

## **Dwelling Affordability from Theory to Practice: The Use of Earth as Indigenous Building Material for Sustainable Development Amidst Post Covid-19 Situation in Nigeria**

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**ABSTRACT:** *Driven by urbanization and demographic growth in Nigeria, the estimated cost for low cost dwelling unit is very expensive, because of high cost of conventional building material. Indigenous building materials abound in our various locations and communities in our nation, in the olden days dwelling place were never an issue as man could make or create a dwelling place for himself and his family with available indigenous resources. He uses local materials such as earth, timber, bamboo, stone, thatch, bush rope, etc with one or two assistant and able to put together a dwelling to accommodate his activities. The paper examined earth as indigenous building materials and assessing local building cultures with earth for resilience and sustainable development for dwelling affordability in Nigeria. Also, it generates a practical guide for community-based assessment of earth material fortification without compromising the durability. The sustainability solution of earth as building material were discussed which include local employment opportunity for socio economic development among others. The paper then concludes on some sustainability strategies known with the earth over the year as productive and effective building material.*

**KEY WORDS:** indigenous, sustainable, earth, affordability, dwelling.

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### **INTRODUCTION**

The aftermath of covid-19 pandemic situation in the nation have led to a revival and harnessing of traditional building practices using natural or recycled resources, the cost of construction in Nigeria, as in many developing countries is increasing at an exponential rate. In spite of the numerous calls by stakeholders to incorporate the use of indigenous building materials which seek to reduce cost of construction, also that there is a perception that buildings constructed from such materials are environmentally benign (Graham, 2001). According to Paul (2006), the interactions between the human race and its environment are becoming more intensive, thereby exerting increasing heavy pressure on their natural context. Historical analysis of earth as building material revealed that earth construction has been in use since mankind learned how to build shelter, Bernard M. F, (2003), Giorgio T (2009), Bascom B. M (1955), explained further that in South western Nigeria, almost every dwelling built prior to '50s has earth based wall, the exterior walls were made using earth techniques and interior walls with same techniques.

The durability and longevity of the earth wall dependent upon the nature of raw material originally employed as it is on the degree of care with which the building will have long lifespan. The raw earth is a material used ages as a building material; earth architecture has many benefits not only on technical terms, but on economies and environmental factors. Earth is readily available and accessible on-site requiring no transportation; it is the simplest natural material we have at our disposal, used by man in construction, with sustainability and techniques that are living testimony to history, cultures and identity (Doat, *et al*, 1991).

According to Reeves and Sims, (2006), earthen architecture is one of the oldest forms of construction. It is composed of structures made from unfired earthen materials, including adobe (or sun-dried mud brick), rammed earth and a host of others.

Earthen materials serve as the primary structural element in such architecture; they are also used for rendering, decoration and conservation. The traditional earth building is evidenced all over the world, in many parts of Africa, Asia and South America, earth remains a prevalent building material. The sustainability of earth as building takes advantage of the energy embodied in the fabric of that building. The energy expended in the manufacture of materials, transportation and construction of building is estimated to equal the energy necessary to heat, light and ventilate or condition the building between five and ten years (Matthew, *et al*, 2012, Bernard, 2003). Also, Paul (2006) said that architects should now more than ever before, be more sensitized on issues such as energy consumption, design concepts and the use of environmentally friendly materials that reduce environmental impacts and cost.

## **RESEARCH METHODOLOGY**

This paper concerns an investigation of dwelling affordability in Nigeria. A preliminary study involving the professionals in the construction industry identified problems of building construction associated with high cost of conventional building material in Nigeria. The study used focus group to engaged building developers in guided interview and discussion at the rural urban centers of Nigeria (Krueger,1994). The participants are experienced building developers from urban centers, the focus groups were led by research fellows, who are aided by a discussion guide developed through prior interview with, experts in and experienced in building construction. The focus groups are a form quantitative researches in which purposely-selected participants in the field of study are interviewed in a group setting. Such setting increases the efficiency of interviewing and interaction among the group members, it leads to more insightful response than attained through individual interviews. Such a pattern suggests the probability of a generalized view within the population being studied. Focus group also carried out structural failure investigation of the foundation of traditional building, by collecting samples of specification used for construction by local builders to determine the relative structural fitness of those specifications.

### **Theoretical consideration of earth as sustainable building material**

Most of the building construction works around are costlier than necessary with some environmental hazards. However, there is the need to imbibe some cultural and traditional

practices by harnessing use of indigenous and local materials to achieve a sustainable development.

Earth construction is one of the most interesting low environmental impact materials. It encompasses a wide range of materials and techniques, stemming out of strong historical tradition. Earth construction exhibits good environment characteristics and could make a significant contribution to the improved sustainability of construction and it have high potential for making earth building of high quality and durable. However, earth in its fullest sense is presently widely used in construction, as primary construction materials such as sands and bricks.

