Journal of Environment and Earth Science www.iiste.org
ISSN 2224-3216 (Paper) ISSN 2225-0948 (Online)
Vol. 3, No.9, 2013

Low-Cost Housing for the Urban Poor in Akure, Nigeria: Materials and Techniques of Construction

Gabriel Fadairo (Corresponding author)
Department of Architecture, Federal University of Technology Akure, PMB 704, Akure, Nigeria.
gablegroup2010@yahoo.com
Abiodun Olukayode Olotuah
Department of Architecture, Federal University of Technology Akure, PMB 704, Akure, Nigeria
olotuah@yahoo.com

Abstract
It is universally accepted that housing is humanity's third most essential need after food and clothing. Rapid population growth and increasing urbanization have led to overcrowding in urban housing, homelessness and overstretching of existing infrastructure and services. This paper examines the various construction materials that are readily available in abundance in Nigeria and construction techniques used in building to support housing for the urban poor. It appraises the architectural functions and values of these materials and their potentialities as common and affordable building materials. The paper concludes that with the application of applied building research and general acceptance of locally available materials and building construction techniques, the problem of high cost of building materials that make it difficult for the urban poor to have their own housing would be greatly resolved in Nigeria urban centres.
Keyword: low-cost, housing, urban poor, material, techniques, construction.

1. Introduction

Housing is essentially one of the basic needs of man. After food and clothing, it constitutes the third necessity of life. Researches have shown that more than half of the world's 6.6 billion people live in urban areas, crowded into 3 percent of the earth's land area (UNCHS, 1993). The proportion of the world's population living in urban areas, which was less than 5 percent in 1800 increased to 47 percent in 2000 and is expected to reach 65 percent in 2030 (UN study as cited in Kwasi Nsiah-Gyabaah, n.d, p. 1). However, more than 90 percent of future population growth will be concentrated in cities in developing countries and a large percentage of this population will be poor. In Africa and Asia where urbanization is still considerably lower (40 percent), both are expected to be 54 percent urban by 2025 (Fadairo and Ogunmakinde, 2011).

The population of Nigeria is over 150 million (Nigerian National Population Census, 2006) and is still rising at an annual growth rate estimated at 3.2% (allAfrica.com, 2008). As a result of this, Nigeria has a large and increasing housing deficit which stood at approximately 8 million housing units in 1991 and between 12 and 14 million housing units in 2007 (Fadairo and Ogunmakinde, 2011).

> Nigeria's urban housing problems manifest in overcrowding, slum housing and the development of shanties in virtually every major Nigerian city. The housing problems vary from inadequate quantity and quality of housing to the attendant impact on the psychological, social, environmental and cultural aspects of housing. Housing is capital-intensive. The cost of adequate housing is beyond the reach of most Nigerians (Olotuah, 2012). This, thus, underlines the economic dimension, that is, the question of affordability of housing. The challenge of housing in Nigeria becomes not only to provide houses but to make the houses affordable to the average Nigerian.

In Nigeria, over 7 out of every 10 people live below the minimum poverty level and 9 of every 10 are in the low income group (Fadairo and Ganiyu, 2010). Therefore, these people cannot provide housing for themselves; they then are rendered homeless or live in poor housing. The government has in place various policies regarding housing delivery to the general public but poor implementation has made it impossible to meet up with the high magnitude of housing units needed (Balogun, 2007; Fadairo, 2008).

2. The study Area

The study area is Akure (Figure 1) – the capital city of Ondo State of Nigeria. The city is in the South Western part of Nigeria. It lies within Latitudes 7^0 15'N and $7^0$28'N North of the Equator and Longitudes $5^0$6'E and $5^0$21'E East of the Greenwich Meridian. It is located approximately 700 kilometres South West of Abuja, the Federal Capital of Nigeria and about 350 kilometres to Lagos the former capital of Nigeria. It is located within the tropical rain forest region of Nigeria. It became the capital city of Ondo State and a Local Government headquarters in 1976. Akure has three residential settlement patterns – the core area, the peripheral neighbourhoods to the core and the suburbs. The city has witnessed immense growth in the size of built-up areas, number of immigrants, transportation, and commercial activities and has attracted both major investors and private developers into the city. The total area is approximately 41.2km2 and it lies on a relative plain of about 250m above the sea level. The population of the city grew from 38, 852 (Thirty two thousand, eight hundred and fifty two) in 1952 to 71,106 (Seventy one thousand, one hundred and six) in 1963. Its population was estimated to be 112,850 (One hundred and two thousand, eight hundred and fifty) in 1980; and 157,947 (One hundred and fifty seven thousand, nine hundred and forty seven) in 1990 (Ondo State of Nigeria, 1990). The last census conducted in 2006 put the city's population at 353,211 i.e. Three hundred and fifty three thousand, two hundred and eleven (NPC, 2006).

