

## **BUILDING WITH EARTH IN NIGERIA: A REVIEW OF THE PAST AND PRESENT EFFORTS TO ENHANCE FUTURE HOUSING DEVELOPMENTS**

**Emmanuel E. Oshike (MNIA)**

Department of Architecture, Yaba College of Technology, Yaba  
E-mail: oshikeee@yahoo.com

**Abstract:** This paper discusses the use of unfired earth for wall construction. A thorough review of literature covering the use of indigenous building materials, especially building with earth was carried out. It was observed that earth has been in use as a wall building material for centuries, in many ways, around the world and particularly in all parts of Nigeria for residential house construction. Then, the practice provided effectively adequate housing stock for the society. However, the drift to cement based construction lead to unaffordable and unsustainable housing presently, resulting in acute housing shortage. Three new earth building techniques: the compressed stabilized earth blocks, the interlocking compressed earth blocks and the rammed were showcased for governments, corporate organizations and private developers to employ in house building. It concluded that these new earth building materials and methods are adequate and could sufficiently augment the conventional cement based and other construction efforts.

**Keywords:** earth, wall, construction, indigenous building materials, housing.

### **INTRODUCTION**

The problems (shortage, low quality, high cost, etc) of housing, though global are more predominant in developing countries. According to United Nation's estimates (2005) about 1.3 billion urban residents live in inadequate housing. Nigeria, for instance, is faced with the both quantitative (short supply) and qualitative (low quality) problems (Federal Office of Statistics., 1997; Olatubara, 2008; Mabogunje 2003).

The World Bank (1998) estimates that Nigeria requires 720,000 housing units to be built annually for the next 20 years in order to be able to close the housing deficit of about 17 million units that would cost about N35 trillion. It is therefore necessary to employ all possible measures, including the improvement of traditional/indigenous building materials, construction methods and technologies to ameliorate the situation. In many parts of the world, including developed nations, building with earth is being revived due to rising energy costs that impact strongly on building materials such as cement and fired bricks.

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This paper sets out to review published research works to find out how the various ways earth-wall has been utilised in house building to date. It will also discuss why the usage is declining despite its numerous advantages and the continued call from all facets of the society for its application. Finally, attempt will be made to introduce another attractive and modern method of earth wall construction, the rammed earth, to facilitate its acceptability in the Nigerian building environment.

A vast literature search was conducted through the internet and relevant researches selected. For obvious reasons, a larger percentage of the publications consulted are research works of Nigerian housing experts and the remaining from other parts of the world including Australia, Europe, United States of America and Asia.

In this paper, 'earth' is used to mean any form of soil used for wall construction and 'earth-wall' is any type of wall structure built of this material, stabilised or unstabilised, or modified in any way by the addition or subtraction of other suitable materials. It is the unfired soil/earth.

### **BUILDING WITH EARTH BRIEF HISTORY**

Since man started the act of shelter construction, advancing from tree top and cave dwellings, earth has been the dominant wall constructing material among timber and bamboo. Dethier (1981) estimates indicate that over 30% of the world population lives in earth built structures. According to Walker and McGregor, (1996), earth is the most basic, and the most ubiquitous, building material known to man. It has been used for thousands of years by civilizations all over the world. Pollock (1999), noted that the use of earth as a building material dates back to at least the Ubaid Period in ancient Mesopotamia (5000 – 4000 B.C.). Earth walled buildings are as old many settlements in Africa and other lands. The prestigious structures-residences, tombs and pyramids, of ancient Egypt were all built with unbaked earth. According to Pumpelly, (1908) Mud brick (adobe) houses were built in Turkestan, Russia before 6000 BC. Earth has been used differently in many cultures for several purposes, ranging from simple residential to religious and industrial buildings. The major techniques generally employed include Adobe (mud brick), Cob, Pressed earth brick. Others are Wattle and daub, Rammed earth and Poured earth. Any other method is a variant of any of the above. Several examples of earth walled buildings abound. Many mosques were built with earth in Africa. For example the Djenne's Mosque in Mali, north Africa (Plate 1) below, is considered to be the largest building constructed with mud brick in the world. The Great Wall of China, built some 4000 years ago was originally built partly of rammed earth. Near the city of Lyon, there

are several buildings that are more than 300 years old and are still inhabited. Also Houben and Guillaud (1989) listed the following settlements that are entirely constructed of earth: Catal Hunyuk in Turkey; Harappa and Mohenjo-Daro in Pakistan; Akhlet-Aton in Egypt and Babylon in Iraq.



