*Structural Analysis of Historic Construction – D'Ayala & Fodde (eds)*
*© 2008 Taylor & Francis Group, London, ISBN 978-0-415-46872-5*

# Innovative and sustainable local material in traditional African architecture – Socio cultural dimension

T.O. Odeyale & T.O. Adekunle
*Department of Architecture, Federal University of Technology, Akure, Nigeria*

ABSTRACT: Local materials are the resources that can be found readily in large quantity at a particular location or area at a certain time. It could also be referred to as materials that can be used to fabricate a finished element. These materials however could be abundant in some area but not available in another. The availability may largely be dependant on geographical location of the area as well as the chemical and physical components of such materials. The paper critically appraises some local material available in south west Nigeria. The investigation revealed such materials as laterite, textile, bamboo, mosaic, mats stones, dye, timber, tusks, snail shell, cow dung, cowries cane and mud. These materials are cheap relative to the imported materials from outside the country. The neglect of these readily available materials should be discouraged. The paper also suggests practical and innovative ways for designers, architects and manufacturers which can serve as an alternative source of material and yet sustainable; and in the long run profitable for all concern. Proper inventory, investments, packaging and modernization can help generate much needed foreign exchange and serve as promotion of the local culture. Close attention must be paid to the sustainable methods and means of using these materials for the good of all. Diagrams, pictures, plates and their application of these materials are also showcased in the paper.

*Keywords*: Local materials, bamboo, architecture, culture, sustainability, economy, Africa.

## 1 INTRODUCTION

The indigenous technology using locally available building materials of our African ancestors deserve to be preserved. West Africa today suffers from the effects of colonization and African Americans are in a unique position to help ameliorate the situation. Architecture is a field in which remarkable achievements have been made in Africa using the indigenous technology and materials. Examples from history abounds of the use of local materials to achieve outstanding architectural monuments such as

i. The ziggurat (mud and stones) 2640–2621 BC
ii. Bight of Benin (stabilized mud brick and plaster, thatch, timber, shingles).
iii. Kofa Buka-The Kano wall (mud and vegetable mat)
iv. Centenary Hall, Ake, Abeokuta (stone, mud, timber).
v. Tomb, Places in Egypt – The Zoster's stepped pyramid at Saggara.

Drawing considerations from the history of African art and architecture where her building technology emanated from is made problematic by the fragmentary state of the evidence. Until the mid-19th century, most European contact with sub-Saharan Africa was in many areas limited to coastal regions, although the accounts of the kingdoms of Benin and Congo provided by 16th century and 17th century traders and missionaries from Portugal are useful exceptions. Arab scholars are also offers some valuable information, particularly concerning the medieval African empires of Ghana, Mali and Songhai, but also with regard to the East African coast. Some early foreign adventurers to the continent saw things historical in a different light and their account vary considerable.

There is still a persistent misconception that precolonial Africans lived almost exclusively in circular mud and thatch dwellings. Some publication since mid 19th century have associated most traditional African with round, thatched roof, mud wall hut. However, historical research indicates that square and rectangular forms are of great antiquity and have existed in diverse geographical regions.

Undoubtedly, some of the structures were influenced by external architectural traditions. In order to understand the aspect of African technology on building it is important to pay attention on the history of kings and queens, princes and emperors, popes and prelates, the story of battles, conflicts and conquests, political maneuvers and dynastic domination.

Figure 1. Indigenous building of Songhai in Mali.

## 2 BACKGROUND ON AFRICAN INDIGENOUS BUILDING MATERIALS

The morpho-genesis of human habitat started inside the cave. Like the Art, the Bee and the Beaver. Man is not contempt with God's earth and he feels oblique to build a better one, more suitable to his exalted majesty. The Art build hills, the Bee makes Hives; the Beaver constructs dams; man creates architecture. Architecture proposes an effect on the human mind, not merely a service to the human fame. Thus architecture is the art which so disposes and adores the edifice raised by man, for whatsoever uses, that the sight of them may contribute to his mental health, power and pleasures(Aluko, 1997).

As a result of this, African people look inward and discovered those materials which were used in building construction, and they are: laterite, sandcrete, stabilized earth, burnt clay, clay brick, bamboo, raffia palm, leaves, timber, palm-kernel shell, crash coconut shell, animal waste, dung and others.