3. Review of related literature

Laterite as a construction material has been used for centuries by people all over the world. Many different techniques have been developed; the methods used vary according to the local climate and environment as well as local traditions and customs. As a modest estimate it is thought that as many as 30% of the world's population lives in a home constructed in earth (Houben & Garnier, 1994: p6). Despite this, laterite construction in many parts of the world particularly in developing countries like Nigeria is considered to be a construction material for the poor and hence undesirable. Loss of traditional knowledge resulting in deterioration in the quality of recent earth constructions has, in many cases, compounded these beliefs. In many countries however, the yardstick for the measurement of national progress is hinged on the degree of contributions of the construction industry to the nation's economic, social and political advancement. Okigbo (1982) and Mogbo (2001) affirm that building and construction sector in Nigeria is 'important' and 'crucial' to her economy. Abiola (2000) identified building materials as one of the principal factors affecting the effective performance of the Nigerian construction industry. The building materials sector is a major contributor to the construction industry because materials constitute the single largest input in construction often accounting for about half of the total cost of most or any construction products (Fellows et al 1983; Sanusi 1993; Mogbo, 1999; Kern, 2004; Okereke, 2003).

The building materials sector can be split into three production groups: modern or conventional building materials which are based on modern conventional production methods like concrete, steel and glass; those materials that have been in local production from ancient times using small-scale rudimentary technologies, e.g. laterite, gravel, thatch, straw, stabilised mud, Azara and raphia palm et cetera; and innovative materials which are materials developed through research efforts aimed at providing alternatives to import-based materials e.g. fibre-based concrete, ferro-cement products etc. (Adedeji, 2011).

There exist calls for the return to traditional materials, referred to in this study as indigenous building materials (IBM). Amongst the reasons advanced for these calls are high cost of both the modern and innovative building materials and their inadequate supply in the market (UNCHS, 1990), as well as the climatic friendliness/ harshness of modern materials in this region.

4. Need for Low-cost housing

Nigeria has a population of over 140million (FRN, 2007). The average population density according to (UNDP, 1999) is approximately 124 persons per square kilometre, making Nigeria one of the most densely populated countries in the world. Access to decent and affordable housing to this large population is a daunting challenge which has made housing an issue of national concern. As asserted by Adam and Agib (2001) housing in developing countries is one of the most important basic needs of low-income groups. Olotuah (2009) has shown that the lack of adequate housing in Nigeria is a manifestation of poverty which is the main reason why a significant proportion of the urban dwellers lives in high density housing and environmental conditions. This has constituted serious health hazards and threats to their general productivity. It has been shown that the poverty level of most Nigerians makes it difficult for individuals to own their houses (Daramola, Alagbe, Aduwo, and Ogbiye, 2005) since construction costs are beyond the means of the poor. The costs of conventional building materials need to be addressed by focusing on low-cost alternative local and indigenous building materials.

5. Improved techniques and products

Swish puddling method is employed in the equatorial rain forest of the Yorubas, Edos, Ibos and other southern tribes. In the South-eastern region the building laterite used is loam which is prepared by mixing common earth containing gravel with high quality clay to strengthen it. In the South-West States, the laterite material is mainly argillaceous clay and is usually very grainy. A mixture of greasy clay and sandy laterite soil is usually the best laterite material for building found in these places.

The process of the preparation of the material for building commences in the middle of the rainy season. A pit is dug with the vegetation top soil thrown out to expose the red clay below. The clay is broken into clods and when they have been sufficiently wetted by rain, they are puddled by stamping with feet to achieve the desired plasticity (Olotuah, 2002). Early in civilization bricks were baked using a fuel in crude oven. The bricks were made of clay mixed with straw to give them added strength.