**Plate 1:** Djenne's Mosque, Mali-Largest Building Constructed of Mud Brick in the World  
**Source:** The Islamic Times: Way To Go Mali

## LITERATURE REVIEW

The large number of research works and publications show the urgency and the need to engage other options in attempts to solving the seemingly unsumantable housing problems of the world especially the developing countries like Nigeria. Many of the research results support the use of different indigenous building materials (IBM) and methods. A trend which hitherto, is yet to manifest in reality as projects involving the use of materials like earth are still rare. The table below shows some of the relevant published research works.

**TABLE 1: SCHOLARLY ARTICLES ADVOCATING FOR THE USE OF INDIGENOUS BUILDING MATERIALS FOR MODERN HOUSING**

No.	Author(s)	Research/Paper title	Date	Remarks
1.	Ekong E. Daniel, Akpanim N. Ekpe and Samuel Okurebia,	Sustainable Development And Utilization of the Red/Brown Earth (Laterite) in South-Eastern Nigeria	2014	
2.	By Adogbo, K.J and Kolo, B.A.	Stabilized Earth Housing Delivery through the Public-Private Partnership: Panacea to Inadequate Housing Provision for the Low-Income in Nigerian Cities	2013	
3.	Kadiri, Kabir O.	Earth Construction Technology as a Facilitator of Mass Housing in Nigeria	2012	
4.	Nwoke, O.A and Ugwuishiwu ,B .O	Local Bamboo and Earth Construction Potentials for Provision of Affordable Structures in Nigeria	2011	
5.	Mohammad Sharif Zami & Dr. Angela Lee	Contemporary Earth Construction In Urban Housing – Stabilised Or Unstabilised?	2009	
6.	B. Baiche, M. Osmani, K. Hadjri and C. Chifunda	Attitudes towards earth construction in the developing world: a case study from Zambia	2008	
7.	By Adogbo, K.J and Kolo, B.A.	The Perceptions on the Use of Indigenous Building Materials by Professionals in the Nigerian Building Industry	2007	
8.	Lorenzo Fontana	Moulding Earth Outline: Typology, Technology and Morphology of Earth Building	2005	
9.	Oloruntoba Kayode and Ayodele E. Olusegun	Local Building Materials: a Tool Towards Effective Low-Income Housing in Nigeria	2003	
10.	Anil Agarwal	Mud, Mud: the Potential of Based Materials for Third World Housing	1981	

### **BUILDING WITH EARTH IN NIGERIA**

Prior to foreign incursion into the west coast of Africa, earth was the predominant building material in the sub region. It was used effectively in the various climatic zones, the application method depends on the type of soil, technical knowhow and tools as well as local traditions and customs of the community (Adam and Agib, 2001). Basic farming implements, procured within, were mostly the building equipment. The houses built then provided

adequate shelter for the occupants and there were no cases of housing shortage. But the modern era labelled such methods and houses 'primitive' and discontinued their production and usage, opting for the modern sand-cement based ones. However, a lot of these ancient buildings, with little or no modifications abound in the core traditional settlements within the large urban areas till date. Bere in Ibadan, Ibadan North Local Government Area, Oyo State and Mushin in Mushin Local Government Area, Lagos State are good examples. Building construction metamorphosed rapidly through the ages from traditional to modern types as shown in table 1 below.

**TABLE 2: REGIONAL EARTH-WALL USAGE TYPOLOGY IN NIGERIA**

No.	Walling technique	Region predominantly used	Remarks
1.	Torchis (Wattle & dub)	Middle Belt, Southern and Eastern Nigeria	
2.	Adobe (earth brick)	Western Nigeria	
3.	Adobe (tubali)	Northern Nigeria	
4.	Cob (direct layering)	Western Nigeria	
5.	Compressed Earth Blocks (CSB)	All regions	The most varied and acceptable modern method

### **Earth Structures in Western Nigeria**

Two methods are generally used in Yoruba land: Adobe(earth blocks) and Cob (direct layering).These methods are used to construct traditional domestic buildings of earth walls of varying thicknesses, bamboo rafters or other termite-resistant timber with thatched or corrugated iron(when available), and room sizes based on a standard module of 10 feet (Osasona, 2007). Initially, the sun dried earth blocks were laid with mixed soft soil joints, but later when cement became available was changed to sand cement mortar. The later type of houses were easily rendered too with same material, giving the impression of modern sand-cement block walled houses. These are shown in plate 3 below.

Cob (direct layering). The earth to be used is pre moulded into balls and are allowed to mature for a few days and set in place over a foundation of stone rubbles and soil, in estimated layers. Otherequipment, apart from bare hands and wooden batten, are rarely used. This makes the walls uneven and irregular in both thickness and shape. About four or five layers make up the complete wall height. The colour of each layer may vary as they are made

differently from various soils and time intervals. In urban areas, most walls are finished with sand cement plastering. Plate 2 below shows a wall made by this method.