### 2.1 *Early man craft*

The early man craft was borne out the need to have what identify man with his culture, belief, tradition and environment using the materials available within his reach. Due to this, man use materials like stone, wood (timber), mud in creating what has a message based on experience, inspiration, focus, norms to showcase his talent and celebrates his creativity which formed the craft (art) and architecture.

### 2.2 *African traditional architecture*

African traditional architecture showcases each region of the continent utilizing various materials available within their environment to build houses. In Tamberma

Figure 2. Indigenous building of northern Nigerian built with local materials.

(Batammaliba) region of Togo and Benin, traditional earthen round houses. Traditional architecture was more manifested in the construction of roofs. Mud construction dominated the whole of the western Sudan and part of east Africa. Most of them were infact not built of mud entirely but were reinforced with timber. The range of roofs found in various parts of Africa falls under different categories. The technology of terrace roofs was very common in Mauritania and upper Niger region. These were, achieved by laying mating or short poles arranged in herringbone pattern on top of the roof beams and plastering the hut over with mud.

In case of the Bamileke, the house has conical roof resting on square walls. The conical roof was construction round two circular platforms built on a pyramid structure which rested on top of the house walls.Western African region, house with thatched roofs above walls had great variations in shape, materials used and construction techniques while some roofs rested on pillars were independent of the walls below them. Saddle back root nearly always rested on wall plates supported on forked uprights within the walls. The ridge pole was sometimes supported by upright poles but usually rested between the gable ends. The beams were occasionally used. The shape of the roof was usually adhering in relation to the shape of the walls. Roofs above round walls would be conical, and roofs above rectangular walls could be saddle back heaped on pyramid.

### 2.3 *Rural settlement*

Traditional rural dwellings are of different types; relatively permanent houses grouped in villages are only visible in agricultural societies. A typical farming village consists of a number of family compounds along with structures that serve the larger community. Each family setting normally have separate buildings for various purposes like cooking, eating, sleeping, storing food, and protecting animals from adverse effect and external aggression at night. Based on their creativity and indigenous technological know-how using

Figure 3. Zulu beehive house built of rope lattice, thatch and wooden strips.

Figure 4. Eastern African nomadic shelter of stick framework covered with hatch.

available materials, resources and manpower within their reach, buildings may be round, rectangular, or semicircular. Communal structures, or holding meetings and teaching children are located in a prominent in the village.

Using available technology, geographical location, materials availability, culture and economic, people of Dogon in southern Mali cultivate grain on a plateau at the top of the Bandiagra cliffs near the Niger River. They built their villages on the steep sides of the cliffs. Their houses are rectangular in shape built of sun-dried mud brick and stone. The roofs are thatched, and the dwellings rest on hedges along the cliffs. The Zulu's in Southern Africa, who engage in grain cultivation and raise livestock, use their indigenous technology built houses shaped like beehives. They built their houses in a circular, fenced compound, and they keep their in the middle of the compound.

Zulu buildings roof are made of thatch that covers a framework of wooden strips and is bound together with a rope lattice. Nomadic herders also need homes they can easily build despite the fact that they move often from one place to another. They build houses which can easily actualize when their herds move to different ground. For, example, Masai found at eastern Africa, builds home using a framework of sticks sealed with cattle dung.

Majority of the rural societies in Africa decorate their buildings exterior with painted designs or with

Figure 5. Ndele women at work doing decorations work and painting of various geometrical shapes in their house. Source: www.google.com

relief (raised) patterns worked into a soft clay surface. The decoration of houses is mainly to the women. Frafra women of northern Ghana use geometric patterns to decorate with patterns walls of their houses and other buildings that communicate information about the social status of a building's owner. Ndebele women of Zimbabwe and the northeastern part of South Africa decorate and paint their houses mud walls with various geometric patterns used on the shapes of windows, step and other building features and everyday objects. Traditionally, Africans indigenous technology has used natural clays as paints, but today brightly coloured acrylic paints are popular (Jolaoso, 2001).

## 3 SOCIO-CULTURAL FACTORS IMPACTING ON INNOVATIVE MATERIALS

Socio-cultural factors are primary forms, which create ideal environment that are culturally comfortable, spiritually meaningful and socially acceptable.

House – forms viewed from these perspectives are usually influenced by family pattern (extended family), lineage system (ancestral line of family), and kinship (relation by blood).

Nigerian Traditional Architecture is an inherited art and science from the past generation on the areas of planning and designing with consideration to the provision of spaces for the individual and public interest and the construction of buildings with the available local building materials. The development of indigenous architecture could be viewed as a matter of circumstances because it was influenced by the regional element of environment.

