

MTECH RESEARCH PROPOSAL

*ON*

**BUILDING MATERIALS IN SOUTH- WESTERN  
NIGERIA.**

(AFFORDABILITY IN BUILDING CONSTRUCTION THROUGH  
THE USE OF INTERLOCKING BRICKS)

BY

**ADEWOLE, HENRY ADEYEMI**

*ARC/03/1893*

DEPARTMENT OF ARCHITECTURE, FEDERAL UNIVERSITY OF  
TECHNOLOGY, AKURE.

MARCH, 2008

## INTRODUCTION

Housing: permanent shelter for human habitation. Because shelter is necessary to everyone, the problem of providing adequate housing has long been a concern, not only of individuals but of governments as well. Thus, the history of housing is inseparable from the social, economic, and political development of humankind. From the beginning of civilization, attention has been paid to the form, placement, and provision of human habitation. Rawar, R.S. (2000).

At present, there is both a demand for housing and a supply of reusable structures that are going unclaimed. This situation is a good example of the complex role housing plays in society. Its primary function is to serve the need for shelter and privacy.

Earth architecture has a longstanding tradition in the south-western part of Nigeria. According to the various techniques and materials, we differentiate between layered, rammed, wood-framed, adobe and wattled earth-walls.

By the 1960's, earth architecture was entirely substituted with brick construction. But starting from the 1970's and 1980's, building with earth has become popular again. A lot of houses have been refurbished, instead of being totally destroyed, and with the assistance of the organic architecture, and other representatives of environmentalism, have started to build new earth houses. Lenin, O.O. (1999).

Interlocking bricks have always been in use to a lesser extent, but extensive studies on this technology only appeared after the first ecological-villages came into being. Few of these buildings are in south-western Nigeria, but there have been several other experiments in different parts of the country. The construction of interlocking bricks structures is limited though, since builders pick this particular material mostly for ecological reasons. This special demand normally comes from only a small group of environmentalists, ecologists or people with a keen sense of

environmental protection, so the use of interlocking bricks has not become widespread among ordinary builders.

## **PROBLEM STATEMENT**

The major problem to be solved is the ignorance of the people towards the advantageous use of interlocking bricks in building construction in the south western part of Nigeria. A very great observation is that developers have neglected the use of traditional building materials, most especially interlocking bricks which have been in existence long ago and have accepted to a fault, the influx of foreign materials and techniques. This has so much contributed negatively to the economy of the nation at large. Indigenous/local materials for the production of these bricks are lying waste and unextracted. This has raised the cost of acquisition of building by both private and public sectors. This calls for an urgent re-orientation of prospective house owners and builders in the south western part of Nigeria and beyond to consider the use of interlocking bricks for better quality housing of its population at a relatively lower cost/rate.

## **AIM AND OBJECTIVES**

The study of interlocking bricks and its mode of construction in this context aim at its use as a walling material. Bricks that has been in use since the Neolithic period of man's existence is presently discovered as being neglected, largely because of the introduction of new materials and their various methods of installation. The interlocking brick as a walling material has some distinct characteristics which make it have an edge over the other walling material. These are exhibited in its relative cheapness, availability, low cost of construction, low cost of maintenance. Others are its simple method of construction, aesthetics and its thermal insulation at extreme weather conditions etc. All the above mentioned attributes of interlocking brick wall be explicated and highlighted in the course of this study to expose the residents, developers and urban dwellers to the enormous benefits accruing to interlocking bricks. The aim of this research is to enlighten people of the south-

western Nigeria on providing better quality housing at a relatively lower cost/rate with the use of interlocking bricks.

The objectives of this study are the proposed ways and strategies by which the aim of the study can easily be achieved. These include

- (a) The in-depth study of interlocking bricks
- (b) Production process of Interlocking bricks
- (c) Exploration of existing interlocking brick buildings in south west Nigeria.
- (d) Cost comparison between interlocking bricks walls and walls of other materials.
- (e) Aesthetical analysis and the justification for its use in public building.

## **RESEARCH HYPOTHESIS**

- There is no significant relationship in the production process of interlocking bricks and sandcrete block.
- The use of interlocking bricks to achieve aesthetic and form has a significant effect of the building.
- There is no significant relationship in the cost of interlocking bricks and sandcrete block.