**Plate 2:** Adobe blocks coursed with soil and sand cement mortar joints.

**Source:** [www.pinterest.com](http://www.pinterest.com)



**Plate 3:** Cob wall/Direct layering wall construction partly rendered

**Source:** [www.en.wikipedia.com](http://www.en.wikipedia.com)

### **Earth Structures in Eastern Nigeria**

The most common type of earth wall construction here is the wattle and daub which comprises the use of timber or bamboo columns spaced at about 300mm intervals along all



external walls and internal partitions. Slats, called wattles, comprising pieces of bamboo stems or tiny but long tree stems are tied horizontally to the earlier installed columns to make up an open formwork to receive the worked soft earth balls- the daub. It is either left that way or additional earth placed to cover the structural framework of bamboo stems and slats. See plate 6 below. The major setback of this system is that the wooden structural frameworks are prone to insect / rot attacks and eventual failure. However, the structure could also be rebuilt with same earth, but with new wattle set up.



**Plate 4:** Wattle and Daub earth wall technique.

**Source:** [www.en.wikipedia.com](http://www.en.wikipedia.com)

### **Earth Structures in Northern Nigeria**

The dominant wall construction in this region is also adobe, that is, sun dried earth bricks. However, it is shaped differently; elongated and most times bare hand shaped. It is called 'tubali'. Much more soil mortar is required for the jointing. Roofs vary, ranging from domelike structures to flat earth finished top. Sometimes thatch is applied. Floor plans are either rectangular or circular in shape.



**Plate 5:** Adobe(Tubali) used in Northern Nigeria

**Source:** [www.pinterest.com](http://www.pinterest.com)

### **SOURCES OF EARTH FOR BUILDING CONSTRUCTION**

Table 3, below shows that earth is one of the indigenous building material that is available in all the states, including the federal capital territory, over the country. Almost all category of available earth in and around the site could be harnessed for wall construction. It could be advantageously sourced from one or more of the following locations:

1. Project site. Excavated subsoil from foundations, basements and septic tank/soak away pits provide a reasonable amount of earth material for wall construction.
1. Excavated subsoil, that is, wastes from other construction sites like road works nearby makes available free or cheap earth for building.
1. Designated local quarries. Commercial sale point where earth/laterite for construction works could be bought and transported to site with lorries.
2. Demolition sites. Earth from disused old earth walled buildings is a good sourced of earth for wall construction.



**Table 3: Availability of Raw (Indigenous Building) Materials in Nigeria**

Type of Material	States predominately found
Granite	Plateau, Ondo, Ado Ekiti, Bauchi, Abia and Ebonyi
Limestone	Anambra, Cross Rivers, Benue, Imo, Edo and Delta
Marble	Kwara, Edo, Delta Benue, Plateau and Kaduna
Laterite/Earth	All States
Clay	Cross Rivers, Ondo, Oyo, Sokoto, Gombe, Kano, Niger, Imo and Anambra
Natural fibre	All States
Bamboo	Eastern Nigeria
Timber	Eastern and Western Nigeria

(Source: Kogbe, 1989; Okereke 2003)

### **EFFORTS TOWARDS REVAMPING THE USE OF EARTH FOR WALL**

Several Nigerian governments in many instances have made policies and programmes geared towards the utilisation of earth and earthen products to facilitate the provision of good and affordable housing for the average citizen. The main objective of establishing the seven clay industries, like the clay industry at Oregun, Ikeja, across the country in the 1970s was to provide a cheaper alternative to the sand-cement blocks. This did not yield positive result as the fired clay products are even more expensive and more complicated to build. Further to the promotion for the use of earth technology for building construction, the Center for Earth Construction Technology (CECTech) by the National Commission for of Museums and Monuments and the French Embassy in Lagos was established to facilitate the production of earth based materials for walling and flooring (Lamort 1993). Other establishments for the promotion of the use of indigenous building materials are the Raw Materials Institute and the Directorate for Food, Roads and Rural Infrastructure (DFRRI) which initiated the use of local raw materials in the construction of roofing sheets in Nigeria.

However, governments in Nigeria are yet to truly demonstrate these arrangements as there are non of their housing estates that are built using at least improved indigenous materials and methods. As Turner (1977) observed that government activities in housing hamper the use of local resources where they continue to build and manage houses, which have repeated the same mistakes by setting material standards, and building codes, which are ill suited and far too expensive for the poor majority.

