CONSERVATION OF TRADITIONAL EARTH BUILDING IN NIGERIA: CASE STUDY OF ORIGBO IN IFE NORTH, OSUN STATE

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ABSTRACT: *Increasing awareness of the past, present and continuous use of the earth as a building material draws attention towards main concept of conservation of the traditional architectural heritage at the rural communities of Origbo in Ife North Local Government of Osun State. The aim was to find out the main problem regarding earth building deterioration with emphasis on the distinguishing character of natural deterioration process of earthen architecture. The study revealed further that moisture attack is the major medium through which earth building deteriorate, also lack of maintenance, bad construction techniques, leaking roof, inappropriate roof eaves over-hang and lack of drainage for rain water are the medium of deterioration. This paper presented conservation model approach to earth buildings that are compatible with characteristics of earthen building materials. The paper then concludes with fundamental strategies that could help to conserve traditional earth building and to improve the durability of earth dwellings.*

KEYWORDS: Conservation, Deterioration, Earth Buildings, Durability and Maintenance.

INTRODUCTION

The raw earth is a material used ages as a building material; earth architecture has many benefits not very on technical terms, but on economies and environmental factors. Earth is readily available and accessible on-site requiring no transformation; it is the simplest natural material we have at our disposal, used by man in construction, with techniques and traditions that are the 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 other earthen components and

Construction techniques that vary from culture to culture and region to region. Not only do 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 conservation of an existing building stock instead of creating a completely new 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 a new 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). Akinkunmi (2012), substantiate further that, sustainability favours the retention of existing building stock. Improving and maximize use of existing buildings is the cheapest and lowest-impact solution to the provision of housing presently at rural communities in Nigeria using Origbo communities as case study, the surface and other general portions of those traditional building are deteriorating fast: plaster spalling, fine and wide cracks

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developed, partial and total collapse of walls are also prominent on these structures. This work examines the cause of decay and the extent of damages to those buildings due to effect of rainfall, sun, radiation, wind, effect and other meteorological variables on various common building materials used. Understanding of material characterization is extremely important for implementing proper conservation intervention (Mileto, et al, 2012).

Material composition of traditional building

In this zone of the country, the common materials primarily used for traditional construction varied from earth to clay bricks (unburnt), sand, wood was engaged as panel windows and doors, windows and doors frame, roof trusses and for stability (structural frame). In recent times however, sand crete for masonry were noticed.

Conservation status of traditional earth building

The earthen traditional architecture has evolved through generation using local materials. The earthen material has proven its validity through ages, its efficiency in architectural solutions and ability to appropriate design against the influence of climatic and environmental factors (Momcmanova, 2007. Michael, F, 2008). The earth buildings at the study area are at advanced state of degradation, thus accelerated in part by the action of many factors this includes: rain, moisture, temperature variation, and erosion. Also, it was noticed infiltration of rain water, erosion and loss of mass earthen walls, cracking walls and peeling of plaster coatings. The prevailing situations are characterized with lack of good quality control measure; this resulted in several multiple cracks failure, partial collapse and dilapidation. It was noticed that the behavioural elements of those building falls basically as traditional process that lacks maintenance. These findings therefore emphasize the need for a comprehensive programme of effective conservation for the improvement of technical, functional performance of the existing rural dwelling.

Theoretical consideration

Conservation is the action taken to prevent deterioration process and to manage decay dynamically; it embraces all acts to prolong the life of cultural architectural heritage. The concept of conservation with minimum effect is always the best in prolonging effective performance of traditional building; it reflects the social and economic value of a society as it is the best physical and historical expression by what society valued (Gans, 1962; Raven. 1967). Historical analysis has proven that man has tried to reshape his environment to persuade himself with suitable habitation. Rapport corroborate further in his writing that house-form is not simply the result of physical forces but a consequence of a range of socio-cultural consideration. The human dwelling according to Osasona *et al* (2007) revealed that house-form is the one tangible thing that combined with cultural identity. Traditionally, house-form has always evolved based on both physical and cultural considerations. Thus every civilization produces its own house-form pattern which is highly reflective of historically prevalent. Therefore conservation must preserve and enhance the message of cultural earthen building; historical evidence must not be removed and must be harmonious with material and construction process that form bedrock for future architectural civilization.