The local available building materials and building technology of Nigerian traditional Architecture are not durable enough to meet the present demand of 20th century architectural demands in terms of resistance to leading, spans of architectural spaces and many other factors. Therefore the need to improve them to meet the present demand is one of the achievements of studying traditional architecture and indigenous technology.

Figure 6. Locally produced sun-dried brick by Timbuktu people.

Figure 7. Palace in northern Nigeria reflecting some socio cultural background.

Nigerian Building Research Institute (NBRI) hand is still studying and developing many of our local building materials to meet the present challenges. Much had been done on clay and clay products and the clay industries all over the country and many other materials which are true witness of these efforts and achievement of Nigerian Traditional Architecture. The earth architecture of late hand been received as a witness to the same achievement of traditional architecture (Madedor, & Asaolu, 1989; NBRRI , 1997).

### 3.1 *Various building materials readily available for housing in Nigeria*

Building materials and their usage in the pre-colonial era to achieve the monumental architectural spaces of Nigerian traditional Architecture is the object of study in two content. Generally, they (building materials) were based on the natural available recourses which of course vary from one locality to locality as the nature had made them readily available. Therefore, available geographical conditions especially vegetation played a vital role in availability of these building materials (Bello, 2001, Arayela, 1996; Madedor, et al. 1985).

These naturally occurring materials include: store, clay, mud, timber, bamboo, thatches, spare, grasses, palm frond, raffia palm, large, leaves, bark of trees, local fibre of bush palm, animal waste (dung), palm

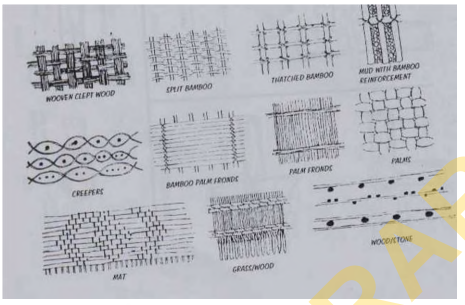



Figure 8. Common materials used in the construction of African Traditional Buildings (bamboo and organic materials).

kernel shell, broken pots and others. The uses of these materials were based on the following factors: availability, crude (yet real) technological know-how, financial constraint, crude tool and equipment, transportation system, the ruling class choice and the climatic effect on such materials. However, much been achieved in the use of these materials. These materials are illustrated in the figure below.

### 3.2 *Innovative technology involved*

#### 3.2.1 *Timber*

Timber was and is readily available and plentiful. More so, bamboo and other forest resources like ropes, forked wood for buildings were in abundant, therefore, the cost of forest building materials resources were relatively cheaper. Saving was locally done, seasoning was done with the help of the some and craft on that could easily handle them were readily available and accessible (Dmochowski, 1990).

#### 3.2.2 *Stone*

The use of stone as a walling material was unpopular in the Nigerian Traditional Architecture in the pre-colonial era due to the fact that instrument used for cutting and the bonding materials for stone were not readily available.

#### 3.2.3 *Clay and mud*

These were the chief and commonest walling materials of traditional architecture. The indigenous technology on clay and mud wall, floor and roof construction developed so much that various methods and forms were used to produce walls, roofs and floor from these two building materials. The technology used included

- Direct usage of mud and clay placing to convenience wall thickness.
- Addition of straw (cob) to clay and mud in the production of moulded small unit bricks and block used for wall construction.

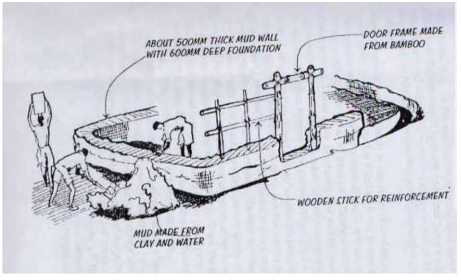



Figure 9. Method of wall construction with mud.

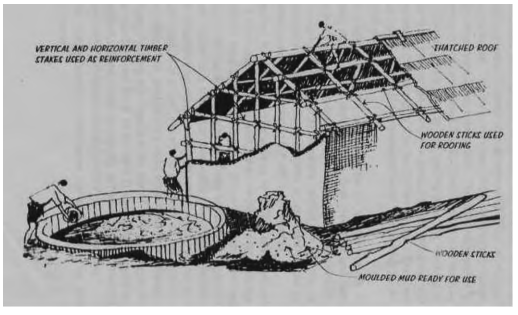



Figure 10. Method of wall construction, reinforcement and roofing.