In many forms of earth construction there are potentials for on-site or near-site sourcing of adequate earth materials. This reduces to a minimum to about 1 percent of energy required by the commonly used of cement-based alternatives (Becky little and Tom Morton, 2001). In the production of earth materials there are no wastes or by-products, any defective product can be recycled and re-used. Where other materials are mixed with earth, these are generally the waste products of other industrial or agricultural processes.

Earth materials create minimal pollution from the selection of material stage all through the production cycle and construction process, earth materials require very low level of processing and create very little polluting waste. It is important to note that at the end of good building life span the materials can easily be re-cycled or returned to the ground.

### **Understanding Earth as a Building Material**

The research suggested that adequate understanding of earth as a building material will enhance performance evaluation of indigenous earth dwellings as its passionate advocates but not just to build with earth because of its availability but must understand the nature and behavioral pattern of earth under different conditions. Akinkunmi (2012).

Earth is vulnerable to weakness according to rural dwellers; in the presence of damp it loses much of its comprehensive strength. Earth dwellings has tendency of re-mix with water to reduce its strength, it extremely susceptible to heavy rainfall, splash-back erosion, seasonal and non-seasonal flooding. This will either cause shrinkage or decay to earth structure (John Norton, 1997). It is important to note that adequate draining of water away from earth dwelling will eliminate the threat posed by the presence of water. Furthermore, it was established that earth is weak in tension but has appreciable compressive strength. The critical constraint in using load bearing earth is the slenderness of the structure, since the lack of resistance to bending has to be compensated for by greater width in the structure to maintain stability. Their research corroborates further that soil composition of the earth construction is paramount important; majority of rural housing developers have no adequate knowledge about the right earth composition for the earth walling. They use earth in wrong context that will not guarantee strength, durability and quality control of earth dwelling. In effect, there are soil which are extremely sensitive to the effect of water, expanding greatly when wet and shrinking when drying out. This is destructive in earth dwelling with a great

deal of multiple cracking. Observations of existing earth dwelling stock provide best information about the local soils. Rain and wind had destructive effects on these local buildings with multiple cracks and absolute collapse. This is as a result of inappropriate soil composition, poor workmanship, poor roof cover, inadequate roof eaves overhang and lack of maintenance.

A great variety of construction techniques have been identified by focus group in response to local soils and weathering actions. In accordance to this study, inappropriate construction techniques resulted in poor quality earth structure associated with cracking and structural defect dwelling. The prevailing construction process adopted in different part of Nigeria includes:

- (a) Direct local construction in western area with the form of multiple cracking and dilapidation due to inability to compact very well.
- (b) Wattle and daub and direct construction in Eastern and Southern area which reflect the problem of structural defect due to rottenness of skeletal element of wattle and daub.
- (c) Unfired brick in form of adobe in Northern part of the country which attains relative compaction enhancing adequate comprehensive strength but problem of flooding causes multiple cracking.

#### **Constructional detail of earth building.**

According to focus report, structural failures in the earth structures are common and of great concern to this study. Raining season leaves evidence of collapse of earth structure and multiple cracks often observed. The following limitations were raised by the participants of focus group.

- Complete absence of adequate constructional knowledge from design to construction.
- Lack of building professional impute in supervision
- Incompetent builder and the use of poor materials
- Low standard of workmanship and lack of quality control in the construction process.

#### **Causes of crack and failure are briefly explained thus:**

Hydrometer test at the laboratory reveal that there is a relatively high sand fraction above the recommended limits in the soil sample collected from Western and Northern parts of Nigeria. The average sand fraction content of 78.5 percent is higher than the acceptable and recommended limits on the other hand soils sample from Eastern part of the country reflect high clay content which shows outright cracking as the structure is drying out. This must have affected bonding properties of the earth structure.

Furthermore, many of the earth structure have no proper foundations design in structural detail they were constructed on bare earth after shallow excavations. Then due to settlement of the applied load, cracking resulted because of no foundation to transfer the load to the ground. This eventually leads to absolute wall collapse.

#### **Assessing local building cultures practice with earth for dwelling affordability.**

An indigenous building culture results from the adaptation of a building practice to the prevailing environmental conditions at the different zones and territories in which it is established - physical,

climatic, social, economic and cultural. Different environmental locations have generally integrated local resources, climate and risks into their building cultural practices, developing their own strategies to cope with natural hazards and to enhance their habitat sustainability, durability and resilience. To this end, local builders and populations have devised various measures, ranging from construction techniques and details, technical devices and temporary provisions, particular beliefs and specific behaviors at territorial, settlement and household levels. These measures vary from hazard to hazard, from region to region, and have repeatedly demonstrated their relevance over time, during catastrophic events, and in relation to existing resources, constraints and capacities. Taking these practices and technical solutions into consideration is extremely valuable for enhancing local building culture practice with earth for dwelling affordability. The guide below is general overview of focus group in construction of durable and cost-effective earth dwelling. (Akinkunmi 2014)

