

PROMOTING THE USE OF ALTERNATIVE BUILDING TECHNOLOGIES IN NIGERIAN CONSTRUCTION INDUSTRY: THE PROBLEMS AND RECOMMENDATIONS

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Abstract— Like many urbanizing societies, Nigeria is experiencing acute difficulties with the provision of adequate housing for her citizens, especially in the urban centre. The building industry in Nigeria as in other African countries is characterized by a high component of imported raw materials. Dependency on imported building materials is a factor that has contributed to the high cost of houses and it is a factor that has made it increasingly impossible to build low cost houses. Successive research proposals have emphasized the need to encourage the use of alternative building technologies as a way of minimizing dependence on imported substitutes, the enormous potentials of alternative building systems have been discovered and effectively utilized in contemporary ways in countries such as India and Mexico. But in Nigeria, these sustainable solutions are not promoted; the unworkable and unsustainable solutions are still been imported and used for construction. The objectives of this paper are to show the potentials that alternative building technologies hold in alleviating acute housing problems in Nigeria, to review the measures and policies being adopted by the government and other stakeholders to encourage the use of alternative building technologies and why these measures are not having much effect. Finally suggestions are made as to the line of policy and practice that could effectively elicit greater popular use of alternative technologies in housing construction.

Key words: Alternative building technologies, local construction industry, sustainable developments

1 INTRODUCTION

Like many urbanised and urbanising societies, Nigeria is experiencing acute difficulties in the provision of adequate housing for her citizens. There is an acute shortage of housing units relative to the demands for them. Several studies have equally documented the precarious housing situation in Nigeria. Housing problems in Nigeria are complex and diverse [1]. The lack of access to adequate housing, which is priced out of the economic reach of the poor, is sometimes so grievous that some are forced to construct shacks on pirated land with all manners of refuse materials [2]. Probably, the one single factor which has contributed most to the housing problem is the unavailability and the high cost of building materials. Inadequate access to affordable building materials is one of the principal constraints to the ability of the poor in developing countries to provide adequate housing for themselves [3]. For those who save to build, the way to reduce the cost of housing lies probably less in lowering interest rates than in reducing the cost of building materials and technology [4].

The cost of building materials and components is known to constitute about 60-70% of the cost of the buildings. This inevitably implies that high cost of building materials will make

way of minimizing dependence on imported substitutes. However, the scenario is different; unworkable and unsustainable solutions are still been imported and used for construction.

The continued dependence on imported building materials has not only imposed additional strains on an already acute balance of payments situation in Nigeria; it has fuelled inflation in the construction sector causing cost over-runs in public projects. It also inhibits private initiatives in shelter production and makes it impossible to provide shelter for the low-income households in the country. Ironically, Nigeria (although it suffers from scarcity and import dependence) is endowed with abundant building materials that have the lowest gross energy requirements [6]. Crucial to these facts would be the strengthening of domestic technological capability to produce sustainable alternative building materials from the available local resources.

Presently, the gap between the rising demand and the stagnating and in many cases declining production levels is widening at an alarming rate leading to the spiralling of prices of building materials in Nigeria, seriously affecting the affordability of housing for the vast majority of the population. An average urban dweller spends between 40-60% of his income on housing [7]. though there is dare scarcity of data on the quantum of housing shortages, according to Federal Ministry of Works and Housing, some 5 million housing units were estimated as required at the national level over the period from 1994-2000[8] to maintain a reasonably dynamic balance in the market. But recently the figure is put at 15-17 million.[9] The question is what has building materials development and technology done to ameliorate the situation? Why are the solutions proffer to the problem not effectively promoted in Nigeria and what could be done to improve the situation? These and other related issues are the focus of this study.

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construction cost equally high. On the other hand, availability on a sustainable basis of relatively cheap, locally produced and tested building materials and technologies is the obvious anti-dote to high cost of housing constriction in Nigeria. [5] Successive research proposals have emphasized the need to encourage the use of alternative building technologies as a

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by a comma, e.g. "[1], [5]" (as opposed to the more common "[1, 5]" form.) Citation ranges should be formatted as follows: [1], [2], [3], [4] (as opposed to [1]-[4], which is not IJSER style).