The obvious weakness of traditionally made sun-dried blocks is their low compressive strength and low durability if exposed to rain. The properties of these blocks can be improved upon taking into account their observed weaknesses. The comprehensive strength of the blocks can be improved upon by controlling the moulding water content and increasing the compacting pressure during production. The block making machine produced by the Nigerian Building and Road Research Institute (NBRRI) which is hand-operated, operates with a compaction effort not less than $3N/mm^2$. The clay is mixed with water a little above the optimum level and the blocks are subjected to accelerate drying without shrinkage occurring during drying, thus giving those desirable compressive strengths (Olotuah, 2009).

Walls of sun-dried blocks need to be protected from the rain if they are to have comparables life span with sandcrete blockwalls. Large roof overhangs are used traditionally to protect the walls while pavements round the buildings will serve to protect the foundations. The walls need to be plastered immediately after construction to avoid moisture concentration.

5.1 Fired clay bricks

Bricks are made from clay and other minerals, processed into a workable consistency and formed to standard sizes. These are then fired in a kiln to make them strong, durable and attractive. Fired clay bricks can be made locally with the use of machine and fired in a simple clamp kiln. The fuels commonly used are wood and brass straws. The NBBRI has developed the down drought kiln using coal and diesel as fuel with a higher productivity.

5.2. Laterite stabilised blocks

Laterite stabilization is done to improve the properties of the blocks. This is achieved through addition of materials such as cement, bitumen, and lime in appropriate proportions (Arayela, 2005). Cement is the most common stabilizing agent, the addition of which enhances cohesive nature of the clay and increases the tensile strength of the blocks. Research findings by NBBRI have shown that 4% cement addition is sufficient to achieve excellent stabilization using the block moulding machine designed by the institute with a minimum of $3N/mm^2$ compaction effort. Loam and silty-loam clay are suitable for stabilization with cement. Earth stabilization with 4% cement content gives an average compressive strength of $1.6N/mm^2$ (Madedor, 1987).

Lime is also used for stabilization. It strengthens earth greatly when it reacts with clay content of laterite. Stabilization with lime is better with earth of high clay content while cement is preferred for earth with high sand content.

Stabilization with bitumen increases the tensile strength, pressure resistance and water proofing properties of earthen walls. It also improves its thermal qualities of low heat conductivity and confers extreme internal dryness in the blocks, thus enhancing its durability even to the level of fired bricks.

6. Techniques of construction

Tools for building construction in the study area are cutlasses, hoes, diggers, axes, ropes, plumbing stave, *abero*, *kuduns*u, anset, locally fashioned mallet (rammer), tying (metal) straps. The tools and implements, and their uses are as follows:

6.1 Foundation

Building operations start with site clearing and setting out with Cutlasses and axes for cutting and clearing of bushes and felling of trees. Ropes are tied to upper trunks of trees and pulled towards the direction desirable for the trees to fall. They are, also, together with hoes, pales and pegs (wooden) used to mark out bounds and maintain straight lines and building edges. Diggers and hoes are used for digging out trees from their roots, grubbing out foundation trenches and softening, turning and mixing building earth. Trenches are made to the size of the block and other functional spaces and are measured out. Measuring modules include step (foot), stride, ankle and palm lengths which are often calibrated out in long plumb poles for use throughout this building and other similar future operations.

6.2 Walling

Walls are built on, and along the foundation trenches. Relevant tools include diggers and hoes for digging, turning and mixing of the earth respectively. Other tools are the *"abero"*, *"kudunsu"* and guiding or plumbing stave. There are two slightly different types of *"abero"*. The first is a rectangular spade like metal blade with a long wooden handle; the second type has a triangular metal blade dovetailing into a cylindrical posterior into which the long wooden handle is inserted and nailed.

It is, however, generally admitted that *abero* is more efficient than the cutlass for peeling off wet earth. By virtue of its long handle, it covers a wider range and can be used from any position around the wall, especially, atop a relatively high one. It is less strenuous to use as it has a much higher mechanical advantage.

The *kudunsu*, (Fig.4), is shaped like the hoe but unlike the hoe has a small but thicker triangular metal blade shooting out of the end, short, wooden handle almost at a right angle.

It is used for cutting off hardened walls in small bits, especially when preparing walls to receive plasters. The guiding or *plumbing stave* is a long, straight, sawn plank, carried by the builder to guide the casting of the wall along a straight line (Figure 6). The *"anset"*, (Figure 5), is a small axe-like tool used to chip off bigger lumps of hardened mud wall, especially when

door and window frames are to be inserted in place. Straps are long, flat strips of metal inserted at intervals across the middle of the penultimate top wall courses, folded around, lapped and nailed to the wall plate above the topmost wall courses, thereby fastening the wall plate (of pales) to the walls. Rafters (also of pales) are then nailed to the wall plate with appropriate nail sizes. In much older times, when roof thatches were in vogue, ropes were used in place of these metal straps and nails.