- Tabuli: This is a production got from broken solid mud mixed with chalk, stone and gravel placed in timber framework with wet mix clay and mud to form the binding member, well rammed to form strong consolidated wall between frameworks used to form various shape of wall.
- Grasses like "zanna" wovened into mats and used as cover for reinforcement got from bamboo or similar poles to produce structural mud and clay wall.
- Sawn bamboo, raffia wovened in such a way to form shape of required wall, whole mud and clay were placed between to form structural wall construction.
- In order to prevent shrinkage and reduced cracks in mud clay walls; grasses, coconut fibres, coarse sand were added to the mud mixed before wall placing.
- The usage of long and projected roof eaves and spouts for mud and clay construction prevented rain falling directly on mud wall.
- Mud and clay walls floors, and roofs constructions were rendered with materials like indigo leave, cattle waste, coloured mud to prevent water penetration into the surface wall. The illustrations of the process are shown above.

3.2.4 *Grasses*

Grasses were found in the Middle Belt and Northern region abundantly for the purpose of construction in

Figure 11. Local building at riverine area built with wild coconut timber framework and raffia palm leave roof covering.

Nigerian Traditional Architecture. The type of grasses available in a locality depends on the climatic region, vegetation and closeness to water source. Toward the South of the Middle Belt region, elephant grasses were common; even in the Northern part of South Western, Mid – Western and Eastern region; while in the Middle Belt and Northern region, spare grasses were very common (Jolaoso, 2001; Bourne, 1981, Denyer, 1978, Encarta,2005).

3.2.5 *Wild coconut tree*

This fibrous tree is found mainly in the savannah region (Middle Belt) of Nigeria. It produced good structural member for root, wall lintel, ceiling and bridges construction. It is also used as overlay for toilet pits. Unlike timber, it is a termite resistance structural and don't easily decay unless subjected to long period of dampness (Dmochowski, 1990).

3.2.6 *Bamboo*

This pole – like structure was mostly used in construction structural members of wall, roofs, floors and ceiling so also in fence construction which was commonly found in South west part of Nigeria (Bassey, 1989).

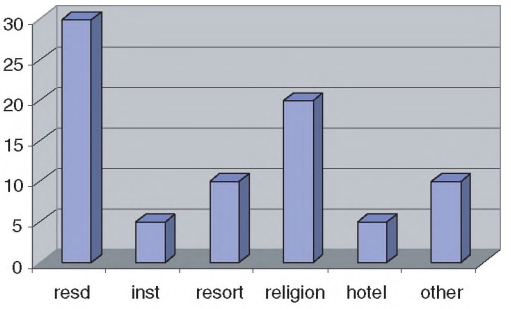
3.2.7 *Leaves and back of trees*

In the rainforest, some deciduous trees have broad and large leaves (like Gbodogi leaves and "Ebi–eni") and bark that could be used as roof cover. Also, the raffia palm leave that found in the most river banks were made into thatch roof cover called "Bambu". The barks of such tree were used as ridges to root while leaves and thatches were used as roof cover. Some leaves could be as well be used for wall finishes e.g. Indigo (Dmochoswki, 1987; Jolaoso, 1991).

3.2.8 *Animal waste*

The animal waste like dungs and bones were used as finishes to wall in the Nigerian traditional architecture. Cowries were used for decorations of walls and floors. Though, building technology of Nigerian Traditional

Table 1. Types of Building examined during study survey.




The chart reveals that many of the buildings examined in the study are mostly residential, followed by religious building and lastly resort and institutional buildings.

Architecture suffered a little setback because of "the relative fragility of building materials and the simplicity of the working tools". But it is worth of note that Nigerian Traditional Architecture left behind "technological perfection" which is a result of a thorough understanding the qualities of the materials used, and of skill developed and improved by many generations of builders great and small (Fadamiro, et al.1996).

## 4 RESEARCH FINDINGS, DATA COLLECTION AND DISCUSSIONS

The target of this data collection is to come out with reasonable and reliable findings which will be of great help as regards the technological influence on Nigerian indigenous (traditional) building materials in terms of innovation, availability, cost- effective, climatic suitability, mass production, improved products, social and legal acceptability, technical know-how, durability as well as the occupation and economic activities, craft activities, religious beliefs and practice, security, compound and housing unit.