Background of the study area

Origbo communities in Ife North Local Government area of Osun State comprise of seven sister towns with the headquarters being Ipetumodu and its geographical coordinates are

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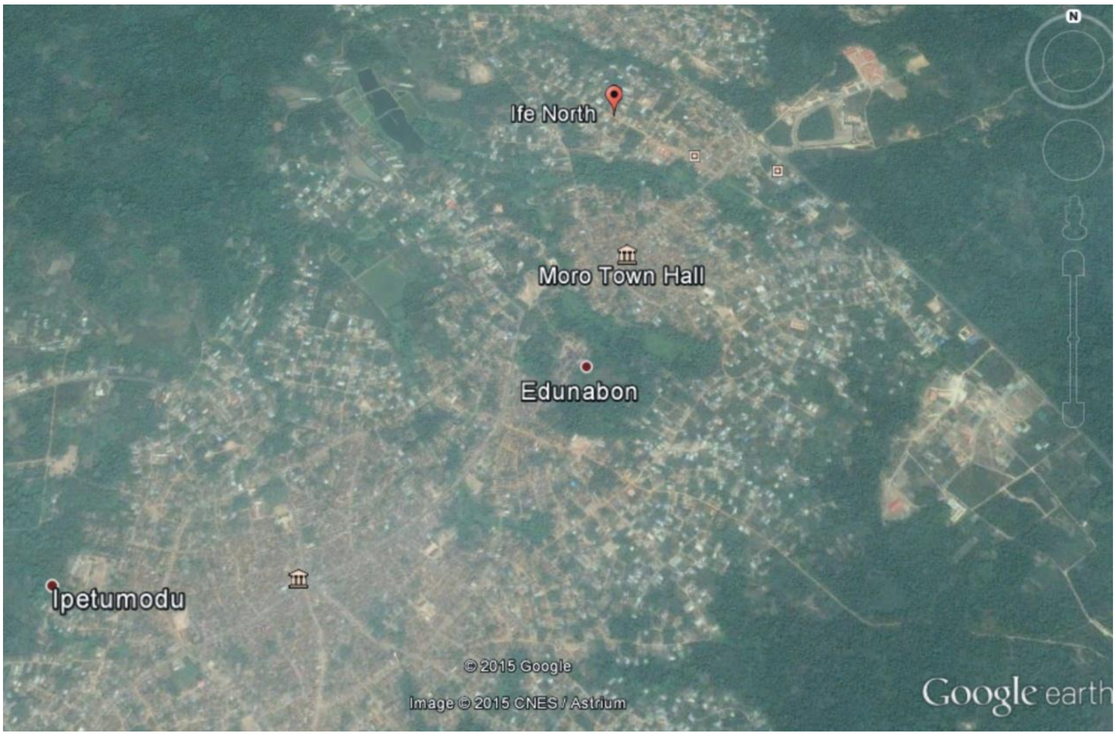
7°22'N, 4° 28'E, 7.367° N and 4.467° E, (fig. I). The seven sister towns are collectively known as Origbo meje, they are: Ipetumodu, Eduabon, Moro, Asipa, Yakoyo, Akinlalu and Isope. The morphological characteristics of the area exhibits features of typical traditional Yoruba towns which are king's palace (*afin*) and traditional king market (Oja Oba) in the front of the palace. The traditional market is to promote the cultural heritage of specific town for instance, at Ipetumodu they are known for poetry works of various kinds. Surrounding the king's palace is the high concentration of traditional residential houses for the indigenous occupants and intermediate zone of contemporary face-me-i-face-you vernacular earth dwelling, whereas the outskirt consist of sparsely distributed modern single family dwelling intercepted with few traditional and vernacular houses. Origbo rural communities have undergone considerable growth in the recent time as influxes of people were necessitate by spontaneous development such as advent of permanent site of distance learning programme by Obafemi Awolowo University as well as corresponding increase of commercial activities. House-form pattern commonly featured at Origbo community are typical courtyard housed and vernacular dwelling built from local materials. Many of those houses are still in their normal natural form while some of them have been plastered with cement, either total plastering or lower part of the building, the roofing element is corrugated sheet, indigenous thatched system of roofing has been substituted with corrugated due to technological innovation and improvement over the thatch.