6.3 Roofing

In the Yoruba older indigenous architecture, roofing was done of leaf and reed thatches on a skeleton of poles and stakes tied together with ropes. Other roof covering types included the bamboo, each split into two halves and arranged according to specific intricate details that may form a subject of future work. In present times, metal sheets are fastened with nails to purlins over rafters that have also been nailed in place.

6.4 Flooring

Solid domestic floors were once achieved with moist lateritic soil (sand and clay) in the approximate ratio of 3 and 2 respectively. These were rammed into place with wooden mallet or rammers fashioned from the petioles of palm branches (Figure 7).

6.5 Finishes and Decoration

Finishes can be applied on walls, floors and roofs. In Yoruba indigenous architecture, finishes are common on walls and floors; and carving on posts, doors and windows in King's palaces, shrines and religious buildings. Floor finishes still include rough trowelling of rammed lateric floors with small calabash or earthenware shells. It could also be tiled with palm kernel, snail shells or earthenware shells. Thus, shells generally double as both building tools (for smoothening and patterning), and as materials (for tiling). Doors and posts decorations are carved into fancied figures and patterns with carving knives, chisels, punchers and smoothened with abrasive, dry, sand leaves, *Gutenbergia nigritana* (Gbile 1984) or '*Erinpin eluju'* in Yoruba. Sand leaves were used in place of emery papers for abrasion and smoothening.

7.0 Research Methodology

The study was based largely on case study and observations of the built environment in Akure metropolis. Data were gathered from the observations made at the various project sites on materials and construction techniques used in the location, the inhabitants, level of accommodation and the environment generally.

7.1 Cost of using laterite for construction

The deduction from the chart (Figure 8) shows that about 71% of respondents agree that laterite usage for construction is cheap as against the 29% who agree it is on the expensive side. It is therefore evident that respondents are well aware of the cost effectiveness of the use of laterite brings even though the use of sandcrete block for construction is still very much in vogue.

7.2 The use of laterite in urban centres

Despite the numerous advantages the use of laterite brings, respondents lament about its poor patronage in the urban centres.

Deductions from Table2 and bar chart (Figure 9) indicate 44% and 42% of respondents agree that it has not been patronised well enough by the people of the urban class

8. Conclusion

Laterite materials have been observed to have desirable qualities for construction of houses especially in Nigeria's climatic conditions because of their thermal properties. With the versatility and strength of mud for example, a wide variety of shapes and interesting architectural forms exists in which the aesthetic values and technical possibilities of the materials could be highly appreciated. Problem of housing is closely tied to the question of how to build an affordable house by the urban low-income earner. This calls for practical solutions to low-cost housing design and construction through the use of locally-sourced building materials and culturally sensitive designs. This includes the development of building methods and technologies that are both appropriate to the resources and skills available, and which offer flexibility while reducing cost. The imperative is for architects to re-examine conventional standards, to explore old and traditional techniques in order to achieve innovative new techniques.

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Table 1: cost of using laterite for construction

s/n	Cost	Frequency	Percentage
1	Expensive	16	29%
2	Cheap	39	71%
	TOTAL	**55**	**100%**

Table 2*: Laterite use in urban centres*

S/n	Patronage	Frequency	Percentage
1	High patronage	3	5
2	Good	5	9
3	Fair	24	44
4	Poor	23	42
	TOTAL	**55**	**100**

Source: Researchers field work 2012.