## **SCOPE OF STUDY**

The knowledge of the use of interlocking bricks in Nigerian housing is increasingly going far and wide over the years. It is not unknown to builders, especially those that are solely after cost reduction. Since Nigeria is regionally divided into various climatic zones which is a significant consideration in the selection of materials for wall. For the purpose of this research, the study is shall be limited to the south-western Nigeria. This region connotes the relatively humid region of Nigeria. The

culture, climate, soil properties and types shall be elaborated to make us see the need to go back to some of the traditional architecture with the intention of improving them technologically and to make materials of such be able to compete with the imported materials when it comes to quality.

## **LITERATURE REVIEW**

The research activities that ultimately led to the development of the interlocking block technique, which is gaining popularity in Thailand, as well as Malaysia and the Philippines, date back to the 1960s. In these countries, houses in the rural areas were traditionally built of timber, which was readily available in the extensive forest areas. However, the alarming rate of deforestation in Thailand - from 70% forest cover in 1936 to about 55% in 1961 (now it is less than 30%) - led the government to initiate research into alternative materials for building construction in the rural areas.

Initially, research undertaken by the Thailand Institute of Scientific and Technological Research (TISTR), Bangkok, focused on soil-cement blocks made with the CINVA-Ram manual block press (which was developed in Colombia in 1956). The demonstration houses built with these blocks were cheaper than timber houses, more durable, resistant to water, fire and termites, and aesthetically appealing. The disadvantages, however, were that the blocks were relatively heavy, and building construction required a certain amount of masonry skills. Furthermore, the mortar joints consumed a considerable amount of cement and construction time was relatively long. (Steve 98)

## **BRICKMAKING LATERITE**

The type and quality of laterite soil used for brick making vary since there is no standard criterion which can be applied when determining the suitability of any laterite deposit for brick production. It was found out that the earliest known bricks were not fired but were a mixture of clay and sand reinforced with straw. The straw

which was added during the making process would have a similar effect to that of a fiberglass in glass reinforced plastics today. Naturally, unfired laterite bricks even when reinforced in this way, will not last very long in a climate with periods of heavy rainfall as we have in south western part of Nigeria.

## **TYPES OF BRICKS**

The various available types of bricks may be classified by colour, mechanical strength and the purpose for which they are intended according to Hamilton, (1978).

***Common Bricks:*** Used in building where their appearance is of little or no consequence. It may vary in colour from red to pale yellow. They are not vitrified and normally not fired higher than 1830°F (1000°C). They are not expected to have a great compressive strength.

***Facing Bricks:*** These are more carefully made and the quality of the raw materials is vigorously controlled. They are sometimes fired beyond 1000°C to produce a more acceptable surface and this is accompanied by greater mechanical strength. They are mostly used on approach elevations, entrance porches and specific areas to captivate the attention of the observer.

***Engineering Bricks:*** These are strong type of bricks which are fired to the point of vitrification or a temperature approaching this state under reduction condition which achieves maximum strength without deformation. Such bricks have very great compressive strength and the production is carefully controlled.

## **INTERLOCKING BRICKS**

This is an improvement on the traditional adobe bricks that were prevalent in the 20<sup>th</sup> century in some African countries. It is a non-hollowed laterite brick stabilised with cement in the ratio 1:19. It involves the use of the “hydraform” machine which was invented by NBBRI in 2002. An interlocking building block system comprises a

plurality of rectangular building blocks, each with longitudinal side surfaces, upper and lower longitudinal faces, and vertical end walls normal side surfaces and longitudinal faces. The upper longitudinal face of the blocks has a central longitudinal accurate rib and a pair of transverse spaced accurate ribs thereon. The transverse ribs extend laterally from the longitudinal rib to the one of the side surfaces. Corresponding longitudinal and lateral transverse concave and accurate recesses in the lower longitudinal face mate with the ribs of an adjacent block when assembled. A pair of spaced vertical slots extends through the block inwardly of each end wall opposite to the transverse ribs and terminates tangentially to the longitudinal rib. One block may be placed on the intersection between of two abutting blocks with one transverse rib from each lower block received in each transverse recess of the upper block and one vertical slot from each lower block in vertical alignment with the slots of the upper block. Corner blocks have a single vertical slot and a third transverse rib and recess opposite and coextensive with one of the pair of transverse ribs and recesses formed on the longitudinal faces.