Figure. 1 Showing the map location



Source: Google earth map 2015

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RESEARCH METHODOLOGY

The methodology chosen for the research is founded on the analysis of case studies with a quantitative method on the basis of abundant information gleaned from different primary sources (interviews and information directly provided by the agents involved in the conservation of the building) and secondary source (project documentation, archives).

This case study analyses used focus group to engage rural dwellers in guided interview and discussion at Origbo communities (Krueger, 1994). The rural participants are well-experienced local house builders. The focus groups were led by research fellows who are aided by a discussion guide developed through prior interview with earth consultants, experts in building local houses with indigenous materials, especially earth.

The focus groups are a form of quantitative researches in which purposely-selected participants in the field of study and interviewed in a group setting. Such setting increases the efficiency of interviewing and interaction among the group members, it leads to more insightful response through individual interview. Such a pattern suggests the probability of generalized view within the population studied. Focus group also carried out structural failure investigation, by collecting soil samples used for earth construction and conservation by local builders. This was done to determine the relative quantities of soil fractions in the soil samples aimed at identifying the intervention criteria, techniques used and evaluation of results, also to study the parameters related with the building itself as related to architectonic and construction characteristics of building and especially building techniques that compatible with effective conservation.

At the Origbo communities, earth buildings were rated according to conservation pathologies. 8,320 dwellings were identified; Primary data on the earth buildings were obtained through the stratification of the study area using stratified systematic sampling methods (Dixon and Leach, 1977). The focus groups generated the following pathological conservative categories using **1**0% samples retrieved. 83% of material pathology, 92% of structural pathology, 80% of environmental pathology and 30% of anthropic pathology. Also, conservation compatibility with the character of earth building was also evaluated.

Data Analysis and Results

The data were analysed with SPSS, using frequency distribution and percentile method of analyses. The computed formula used is $(f_i \times 100)/n$ where f_i is the frequency of pathology categories; and n is the total number of represented sample. Further analysis was carried out using the Variance of (ANOVA) test to explain the linear relationship and determine the level of significance between earth building conservation status and identified pathologies. The result is established at both 0.01 and 0.05 probability.

The analysis and discussion of results are based on the assessment of focus groups identified from the study area. The results are presented as follows:

Material Pathologies

Table 1 shows brief report from focus group it revealed that earth buildings from study area were 10-60 years old and above, from the report 689 of those building stock from stratified samples which amount to 83% were in a gradual dilapidation due to non-suitability of material

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composition for construction, environmental deterioration of earthen walls and lack of maintenance.

Table 1: Age range of the earth building

	10 – 20	***21 – 30***	***31 – 40***	***41 – 50***	***51 – 60***
Traditional Earth Building	59	103	285	226	123
Vernacular Earth dwelling	35	43	85	63	48
	73	96	173	187	161
				Σ = 690	

Table 2: Earthen wall deterioration

	Low level erosion	***High level erosion***	***Plastering disintegration***
Traditional Earth Building	530	518	520
Vernacular Earth dwelling	170	163	174
%	84.34	82.15	83.61
		Mean value = 83.33%	

The focus group strengthens further that 98.2% claimed ownership of their dwelling. 60% of those in this category inherited through their great grandfathers, 25% had their houses built by their grandfathers and while 15% had theirs built and transferred by their fathers. According to jiboye (2010) in each of these cases, house ownership was by inheritance and significant proportion 60% of houses had been in use for over 60 years. This confirms the pattern of home ownership among Yoruba people where such is inherited through lineage (Adedokun, 1999).