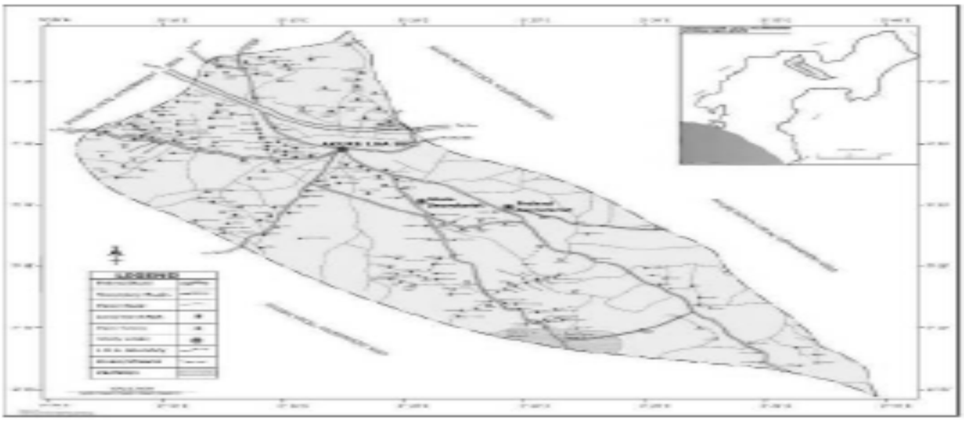

Figure1: Map of Akure South Local Government

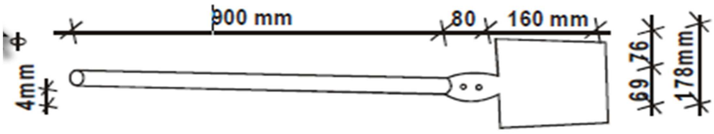

Figure 2: *abéró with rectangular blade*

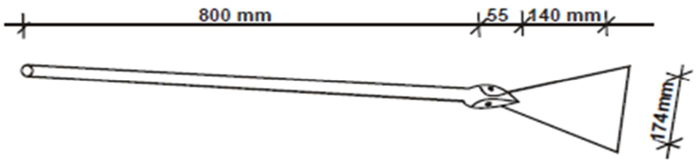

Figure 3: Abéró with triangular blade

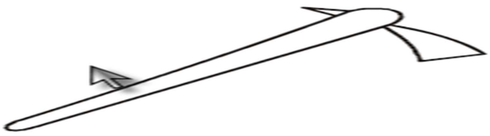

Figure 4. *Kúdúnsú*

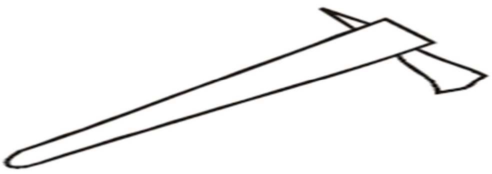

Figure5: *Anset*

Figure 6: *Plumbing Stave*

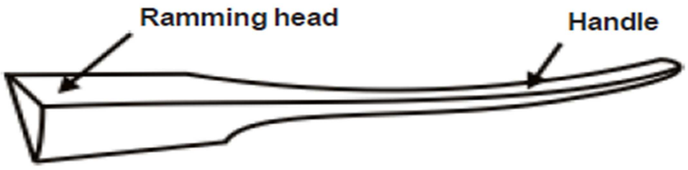

Figure 7*: Rammer of palm petiole*

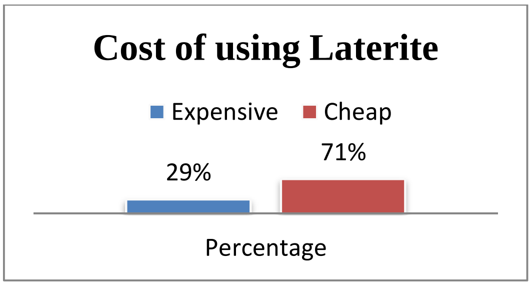

Figure 8: Cost of Sancrete blocks

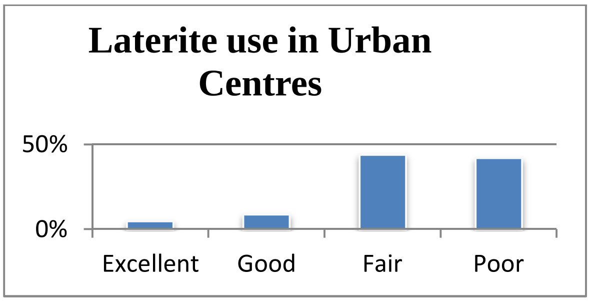

Figure 9*: Showing laterite use in Urban Centres*

Case studies


Plate 1: Use of laterite blocks in perimeter fencing, Plate 2: External facade finished with laterite blocks, Elizade University, Elizade University, Ilaramokin. Ilaramokin.


Plate 3: Laterite blocks used in Faculty building Plate 6 Laterite adobe walls used in residential building,
Elizade University, Ilaramokin. Ilaramokin.


Plate 7: Laterite adobe walls used in residential building Plate 8: E-Testing Laboratory constructed with Ilaramokin.. laterite blocks, Federal University of Technology, Akure.