Table 1: Prices change of building materials

Materials	1982-1986 N	1987-1992 N	1993-1996 N	1997-2000 N	2013 N
50Kg Cement	5	12	85	550	1750
A sheet of Plywood	39	49.50	400	1500	8,000
5 tonnes of Sharp sand	65	70	800	4500	12,500
10 tonne of Granite	95	125	1,800	7,500	42,000
Reinforcement (high tensile)	500	2000	5000	40,000	80,000
250mm Sandcrete block	50	5	20	50	120

Source: Field work,2013

Appraisal of Measures and Policies Adapted By Government and Stakeholders

Several measures and policies have been adapted by government and stakeholders to alleviate the problem of affordable building materials all to no avail. An appraisal of the housing/building material industry in Nigeria reveals that:

Since independence in 1960, Nigeria generally pursued an industrialization strategy based on import substitution. With the assistance of foreign exchange earning from petroleum in the early 1970s, government and private enterprises embarked upon ambitious and costly resource-based industrial projects. These took advantage of an array of government incentives. However, problems of the manufacturing sector have often been attributed to inadequate infrastructure, lack and poor utilization of human capacity and available manpower, and absence of a sound technological base. By early 1980s as the country's foreign exchange earnings declined significantly, the high import dependence of the manufacturing sector became a serious liability on the economy [6]

One of the most striking features of the house construction industry is its atomistic nature. Unfortunately, except for the most basic of all local materials, building materials could not be produced on the profitability scale in this atomistic nature. Most of the building materials, especially those that have survived various onslaughts in Nigeria have to be produced mechanically and on a large scale. This is why, overtime, the Nigerian building industry has a history of building materials problem [10];

The Nigerian Building and Road Research Institute (NBBRI) has been working on some local materials for some years now but the impact on the housing sector so far is negligible. Perhaps there is a communication gap between research institutes and house builders [4];

Overall there is evidence of declining activities in housing finance generally. The average share of GDP invested in declined from 3.6% in the 1970s to less than 1.7% in the 1990s. In addition, between 1992 and 2001, the volume of savings and time deposit with the banks and non-bank financial institutions grew by 604.94% from N54 billion to N385.2 billion. However, the proportion held by the housing finance institutions declined from 1.4% to 0.22% in 1998, indicating a fall in the flow of funds into the finance sector. [11]

Achievements of Research and Development Efforts.

The main cause of the high cost of conventional building materials is the low value of the naira against hard foreign currencies [12]. The result of this is that the prices of imported raw materials have risen sharply. These key materials include aluminium roofing sheets, glass, steel, reinforcing rods, aluminium windows and doors. Even cement, with a small percentage input of imported gypsum, has escalated in price due mainly to the advanced technology of production and the attendant high cost of maintenance of the cement factory.

As a result of this local scenario, one of the widely proposed solutions to the high costs of building materials is intensive research and development on locally abundant raw materials. The aim is to produce cheaper and equally durable alternative building materials. This solution is widely advocated not only in Nigeria but throughout the third developing world. Research carried out over the last 20 years in industrial and building research institutions worldwide have led to the development of a range of new building materials and techniques which can be produced entirely from local resources using simple, small-scale technologies and adapted to local building traditions. Among the more promising developments are the following:

Compressed Stabilised Earth Blocks

These are dense solid blocks manufactured by pouring slightly moistened soil into a steel press with stabiliser (lime/cement) and then compressed either with a manual or motorised press. The input of soil stabilisation allows people to build higher with thinner walls, which have a much better compressive strength and water resistance. With cement stabilisation, the blocks must be cured for four weeks after manufacturing. After this they can dry freely and be used like common bricks with a soil cement stabilised mortar. Many stabilizers can be used. Cement and lime are the most common ones, others, like chemicals, resins or natural products can be used as well. The selection of stabilizers will depend upon the soil quality and the project requirements.

A finished m3 of CSEB wall is generally 48.4% cheaper than wire cut bricks and 23.6% cheaper than country fired bricks

[14]. Other advantages of CSEB include energy efficiency, elimination of plastering, better block finish and aesthetically pleasing appearance. Fig (1) shows a manual production of CSEB .

Vault and dome constructions using unreinforced masonry have been available for more than six centuries. Due to the advent of steel and reinforced concrete these techniques were abandoned. Because of the advantages like aesthetics, cost, durability and savings in energy, vaults and dome constructions have been revived. Recent works at Aurville Earth Institute India has shown that vaults and domes can be built with compressed stabilized earth blocks.

A metal formwork of about 1m width defining the vault shape can be repetitively used to construct such vaults. Various shapes can be adapted for the vaults. Centenary-shaped vault is the most efficient. The thickness of the vault is dependent on the span of the vault.

Filler Slab Roofs

Filler slab roofs are basically solid reinforced concrete slabs with partial replacement of the concrete in tension zone by a filler material. A number of alternative materials can be thought of (a) brick or brick panel (b) stabilized mud blocks (c) hollow clay tile/block e.t.c fig 6 shows ceiling of a typical filler slab roof using SMB filler. Quantity of concrete in the tension zone of the slab that can be replaced by a filler material depends on the shape of the filler material and the thickness of the slab. For example in a solid concrete slab of 125mm thickness, a filler block, 25% of the concrete can be replaced by a material , which costs one third the cost of concrete. This means that 15-20% of the cost of concrete can be saved by this operation.