The introduction of modular interlocking bricks in the building industry not only provides a dimensional basis for the coordination of dimensions and of those building incorporating them, but it also acts as a tool towards rationalization and industrialization of the building industry. Modular building design and construction were born of the need for flexibility, economy, and adaptability. The proposed interlocking blocks can offer several advantages such as design flexibility, cost effectiveness, reduced construction time, environmentally friendly and a solution to space shortage. On the environmental end, the use of entirely non-hazardous waste material for such blocks to achieve the above results from locally abundant, readily available indigenous materials with low embodied energy counts. Because of the excellent properties in terms of appearance durability and cost, laterite has been chosen as main material for the project. The object of this research is to investigate the properties of the various materials.

## **CHARACTERISTICS OF INTERLOCKING BRICKS**

Interlocking bricks have so many characteristic features and attributes which aids its identification for use in building construction. Such characteristics are discussed below.

### **APPEARANCE**

Interlocking bricks are the perfect staple for any building. They fit together beautifully, are easy to maintain, and give the building a stunning touch. They can be found them in a variety of buildings from the most modest to lavish estates. Interlocking bricks is a type of earth material with a distinct reddish brown colour. The colour is due to the presence of large amount of laterite. Interlocking bricks could also come in

### **THERMAL PERFORMANCE**

There was an investigation of the thermal performance of reinforced concrete, interlocking laterite brick building and sandcrete block building in Port Harcourt carried out by Nyenke and Opara, during dry and wet seasons reported by the National Association of Certified Engineers Journals. It was observed that the building with interlocking laterite brick has the best thermal performance than the others which require mechanical ventilation or cooling in order to maintain the minimum thermal comfort level within the building. Enchore, I.J., (2003). The high cost of building and construction materials in Nigerian has been linked to the high import dependence of these materials duet poor quality of the locally produced materials, Opara, (1998). Also the high cost of energy consumption in buildings has reached an alarming rate. Interlocking brick buildings generally, are appropriate for different climates and suite solar heating and cooling. If well designed, they stay warm in the cold seasons and cool in dry season with little or need for auxiliary mechanical energy. About half of energy sector is consumed in building space cooling the urban and semi-urban areas of Nigeria. The space cooling is caused by losses or gains due to heat transfer by air movement due to infiltration and \or controlled ventilation.



## **FIRE AND WATER RESISTANCE**

When interlocking brick is buildings, it gives a significant level of fire resistance. The fact that it had spent a period of at least 36 hours in the kiln during firing is evidence that it can withstand fire for a long time while it is being strengthened further. Burnt pulp and saw dust create small holes inside the bricks, which increase the heat insulation. During grinding, bricks of high margin plain are produced; this increases the smoothness of the surfaces and thus, appears coated against easy penetration at a relatively low rate.

## **AVAILABILITY**

To the lay man, laterite means earth or any type of soil but in the sense of it, the analogy simply demonstrates the ready availability and abundance of laterite. It is found almost every where in south western Nigeria, but more commonly found in the savannah, where there is very little amount of rainfall throughout the year. The type available down south is darker than that of the savannah but also very good in building construction. Study shows that the abundance is relatively moderate in south western Nigeria and even much more than can be fully exploited for use in interlocking bricks by the south western dwellers of Nigeria when it comes to its use in building construction.

## **COST**

Since the raw materials for the interlocking bricks are very much readily available in our immediate environment, it is very cheap and requires little skill in manufacture.

Where the same size of interlocking bricks and sandcrete blocks are compared, it was discovered from the immediate market survey, that the sandcrete blocks cost more and need to be plastered while interlocking bricks may be left unplastered to showcase the different aesthetic colours.

## **AESTHETICS**

No doubt, interlocking bricks when used in building are very aesthetically sound and very pleasing to the sight. In most cases there is no need for plastering. They are extremely beautiful if well arranged, it also gives some predetermined shapes and patterns after installation. They interlocking bricks could also be given different pigmentation to show various glowing colours.