### **Practical guide for community-based assessment of earth**

#### **Choosing suitable site for earth building and appropriate soil composition for earth building.**

According to focus group report, earth building requires stable site which do not flooded and providing some weather protection from erosive effect of driving rain. Knowledge of earth as a building material by rural dwellers is important for excellent performance of earth dwelling from selection of soil through construction and maintenance processes. Moisture must be perpetually drained away from the earth structure, its external fabrics must be protected against moisture, it must render impervious to moisture and preventing the clay from losing its binding capacity. Choose suitable soil for earth construction is vital to overall durability of the earth dwelling. Adequate knowledge that guards balancing the acceptable level of clay, sand, silt and water is essential in construction of earth structure. The crucial features of the appropriate soil composition must be understood, it must contain at least five to fifty percent clay to achieve bonding. This must enhance effective cohesion and waterproof ness that will enhance durability of earth structure. In building with earth, necessary modification can be carried out in an unsuitable soil by adding necessary composition that will affect adequate cohesion and waterproofing.

#### **Choosing suitable earth building technique.**

There are different earth-building techniques requirement for different soil mixes. This study showed that most of rural area visited used direct earth construction, which are not frequently effective because of inability to compact well and is usually accompany with shrinkage and cracking, the known technique has been identified suitable. Rammed earth, poured earth, adobe, pressed brick, wattle and daub each of these techniques has different mixes that must be abided with.

#### **Design of earth Building.**

Good design takes account of the limitation of the earth to be useful as building material, it must be used as thick wall built of limited height. It must be designed in such a way that all forces must pass down within the thickness of the structure to the ground. The structure to maintain stability, also openings and joinery must not pose a threat to the stability of adjoining walls. Opening should

be kept out at least 50 CM away from corners of walls. Joining should not be positioned in the thickness of the wall in such a way that when the door or window is opened it will pivot on the corner edge of the openings. An experienced earth designer can assist with design that works for structure and durability.

### **Detailing Precisions**

There are rules to be strictly abided with if the earth structure is to be improved for effective performance. Indigenous earth structure requires good foundation that will discourage moisture absorption and protection from foundation. It must be effective in preventing rain splash that causes lower erosion, also must discourage any rising damp that weakens the lower part of the structure. Roof eaves overhang must be adequate to discourage upper level erosion. Structure orientation in which majority of rural dwellers are ignorant of causing majority of weathering effect on earth structure. It must be positioned to minimize exposure to prevailing rain bearing winds as this will protect external wall that are in direction of rain. (John Norton 1997). The choice of protection must be done carefully, within the most effective limits the best protection to be used is earth itself, difficult with many other protections is that it will not adhere well to earth structure especially un-stabilized indigenous earth walls. In particular cement does not achieve a chemical bond with earth because of seasonal changes. In this condition, difference of rates of expansion of different materials lead to cracking of earth building materials.

### **Developing Maintenance Culture**

Regular inspection of the earth dwelling is always worthwhile for improved performance of the earth dwelling. Majority of rural dwellers lack maintenance culture they built without regular maintenance practice. The rural dwellers must be educated for the need for regular maintenance lack of which will result in deterioration of earth structure. This leads to decay, cracking and total collapse. Proper and adequate maintenance will restore the building to effective state of improved performance. On the other hand, it is important to note that better protection cannot replace regular maintenance practice once the protection is affected the wall is exposed. Regular maintenance must prevent absolute dilapidation, whereas lack of maintenance will result in total collapse of earth structure and returning to soil.

### **Sustainable solution of Earth as building material.**

- a) Local and unprocessed
- b) Recyclable material
- c) Minimised transport and manufacturing energy and air pollution
- d) Local employment

Victoria university of wellington, New Zealand. 2007

### **Supporting strategies for Earth as sustainable building material.**

It would be useful to translate issue and finding obtained by focus group into strategies for earth as sustainable building material in the developing economics, simply because provision of infrastructure facilities is towards urban centers. These have led to substandard and dilapidated



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housing stock, poor living condition, economic breakdown and overall environmental degradation in the rural areas.

To put the record straight according to Mabogunje (1980), improving the performances of indigenous earth is concerned with the improvement of standard of living of the low-income rural population through transforming the social-economic structures of their productivity activities. The ways to measure the practicality of focus group participants is in term of effectiveness of proposed supportive actions include efficient, equity and acceptability.

### **Findings and Discussions**

Comments from the discussion are categorized into the following sustainable indicators.

- (i) Suitability of building site for earth structure.
- (ii) Selection of preferred earth building technique and suitability of workmanship that matched with standard, as showed in the field test.
- (iii) Consideration of suitability of soil for construction work.
- (iv) Designing an-earth building that will enhance structural strength and durability.
- (v) Detailing precautions.
- (vi) Effective external Fabric protection.
- (vii) Frequent repairs and maintenance measures.

### **CONCLUSION**

This research focuses on how indigenous earth building can be adopted and improved to provide affordable, adequate and appropriate building performance for a variety of purpose that will enhance sustainable development. Furthermore, to achieve improved dwelling performances a practical improved implementation of the above listed recommendations is required for the opportunity of spreading sustainable development. This becomes tools to enhance dwelling affordability with the use of earth as building material in our nation.

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