The research methodology adopted was by studying various modern/ traditional buildings built with local materials found in some selected towns and cities in Nigeria and the effect of innovative technology on these materials and houseform using questionnaire.

### 4.1 *Data Presentation, sample size and techniques*

A sum of 90 questionnaires were prepared and distributed for administration at various locations in some selected towns and cities. The buildings focus are residential buildings, traditional buildings, public and institutional buildings. Questionnaire of close ended type was used, all questionnaires were distributed and administered and 80 retrieved after proper follow-up

Table 2. Bar Chart showing the determining factors of innovative building material in some selected cities of Nigeria.

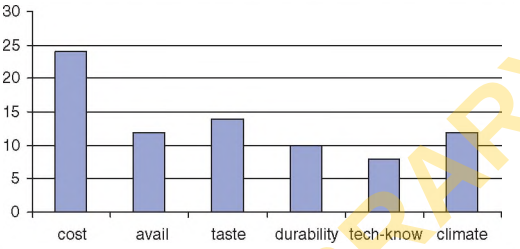
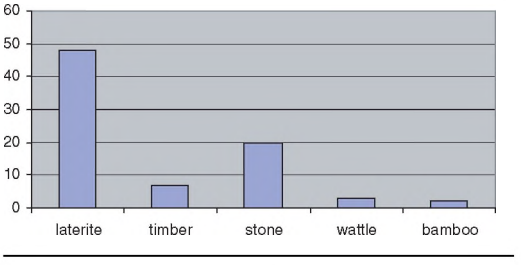



Table 3a. Mostly used indigenous building materials for walls.

| Labels | Frequency | Percentage % | Cummulative percentage % |
|---|---|---|---|
| Mud /laterite | 48 | 60 | 60.0 |
| Timber | 7 | 8.75 | 68.75 |
| Stone | 20 | 25 | 93.75 |
| Wattle | 3 | 3.75 | 97.5 |
| Bamboo | 2 | 2.5 | 100.0 |

Table 3b. Bar Chart interpretation of mostly used indigenous building materials for walls.




from the respondents but 10 were not retrieved. Therefore, this data analysis will make use of 80 questionnaires retrieved as 100%. Random sampling technique was adopted for this project work and residents in different locations were interviewed to uncover their opinion about innovative technological influence on indigenous building materials in their modern housing design.

Table 2 corroborates the known fact that cost is a deciding factor in the adoption of new technology and use of innovative materials. Several of the respondents believe that innovative material should be made available at affordable price at the open market. Table 3 a & b suggested that laterite/ mub block accounted for the 60% of the material used in indigenous buildings. Bamboo is the least used.

Table 4. Socio-cultural factors impacting on the adoption of innovative local material.

| Labels | Frequency | Percentage % | Cummulative percentage % |
|---|---|---|---|
| Political/social Status | 8 | 10 | 10 |
| Religion | 10 | 12.5 | 22.5 |
| Occupation | 11 | 13.75 | 36.25 |
| Leisure activity | 31 | 38.75 | 75 |
| Family Organisation | 20 | 25 | 100 |

## 5 CONCLUSIONS

Also, there are several existing evidences that indigenous materials such as mud, bamboo, stone, grasses, leaves, reeds, cow dungs among others were used for construction of various buildings in Nigeria. As these materials are readily available in abundance, the usage has been on decline in some time past due to flair for imported building materials which are produced with disregarded for the climatic suitability of Nigeria and high cost implication.

The fact that most people believe that living in brick, timber or stone houses symbolize abject poverty which has created hatred for these materials. Also the quest for modernization without considering our background did not help us to look inward and develop our indigenous building materials rather than searching for foreign materials.

In view of this social impression that causes the decline in the utilization and with cognizance to these materials' numerous advantages, cost benefits, this research work provide vivid information on available sources of building materials, their classification, properties, advantages and their uses as well as the production of some building components using identified local materials.

### 5.1 *Suggested recommendations*

The encouragement of the use of local building materials produced modern technology should be a collective responsibility of the government, individual and private organization, for instance, the following recommendations will be of great help:

(i) That the Government should ban or place restriction on some imported building materials. This will allow the growth of local building industries and encourage people in using locally produced building materials.