## **PRODUCTION PROCESS OF INTERLOCKING BRICKS**

The raw materials for the production of interlocking bricks need to go through some pre-determined processes before emerging as being structurally capable of carrying load. These processes are:

- **Soil Preparation**

This involves the sieving of the dry soil which is either done manually or with the use of constructed wire mesh sieve. Some machines are also available for this type operation in case of large scale production.

- **Mixing**

Here, proportional quantities of the materials required are measured and mixed together. The measurement is achieved by weight or by volume. Cement of about 4-5% could also be added to further the product. The mixing is done manually by using shovel and head pan while the large scale production requires the use of mechanical mixer. At this stage water is added proportionally. The maximum quantity of water to be added is determined by "**Ball Test**"

- **Ball Test**

The test confirms the plasticity of the soil sample being used for block production. It is done by shaping a little sample into a ball and allowing it to fall from a height of

about 1.5m. If the ball scatters, then it is too dry to be used. If the ball breaks into 4 or 5 pieces, then it is suitable but a ball sample that flattens on landing is rather too wet.

- **Compression**

Compressing a soil sample means the application of internal strength to the material to make it stronger. This is done with the use of hydraulic machine.

- **Stacking**

After compression, the resulting bricks are stacked in the open to gain some freshness shortly before installation.

- **Curing**

This is the stage whereby the product is meant to gain maximum strength by stacking under 100% humidity for about seven (7) days. The interlocking bricks are covered with fabric materials to reduce rapid loss of water. Water is also sprinkled on the interlocking bricks to maintain good moisture contents of the bricks. It should be noted that after curing the bricks are ready to be stacked (installed as walls).

## **ADVANTAGES OF THE INTERLOCKING BRICK SYSTEM**

**Some major advantages of this system are:**

- 1 The system is very aesthetic and gives more interlocked effects from key and slots.
- 2 The construction procedure is simple. It does not require temporary formworks or propping. Therefore, it can be erected quickly by unskilled labour, hence saving cost of installation.

- 3 Less wastage of materials is involved. There is no cutting of bricks required during construction.
- 4 Construction site cleaner in contrast to traditional methods of construction.
- 5 Renovation work of interlocking bricks is much easier to handle.
- 6 Construction is faster, thus the waiting time for occupancy of a building is reduced is reduced to the minimal.

## **RESEARCH METHODOLOGY**

For the purpose of this research work, the method of data collection and its subsequent analysis, a research methodology will be adopted. This section presents the methodology that will be used in this research work. It will comprises the study area (target population), methods of data collection and analysis and model formulation. Okoko, E. E. (2002), referred to research methodology as a tool that serves as scaffolding for the validation, proper analysis and interpretation of data towards guiding a researcher for the realization of the set goal and objectives. It is simply the various processes, procedures, methods and instrumentalities, by which data are secured, specified, collated, processed and analysed Fasakin, (2000).

## **PURPOSE OF RESEARCH**

Researches are often carried out in an attempt to survey, analyse and replan an existing situation to produce positive effects(s). This is achieved through a systematic process of data collection, presentation, analysis and interpretation (Okoko, E. E. (1998). The subsequent information and deductions from the research is implemented into planning proposals and are likely to influence one's proposals in solving problems in view.

In most cases, researches are meant to give necessary information on the problem and the feasibility that the proposal put forward is workable. This must be well backed by survey data

## **METHODS OF SAMPLING**

Any attempt to collect data from all the professionals in the building industry and from all the people living in interlocking brick buildings in the south-western Nigeria will be technically and economically ambiguous, wasteful and time consuming. It is therefore desirable to adopt a sampling process that will be suitable for the targeted population and study area. Four sampling methods were identified by Boyd et al. The sampling techniques are simple, random, systematic and multistage sampling which is also known as cluster sampling method.

In multistage sampling, there is the classification of the study population into compartments or zones which are mutually from which the desired sample can be selected. Kitchin and Tate (2000), contends that sample size depends on the variability of the population to be sampled. He established that one can only estimate the size of sample needed in order to estimate population value with a certain degree of confidence if one already knows something about the variability.

## **MULTISTAGE SAMPLING**

Housing inventory (studies particularly in cities) normally involves large coverage areas sometimes separated by hundreds of kilometers far apart from each other. In most cases, locating and getting to a sampling unit is expensive while measurement of each unit is relatively cheap. It would be of advantage to concentrate measurements on a few locations. Multi-stage sampling or sub-sampling has the objective of trying to provide a sample unit that can be cost efficiently measured and to cluster these samples in higher level larger unit to reduce the travel cost between measurement units Nichols (1979). Loetsch and Haller (1973), described cluster sampling while the two words were used interchangeably by Cochran (1997).