## **NEW EARTH WALL BUILDINGS FOR HOUSING**

Building walls with earth is actively being revived all over the world. Remarkable progress has been made in many countries, notably New Zealand, Australia, India, New Mexico, United States of America etc. New Zealand has developed and published standards guiding the erection of earth buildings. There now exist a movement for 'New earth building' in most parts of the world. Nigeria is yet to experience this wave of events in the construction industry therein. For now, elsewhere, adobe blocks are mostly employed in the construction of these earth buildings, but here in Nigeria the compressed earth blocks and compressed interlocking earth blocks are common. Another popular new earth method not used in Nigeria is the rammed earth. The introduction of this method into the Nigerian building environment is very crucial to engender the ever sought acceptability of earth wall by housing consumers. The three methods enumerated above will be further discussed to foster construction of new earth buildings.

## **COMPRESSED STABILISED INTERLOCKING EARTH BLOCKS**

Unfired solid interlocking laterite / clay (Hydraform blocks) is a form of stabilized building blocks for construction (Oti et al, 2009). This is one of the few earth material that is beginning to gain ground in the Nigerian construction milieu. It is a more advanced type of compressed earth blocks and it is capable of being laid without mortar or any other jointing material. Its minor setback is that it can only be produced by a specialised machine, which may not be advantageously acquired by an individual builder for a single project. However, the production of the interlocking blocks and the assemblage requires little skill which can be acquired within a short period of training. One of its advantages as asserted by (Joseph, 2010) is that it can significantly reduce the energy use and also cut down carbon dioxide (CO<sub>2</sub>) emissions and minimize generated wastes. Another advantage that the use of interlocking blocks offers is the high speed of erection, compared to other building methods (Adedeji, 2011). Additional finishes such as rendering or plastering and painting applied to sand-cement block walls may not be necessary that is more cost savings. It is beautiful and attractive. Plate 2 below shows a typical building constructed with interlocking blocks. Interlocking blocks was used to build the houses in Obasanjo low-cost housing estate, Ado-Ekiti.



**PLATE 6:** A Building made of Compressed Interlocking Earth Blocks and Concrete  
**Source:** Taiwo and Adegboye, 2013

### **COMPRESSED STABILISED EARTH BLOCKS (CSEB)**

The compressed stabilized earth blocks are produced like the compressed interlocking earth blocks. However, the laying procedure is different, with the addition of mortar for jointing. This is the most widely used modern earth walling method in Nigeria and many other countries around the world to provide low cost housing. For example, 2,698 low cost housing units were built in a year time, in 39 villages in India in 2005. The use of compressed stabilized earth blocks proves advantageous in many ways. It is beautiful and can meet any modern standard for house construction. Another advantage is the reduction in cost as it is cheaper than the conventional sand cement made block wall by as much as 20-70% in most construction projects (Adam and Ajib, 2001). CSEB could also be made through 'self help', that is doing it yourself, gathering materials around at little or no costs (Adam and Ajib, 2001). Plate 7 below shows a building constructed with compressed stabilized earth blocks.



**PLATE 7:** A Building made of Compressed Stabilized Earth Blocks  
**Source:** Adam and Agib, 2001

### **RAMMED EARTH BUILDING**

Though not known or used in Nigeria, the rammed earth technique is not new as Handbuch der Lehmbackkunst cited in (Gilly,1787), long ago described the rammed earth technique as the most advantageous earth construction method. It is a method of unfired earth construction where a mixture of suitable earth and 5% cement (as stabiliser) at optimum moisture for maximum dry density compaction is poured into formwork, set up on site. The earth is then rammed or compacted either manually with suitable rammers or pneumatic or electric compressors. Rammed earth is commonly used in all style of buildings ranging from small residential buildings to largest mansions. The finished is close to fair-face concrete and could be in a variety of colours. Notable examples include the church at Margaret River, Western Australia and



**PLATE 8:** A Building made of Compressed Stabilized Earth Blocks  
**Source:** Stehpen Dobson,2000



**PLATE 9:** Rammed Earth Residential Building  
**Source:** [www.en.wikipedia.com](http://www.en.wikipedia.com)

## CONCLUSIONS

When earth was the dominant walling material, there was limited housing shortage because consumers could easily build their houses according to their capability. Till date earth



buildings are still relegated to the background, when used at all it is usually in remote areas that are unnoticeable. Introduction of new, through research on earth as a building material, but accessible construction methods is vital for high output but cheaper requirements to positively compete effectively with the counterpart materials. Where machines are necessary, it should be simplified as much as possible for ease of access. Such machines should also be procured in large quantities for public use by the government, either on rental or hire purchase basis. New sets of building artisans, who in turn will be training others, should also be trained to facilitate the execution of building projects with earth. The curriculum of building professionals in the schools should also entail earth construction materials and methods. Pilot projects at open locations in both new and old residential areas should be put in place to showcase the possibilities of modern earth structures, like rammed earth or interlocking blocks.

For new earth buildings to be successful, all types and methods must be seen by consumers as good or even superior to other methods. Already, the environmental benefits of earth buildings over the conventional buildings are a major advantage as the world is going green.

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