Earth is made up of varying proportions of four types of constituents varying from, gravel, sand, salt and clay. The total porosity determines the behaviour of earth towards water and their vulnerability with respect to decay process. Thus the capillary rise and dry kinetics is indicative of the susceptibility of earth to moisture attack, earth behaves in a characteristic way so that when exposed to variation in humidity it become weak, some change in volume and others do not (Gernot, M. 2006), According to focused group it was evident from table 2 that the earth usually employed for construction at the study area is direct moulding construction system, which comprises of high clay content in order to achieve sufficient strength, it contain particle distribution of 25% clay, 5% silt, 23% sand and 3% gravel, thus usually creates swelling and shrinking problem upon wetting and drying respectively. The analysis revealed that high percentage of traditional earth buildings was affected with high and low level earth erosion and peeling off cement plaster.

Structural pathologies

From the study, higher percentage of these buildings about 83 percent have been existed over 60 years without any maintenance measure administered over time of use. It was observed that 92% walls were cracked, partly collapsed and dilapidated, while those built in recent years constitute 8% however shows structural soundness, there exists a correlation between relative habitation and age of the building as illustrated in Table 3.

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Table 3: Nature of maintenance and building defects

	Maintenance Status		*Observed Defect*	
	Steady	**Lack**	**Cracks**	**Collapse**
Traditional Earth Building	44	600	579	55
Vernacular Earth dwelling	21	165	164	32
Percentage	8%	92%	89	11
	Σ = 92%			

Construction pathologies

The focus group revealed that majority of those earth buildings lack structural foundation, where such exists, it was very shallow and vulnerable to rain water erosion. The usual practice of local builders is just to build without testing the suitability of the earth composition for construction, also, the appropriate depth that is suitable for land bearing on the ground is not attained, thus lead to structural failure as illustrated in Table 4.

Table 4: Constitutional detail

	Sound foundation	*Shallow*	*Earth appropriate*	*Unsuitable*
Traditional Earth Building	-	634	02	632
Vernacular Earth dwelling	08	186	06	190
Percentage	1%	99%	1%	99%
			Σ = 830	

Poor Drainage Network

The focus group highlighted from table 5, those structural defects and failures are common during the rainy season. This is as a result of lack of rainwater drainage network, rain water becomes a threat to earth structures because earth has tendency to remix with water, thus making the earth to weak. Also, material composition encourages absorption of moisture by capillary action, the earth building deteriorates gradually at it absorb moisture.

Table 5: Damage system

	Adequate	*Lack of drainage*
Traditional Earth Building	-	634
Vernacular Earth dwelling	-	196
Percentage		100%

Also further analysis of the result was carried out using the analysis of variance (ANOVA) test to explain the linear relationship and verify the level of significance between conservation of earth building and pathological variables. The result (F-value) of the test presented in table shows that no significant difference and that there is a linear relationship exists between building conservation and pathologies, material ($F = 1.874$; $p<0.05$) structural ($F = 3.337$; $P < 0.01$), Age ($F = 2.429$: $P<0.01$), Construction Techniques ($F=3.249$; $P<0.01$), Moisture ($F= 3.591$: $P<0.01$).

These results indicate that building pathologies, conservation techniques, material, lack of maintenance and moisture influences the dilapidation process of earth building.

Discussion of Findings

The analysis revealed the deterioration process of traditional earth building through the pathologies. The specific issues generated during the interview conducted by the focus group are being developed into categories that could help to identify deterioration process affecting the earth building. The following issues were generated:

(a) **Age of those building**

The findings show that most of the tradition buildings sampled have been constructed centuries ago. 85% of those house-hold heads living in the existing houses in the study area were well over 70 years old and above, many of them have been occupying their houses for over 50 - 60 years. The traditional building ownership has been through inheritance, (Jiboye, 2010). Most rural dwellers are only responsible for mainly the provisions of earth structure without giving adequate attention to effective management of such structures. With the extensive damage this attitude has done, shift and orientation emphases are very necessary. If a satisfactory service is to be provided for the rural housing in comparism with the important role housing play in the lives of the rural area, maintenance practice must be given a top priority. Although, large programme of new house building may continued for many years with the adequate knowledge of earth as building material. It should still be appreciated if good maintenance measures in the existing housing stock are administered. Available housing should be utilized in the best possible manner to achieve the greatest possible satisfaction of the various housing needs. Furthermore, in order to achieve the objective of improving the performance of indigenous earth dwellings, education and re-orientation of rural dwellers in the most efficient manner on the adequate of holistic knowledge about earth and maintenance culture must be embraced (Akinkunmi, 2014)