Multi-stage sampling has a number of advantages over simpler methods. For instance, Yates, (1960) noted that sampling introduces flexibility into sampling and it enables existing natural divisions and sub-divisions of the population to be

utilized as units at the various stages. Husch et al, (1982) claimed that two-stages sampling may result in the reduction of non-sampling errors since there is closer supervision and control of field work when sampling units are concentrated in few locations. Also, two-stage sampling yields estimates of a required precision at a lower cost than single-stage sampling. Precision and cost both increase as the number of primaries is increased and the number of secondary per primary may cut down cost, although precision will suffer. Freeze (1965), further suggested that the greatest precision for a given cost could be achieved by determining and taking an optimum number of secondary per primary.

## **RESEARCH TOOLS**

These are essentially the practical methods and ways of getting information about a subject matter from the different sources available. These include among many; observation, interview, questionnaire, ocular presentation. These various methods are discussed below.

### **OBSERVATION**

Someone once said “you can learn more by watching”. This method does not require verbal or written approach on the source. There, the observant only needs to watch events happen and record observations. Observed issues may either be behavioural or non-behavioural whereby the former involves the observer to participate in the event for “to catch a monkey, you behave as one”. He acts as a part of the system and this gives him uninterrupted access to information. While the later does not involve as much effort as the former. He just has to watch and observe happenings.

### **INTERVIEW**

This brings the researcher and the source to a face to face conversation where a list of questions are prepared by the researcher and thrown to the respondent according to the level of complexity of those questions. The reliability of this method lies in the fact that verbal and non-verbal responses are recorded and one can also

ask questions outside the ones already listed by the researcher. Also, expressions on the respondent's face can be judged when some certain questions are asked.

## **QUESTIONNAIRE**

There are set of questions are designed by the researcher to elicit some specific information on a particular matter, it is called questionnaire. These set of questions are later collected, analysed and presented for use in the testing of hypothesis. This is very advantageous in the sense that it is time saving. It can cover a larger population than interview.

## **TYPES OF DATA**

There are different types of data collected from the site, field or any other relevant source, which needs to be analysed as soon as collected. The various types include:

**PRIMARY DATA:** These are often referred to as raw data, gotten by the researcher through the use of any of the above mentioned research tools. It is also extracted directly from the various sources such as the respondent and the area(s) under study. The questionnaire administered were sixteen (16) questions with options and fill in the gap. Questions were asked to find out about affordability, availability, cost of construction and maintenance cost of the . Personal interview involved many people residing in interlocking brick buildings and masons who are specialized in the use of interlocking bricks in building construction. The interlocking bricks dwellers were interviewed on the durability and sustainability of the material as a walling material.

Masons were interviewed on the period of construction, availability of the material, method of construction and probable effect of weather and human forces on the standing wall, and how to maintain them for a long life. Some developers were also spoken with in the bid to get information on the cost of production and its effectiveness in solving the housing need of low income earners in the south western Nigeria. Observation and photograph taking were carried out on

interlocking bricks, interlocking bricks production and interlocking brick construction sites to demonstrate the level of awareness and use of this building material.

**SECONDARY DATA:** These are the processed information and kept in record for different purposes. They exist in published materials and are merely collected for the purpose of research. In this regard the researcher will explore the general use and production of interlocking blocks in the state

## **EXPECTED CONTRIBUTION TO KNOWLEGDE**

It will, perhaps not surprising in these times of increased awareness of the impact that we have upon the earth, that there is a burgeoning desire and movement to construct our buildings from materials that are from the earth; using methods that are simple, non-invasive and self-reliant. There are building materials that suit every climate, every aspiration and every purse.

The research will also revealed that the south-western part of Nigeria is endowed with lateritic soil which is suitable for laterite fabricated materials such as stabilised bricks, ceramic tiles, roofing tiles, clay pipes and brick facing and most importantly interlocking bricks. The large scale production and use of interlocking bricks in building construction will immeasurably boost the level of industrialisation and job opportunities and most importantly make building affordable for the people in the south-western part of Nigeria.