Containment Reinforcement for Earthquake-Resistant Masonry Structures

History of earthquake damages indicates that greater damage to buildings and loss of life take place in one- and two-storeyed masonry buildings. Unreinforced masonry walls have poor flexure strength and very little ductility. Earthquake ground motions generally lead to out of plane bending failure of unreinforced masonry walls. Reinforcing such walls properly can prevent out of plane failures and impart ductility to the wall. An innovative way of providing vertical reinforcement to masonry wall has been developed, which is called 'containment reinforcement'.

The method consists of wrapping the thin reinforcing bars in vertical direction on both the faces of the wall and is held together by ties provided in the bed joints. Containment reinforcement is anchored to RC bands at roof and plinth level. Such reinforcement is provided at 1 m intervals along the length of the wall and at door and window jambs. This new technique has been validated through a large number of shock-table studies on scale models. This technique is simple and cost effective. About 1000 buildings have been built using SMB walls and containment reinforcement in Gujarat state, India after the Bhuj earthquake. [15]

Lime-Pozzolana Cement

The Lime-pozzolana (LP) cement is made by mixing calcium

hydroxide (lime) and pozzolana in the ratio of 1: 1.5 or 1: 2. Secondary grade lime available locally in many areas can also be used by adjusting the mix proportions. Variety of pozzolanas like burnt clay pozzolana, rice husk ash, good quality fly ash or combination of pozzolanas can be used. Ideally lime and pozzolana have to be interground in a ball mill. But such mixtures have poor shelf life (15 days). Volume proportions of 1: 3 or 1: 4 (LP cement: sand) can be used. The strength of the mortar mix can be easily manipulated by adjusting the proportions of various materials. LP cements are low energy consuming materials and can be used for a majority of secondary applications except for reinforced concrete works.

Others Include;

- Stabilized rammed earth foundations
- Stabilized rammed earth walls
- Composite columns (round and hollow CSEB with reinforced concrete)
- Composite beams (U shape CSEB with reinforced concrete)
- Stabilized earth mortars and plasters
- Alternative stabilizers to cement ("homeopathic" milk of lime and alum)
- Alternative waterproofing with stabilized earth (mixes of soil, sand, cement, lime, alum and juice of a local seed)

Problems Inhibiting the Use of Alternative Building Technologies in Nigerian Construction Industry.

Presently, in the Nigerian housing industries the above named technologies are not utilized for construction of houses, unsustainable solutions are still been imported and used for construction. This underscores the existence of some lingering problems. They include the following:

User Prejudices

Production technologies for alternative binders such as lime and pozzolana that can replace cement in most applications are already available in many developing countries but they have not found wide -scale use because of user prejudices. Similarly, a variety of earth-based technologies is available to replace bricks and concrete blocks, but after years of research and development these technologies still remain confined to a few, often unimaginative and poorly organized demonstration projects that fail to inspire the confidence of private house -builders [3].

Although the Federal and State Government have made explicit statement supporting the wider use of alternative building technologies, they have failed to take corresponding concrete actions to promote these materials. In this regard, one recalls that the large scale use of sandcrete block in the nineteen forties by the Public Works Department in government owned buildings accelerated the use of these blocks by the populace. It was the government support for the sandcrete blocks that led eventually to the rapid eclipse of fixed clay blocks (Medador, 1995). This is because, given the socio-economic situation in Nigeria, Government patronage is regarded by the public as a confirmation of the good quality of

the material concerned.

Use of Inappropriate Technology

Faced with increased demand coupled with the decline in the supply of building materials the Nigerian government has, in the past, sought to make good the deficiency by establishing large -scale factories for the production of basic building materials. Within a short period, many of these factories have been faced with numerous difficulties, arising primarily from the choice of technology. They have been established on inter-

-borrowed capital which has involved a heavy burden, often increased over time because of devaluation. They have depended heavily on continuing imports of factor inputs and spare parts and machinery. The absence of stable markets and production interruptions resulting from the lack of spare parts and power supply have, often made production planning difficult, resulting in low capacity utilization. Economies of scale have rarely been achieved in these large-scale production facilities.

Legal Problems

The inflexibility of existing building regulations is another barrier to the increased utilization of alternative building materials in shelter production especially in urban centres. These building regulations and codes need urgent revisions and modifications to permit the use of these materials.

Capital

Probably the greatest barrier to the small scale commercial production of conventional and alternative local building materials is the great difficulty in raising capital in Nigeria. The interest rate is very high and this significantly affects prices of the finished products. In the case of small scale industries, the local entrepreneur finds it difficult to raise a loan from conventional banks and finance houses. Apart from high interest rates, he finds it difficult to provide acceptable collaterals to support his loan. For him to break even, quality is often sacrificed for quantity leading to poor quality of the finished product.