(b) **Attack of earth building at low and high level erosion**

The focus group frequently emphasize the base of the wall just above the ground level is highly vulnerable to low level earth erosion. This is as a result of dripping rain water from the roof levels on the ground surfaces and splashing into the lower parts of the earth structures, this weaken the earth. This resulted in decay and deterioration of the affected lower part(s), this often leads to partial or total collapse of the building. The focus group also reported on the increase earth erosion of the surface of the wall at high level showed that roof eaves overhang is inadequate. Thus weaken the earth, resulting in decay and deterioration of the building fabric (David, 2007, Doat, et al, 1991).

(c) **Inadequate strength attainment in the presence of dampness**

The durability of earthen wall was established during the interview with focus group that excess moisture added to the earth when building or to the earth structure either through capillarity and rain water splash, cause shrinkage. According to the group interview, it has been indicated that water has tendency of remix with earth thus weaken the strength of the wall (Matthew, 1993, Michael and Collins, 1994). Furthermore, the earth material allows the absorptions of moisture by capillary actions; the structure

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deteriorates gradually as it absorbs moisture, prolong moisture weakened the structure that cause structural cracking and collapse.

(d) **Threat posed by building site**

Focus group participants reported that earth structure are vulnerable to cracks and decay in a location that always flooded, wet or in terrain that encourage erosive effect of driving rain. It was also indicated that drainage system were poor at the study area, earth building exposes to decay due to terrain of the site which leads to cracks. Ward-Harvey, (2009) corroborate further that prolong wetting of soil leads to differential settlement, which cause cracks from the weakened point for moisture attack in earth building.

(e) **Inappropriate roof covering and inadequate foundation detail.**

Focus group report showed that roof covering are inappropriate. They are very short; others have worn out over time due to weathering effects. They are ineffective; rain water remains a threat to earth structure. Also at the area of the study, 99% of earth buildings lack basic appropriate adequate building foundation because artisan starts construction of foundation on shallow vegetable soil.

. This resulted in multiple cracks due to differential soil settlements as a result of pressure of earthen wall on compressible top soil.

(f) **Cracks defects in earth structure**

The report from focus group shows the complaint of participants of low tensile strength of the earth building materials as the commonest problem with earth building. Cracks are found at corners where tensile stresses are greatest, such as window and door opening. It was also reported that once cracks occur, adjacent wall is free to move, so differential movements cause falling apart of the wall. It was also reported that unsuitability of earthen material and poor workmanships are responsible for weakness at the corners of openings (Norton, J. 1997, John and Geoff, C. 1994).

(g) **Lack of routine maintenance practice**

The participants of focus groups reported that people just build the earth building and inhabit the houses until total collapse of the structure. It was indicated that no planned or occasional planned programme of maintenance practice on the building, this leads to absolute dilapidation of traditional earth buildings (Akinkunmi, 2014).

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

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- 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 study area. The average sand fraction content of 78.5 percent is higher than the acceptable and recommended limits. This must have affected bonding properties of the earth structure. Furthermore many of the earth structure have no proper foundations design and structural detail of soil bearing capacity they were constructed on bare earth after shallow excavations. Then due to settlement of the applied load, crack resulted because of no foundation to transfer the load to the ground. This eventually leads to absolute wall collapse (Ward-Harvey, 2009).

Conservative model Proposal

In view of the circumstances outlined, it seems important to examine ways in which traditional earth building can be conserved.

Conservation of the existing indigenous earth dwelling.