The research will also shed more light on building materials, their peculiarity and availability in this particular region or location. It will be hope that this material, with the discussed attributes and merits will in great measure be put into large scale building project such as the mass housing project for Ala Quarters residents.



## REFERENCES

- Aleva, G.J.J. (Compiler) (1994):** Laterite; Concept, Geology, Morphology and Chemistry. Wageningen, The Netherlands. Pp 169.
- Anand, K.B. and Ramamurthy, K. (1999):** Techniques for Accelerating Masonry Construction. International Journal on Housing Science and its Application. Pp. 23-29.
- Anand, K.B. and Ramamurthy, K. (2000):** Development and Performance Evaluation of Interlocking Block Masonry. Journal of Architectural Engineering, Pp 45-51.
- Anand, K.B. and Ramamurthy, K. (2003):** Laboratory-based Productivity Study on Alternative Masonry System. Journal of Construction Engineering and Management, Pp 241.
- Arayela, O (2005):** "Laterite Bricks: Before, Now and Hereafter" Inaugural Lecture, Series 40. Federal University of Technology, Akure, Ondo State, Nigeria.
- Bardossy, G. and Aleva, G.J.J. (1990):** Laterite Bauxites. Journal of the Developments in Economic Geology, Pp. 624.
- Barry, R. (1977):** The Construction of Buildings, (Volume I – V). London. The English Language Book Society and Crosby Lockwood Staples.
- Bianco, A. (2002):** The Mud Brick Adventure. Trentham, Victoria. Earth Garden Books.
- Cloise, E.K. and Joan, C.K. (1986):** Residential Housing. United States of America. The Goodheart Willcox Company Inc.
- Fadamiro, J.A. and Ogunsemi, D.R. (1996):** Fundamentals of Building Design, Construction and Materials. Ile-Ife. Fancy Publications Limited.

**Gary, W.Z. (1996):** Cob, Leichtlembau, Lightweight Straw Clay. Journal of Architectural Engineering.

**Golightly, J.P. (1981):** Nickeliferous Laterite Deposits. Journal of Economic Geology. Pp. 75, 710-735.

**Hamilton, D. (1978):** Architectural Ceramics. London. Thames and Hudson limited.

**Huch, B.C., Miller, J. and Beer, T. (1982):** Forest Measurement. New York. Ronald Press Company. Pp143.

**Jochin, A.W.R. and Kendiah, S. (1941):** The Composition of Some Local Soil Concretions and Clays. The Tropical Agriculture. Pp. 67-75.

**Lawson, B. (1996):** Building Materials and the Environment, Towards Ecological Sustainable Development. Australia. RAIA, ACT.

**Mabogunje, A. L. et-al (1978):** Shelter Provision in developing Countries. John Wiley, 1978. Pp 25-36.

**Nicholas, J.D. (1979):** Multistage and Multiphase Sampling. Resource Inventory Notes, BLM 18 United State Department of Interior, Bureau of Land Management, Denver Service Center, Denver Co. 1-5.

**Obande, M.O. (1981):** Blocklaying and Concreting. Lagos. Longman Limited.

**Okoko, E.E. (2001):** Quantitative Techniques in Urban Analysis. Ibadan. Kraft Books Limited.

**Ola, S.A. (1985):** Strength and Structural Properties of Some Stabilised/Unstabilised Compressed Kwara Soils. Proceeding of the Seminar on Clay Bricks and Blocks. organized by NIBBRI, Nigeria. Pp 59-78.

**Opara, E.E. (1998):** Thermal Performance of Cement Stabilised Bricks and Sandcrete Buildings. Journal of Nigeria Institute of Physics. In Press.

**Opara, E.E. and Abumere, O.E. (1999):** Adequate Housing for Poverty Alleviation through Building Planning, Design, Cost and Comfort Studies. Journal of Nigeria Institute of Physics. In Press.

Oxford Advanced Learner's Dictionary of Current English, Special Edition. (2001): Italy. Oxford University Press.

**Seely, I.H. (1977):** Building Technology. London. Macmillan Press Limited.**Scherwtfeger, F.W. (1982):** Traditional Housing in African Cities. Chichester, New York. JohnWiley and Sons.