Adverse Policy Environment

Government policy sets the economic environment in which the building- materials sector operates. The growth of the sector is often hampered by inadequate recognition of and support for its need, and in some cases by policies and regulations which clearly inhibit its development. Seldom is there a national policy specifically addressing the needs of the building-material sector. Tax incentives are seldom given to encourage the manufacturers of new and innovative building materials, especially those using agricultural and industrial wastes and energy-efficient technologies.

The Way Forward

- The Nigerian building and road research institute (NBBRI) has been working on some local materials for some years now but the impact on the housing sector so far is negligible. Perhaps there is a communication

gap between research institutes and house builders. Dissemination of information to the public and "leadership by example" is required of our public sector. In some countries, when governments are committed to a certain policy, such as the use of alternative building materials, they convince people by executing projects using such materials. In Mali, Burkina Faso, Senegal and Algeria, for examples, there are a number of important government projects executed in stabilized laterite [4]. Here in Nigeria, we pay lip service to ideas but do not concretize them in our action, so the public is skeptical of our utterances. The solution to this will required a genuine political will to address the issue in a fundamentally structured and sustainable manner. Alternative building technologies should be generously utilized in the construction of most of the government buildings especially official residential housing schemes.

- In the use of alternative building materials and technologies, we need to come up with building codes that standardize and recognize the use of local building materials. The public sector is responsible for establishing criteria for the use of local materials. In the area of codes and planning regulations we tend to model ours after those of more affluent societies of the west. We sometimes make ours higher or more stringent than theirs, without realizing that our income levels, credit facilities and production capacity cannot adequately support these "high standards".
- The choice of technology in the production of building materials is the most critical factor in ensuring profitability and subsequent sustenance of the industry after its establishment. At the early stage, a simple technology is advisable and thereafter the technology can be updated or modified in the light of increased demand and available technical manpower to successfully ensure and sustain the expansion. In this regard, indigenous entrepreneurs should obtain all available data from appropriate information centres and seek technical advice from professionals/experts before taking a final decision.
- The dependence on large scale industries should be discouraged and deliberate efforts should be directed to encouraging small industries to produce variety of building materials. Small scale industries have been found to be effective and economical in producing a variety of basic building materials with the use of modified or simplified technologies. Some of these include: pozzolona from various types of kiln depending on level of production; stabilized blocks from manually or hydraulically operated presses; fibre concrete roofing e.t.c.
- Given the size of Nigeria, the provision of building extension centres, specifically charged to bring build-

ing technologies and related services to urban and rural communities appears appropriate at this time. For the housing problems to be positively addressed, Government should evolve a strategy for ensuring the dissemination of new building technologies and innovations to the grass roots. Building centres should be established at state and local Government levels.

- Entrepreneurs interested in establishment of small scale alternative building material industries should have access to soft loans and capital with low interest rate. There is need for Government to establish sound economic and monetary policies to overcome the negative effect of inflation on housing and other construction finance, which require long-term credit in the country. Also, to promote industrial production, the government should provide financial incentives by means of taxation, effective protection and other relevant fiscal measures. Under taxation, pioneer status may be granted to small scale industries whereby they are granted a tax holiday for some years. Effective protection should be provided to local building materials industries in selected areas such as walling and roofing.

Concluding Remarks

Probably the one single factor which has contributed most to the housing problems is the unavailability and high cost of building materials. Since building materials components of walling and roofing constitute about 40-45% of a residential house, they constitute a high centre of housing cost. The thrust on reducing housing cost should therefore be on the exploitation of alternative building technologies to produce these components in an efficient manner. The consideration of the current structure of the building materials industry leads to the inescapable conclusion that it should be expanded to include small scale industrial enterprises. This is in harmony with experiences in other developing countries in Asia who have made progress in this direction.

Accordingly, an enabling atmosphere should be created by Government to promote the use of alternative building technologies in the Nigerian building industry. A strong political will on the part of the Government is a requisite to promote the use of alternative building technologies. This is necessary in an environment that is hugely biased towards import-intensive, costlier building materials. Provision of soft loans, tax incentives and the dissemination of current and less capital intensive technologies are also essential to sustain this drive.

Currently R&D efforts in developing sustainable building technologies are limited in the Nigerian context. There is a large scope for R&D in developing alternative building technologies, addressing the following issues:

- Clear understanding of the sector-wise demand and growth of the Nigerian construction scenario.
- Estimating current building stock and the contribution of unorganized sector in manufacturing and supply of energy intensive building materials.
- Developing alternative building technologies to meet regional specific needs/demand for buildings.

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