(ii) That the Government should encourage the local building materials industries by creating conducive atmosphere for operation right form the registration process to the grant as well as granting of holiday tax in some cases when it is highly needed.

(iii) That government should encourage the exportation of the locally produced building materials to find places in the world market and to generate enough capital to enhance the development of home based manufacturers.

(iv) That government and private bodies/ organizations should be encouraged to establish industries that produce local building materials.

(v) Some planning authorities who hitherto restrict people from using local building materials in the cities should be made to relax their stringent condition thereby encouraging developer to commence their development with the use of local building materials.

(vi) That the Government (at all levels) should always ensure that all related research findings are implemented and not for record purposes alone. This may be achieved by establishing a well funded, research findings' implementation commission, which would be responsible for demonstrating such findings in the form of mass housing (construction) units. Thus, serving as an architectural/structural model that would help in no small way in encouraging and promoting; the acceptance of the use of locally sourced materials with the corresponding and appropriate indigenous technology.

(vii) That public enlightenment campaign or dissemination of information should be encouraged on the developed local building materials and their applications to the masses, as better substitutes to the expensive and relatively scarce conventional materials, possibly through the existing rural development programme of the Government.

(viii) That the curriculum of technological, architecture, engineering institutions should be reviewed to reflect the study of the application of locally sourced building materials.

(ix) That the Government, Architects, Engineers and other relate professionals should lay examples by building their respective houses with these materials as a substitute to the conventional ones.

## REFERENCES

ALUKO, O.O. 1997. Nigerian Traditional Architecture, A Case Study of South-west Nigeria. A Lecture Notebook, Department of Architecture, Rufus Giwa Polytechnic, Ondo State (Unpublished). pp. 1–10, 20–25.

ARAYELA, O. 1996. The Politics of Housing the Masses in Nigeria – A Retrospective Introspection. *A Journal of the Association of Architectural Educators in Nigeria (AARCHE)*. Vol. 1, No 3. pp. 29–33.

BASSEY, N. 1989. What are Local Building Materials? A Paper presented at the Mineral Seminar of the Nigerian Institute of Architects, Edo State Chapter.

BELLO, Y.O. 2001. Elements of Creativity in Traditional Architecture; A Descriptive Study of Theory of Architecture. *A Journal of AARCHE (Association of Architectural Educators in Nigeria)*. Vol. 1, No 6. pp. 95–13.

BOURNE, L.S. 1981. *The Geography of Housing*. Edward Arnold (Publishers) Limited, London. pp. 13–21.

DENYER, S. 1978. *African Traditional Architecture*. Heinemann Press, London. pp. 155–171.

DMOCHOSWKI, Z.R. 1987. *An Introduction of Nigerian Traditional Architecture, Southwest and Central Nigeria*. Vol. II. Ethnolographical in Association with National Commission of Museums and Monument. pp. 20–70, 110–288.

DMOCHOWSKI, Z.R. 1990. *An Introduction of Nigeria Traditional Architecture, South- Eastern Nigeria, the Ibo speaking Area*. Vol. III. Ethnographical in Association with National Commission of Museums and Monument. pp. 1–36.

FADAMIRO, J.A., & OGUNSEMI, D.R. 1996. *Fundamental of Building Design, Construction and Materials.* Fancy Publications Limited, Ile-Ife, Nigeria. p. 5.

JOLAOSO, B.A. 1991. A Study of the Use of Local Building Materials for Low Cost Housing in Western Nigeria. Unpublished, B.Sc Terminal Essay. Ahmadu Bello University, Zaria.

JOLAOSO, B.A. 2001. *Housing and Indigenous Building Technology; An Introduction.* Desi-GCA Publications, Abeokuta, Nigeria. pp. 116, 123–131.

MADEDOR, A.O. & ASAOLU, E.G. 1989. *Technology and Standards for the Production of Local Building Materials in Nigeria*. NBRRI Information Pamphlet. pp. 12–15.

MADEDOR, A.O. & OMOGE, G.N. 1985. *Survey of Brickmaking Industries in Nigeria*. A proceed from a Seminar on Clay Bricks and Blocks: Research Development and Current Practice in Nigeria; NBRRI Information Pamphlet. pp. 7–22.

Microsoft Encarta Encyclopedia. 2005. *Information on African Housing and Nigeria.*

NBRRI 1997. Spotlight: The Nigerian Building and Research Institute, Lagos. *In Housing Today*. July/ August, Vol. I, No. 1, pp. 10–17.