large opportunities for research institutes such as NBRRI, chemicals and local building materials companies to carve out early entry and incumbent positions in the buildings and infrastructural space for housing development in Nigeria.

### **4.2 Recommendations**

As a way forward, the followings are recommended;

- i. Local manufacturers of construction materials need to network more in order to:
  - Create and develop a realistic data based on activities, innovations and the needs for the construction industry.
  - Streamline activities in the sector.
  - Judiciously use resources available to the sector.
  - Identify ways and means of improving on the quality of their products and their packaging.
- ii. The governments at all levels need to encourage the use of locally sourced building materials by using them in their projects.
- iii. To effectively participate in the industry, training and retraining of artisans for necessary skills is required.