This study shows that majority of earth dwellings have been damaged over time due to weathering effect and lack of maintenance. Conservation work must be carried out on those that are within the safe limit of structural stability, durability and weather proof-ness of earth dwelling, the conservation includes:

I. Roof repairs

   Roof covering and inadequate roof members that have been damages should be replaced promptly to disallow rain water soaking in to the earth structure.

II. Repairs of low-level and high level erosion

   Damages causes by rain splash into the external wall fabrics must be repaired using earth mix to fill back the eroded parts. It is important to note from focus group report that cement mix will not be effective because it will peel off over short period, because of impervious of cement to moisture flow. Moisture will be trapped inside the earth structure thus weakened the earth structure (Giorgio, T. 2009).

III. Repairs of cracks defects

   Cracks that are obvious to eye must be repairs by studying what are the likely causes, if it is a result of poor workmanship it should be filled with earth mix but if the causes requires experts knowledge, their effort be promptly called for, for effective solution.

IV. Protect the external wall fabric

   External wall should be protected because of prolong exposure to weathering effect. Mud plaster can be used to protect it against weathering effect, this is effective because it conform to behavioural pattern of the earth allowing earth structure to breathe and maintaining a fairly constant moisture level.

V. Ensure that ground level are below floor level and the surface water is drained away from the building

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CONCLUSION AND RECOMMENDATIONS.

The information obtained from this research comes from vintage point of highly professional involvement in delivery effective housing system for rural areas in Nigeria (Olotuah, 2000). The challenge is to reflect how this information might be used to develop guidelines for improving indigenous earth dwellings. It is also to foster the co-existence of functional environmental development. The following recommendations have been put forward, to act as guidelines in enhancing the ability to safely and effectively improve indigenous earth dwelling.

In order to be effective and to avoid aggregation of existing problems, the following practical guide will help for site selection, through construction and maintenance that enable true professionalism in conservation design and construction.

1. **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 building 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 building. Adequate knowledge that guards balancing the acceptable level of clay, sand, silt and water is essential in construction of earth structure. Reeves, et al, (2006) explained further that 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 water proofers 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 (Doat, et al, 1991)

2. **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 moulding, 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 (Mileto, et al 2012).

3. **Design of earth Building.**

   Good design take 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 (Norton, J. 1997). 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 Centimetres 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

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on the corner edge of the openings. An experienced earth designer can assist with design that works for structure and durability.

4. Detailing Precisions

There are rules to be strictly abided with if the earth structure is to be improved for effective conservation. Traditional earth structure requires good foundation that will discourage moisture absorption and protection from foundation decay. It must be effective in preventing rain splash that causes lower erosion; also it 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. (Norton, J. 1997). The choice of protection must be done carefully, within the most effective limits the best protection to be used is earth itself and difficulty with many other protections is that it will not adhere well to earth structure especially un-stabilized 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 cracks of earth building materials (Giorgio, T. 2009).

5 Developing Maintenance Culture

Regular inspection of the earth dwelling is always worthwhile for improved conservation of the earth structure, majority of rural dwellers lack maintenance culture they built without regular maintenance practice (Obiegbu, 1998). The rural dwellers must be educated on harmful effect of lack of maintenance which resulted in deterioration of earth structure. This leads to decay, cracking and total collapse, proper and adequate maintenance will conserve the building to effective state of improved performance. On the other hand Amobi (2006), corroborate further that 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.

6 Compatibility of materials for conservation

Several cases have shown in which the use of material non-compatible with original material used in conservation of traditional building structures result in damage to the original materials, these led to conservation practice of using materials and techniques identical, if possible, to the original ones (Giorgio, T. 2009). . This is based on a principle of homogeneity, conservation should be guided by a principle of compatibility stating that the materials used in conservation should be compatible with the original ones, i.e., it should cause no further damage to earth structure while contributing to their conservation. In other words, the original materials and those added in conservation should form a composite structure that shows a satisfactory behaviour under the stress created by the environment factors that the structure will experienced. This is intended that the inevitable onset of new deterioration process should be delayed as long as possible.

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