Blending Traditional Earth Building Practices and Improved Technologies in Earth Building Construction to Provide Quality Low-cost Houses for Rural Shelter

By

Dr. N. A. Nwankwor
(nwanks4@mautech.edu.ng)
Department of Technology Education,
Modibbo Adama Federal University, Yola
Adamawa State, Nigeria

Abstract

The use of mud for housing construction technically known as Earth building is a tradition that is as old as the history of man living in man-made shelter in different forms and shapes over time and space. But three major weaknesses inherent in the earth-material is affecting the progressive use and acceptance of these earth-materials(mud) for modern housing construction. These natural weakness of the earth-material include - water erosion, low compressive strength and its predominantly traditional roundish architecture. Secondly, the long years of the introduction and use of cement- and steel-based construction materials, which became widely accepted has also relegated earth buildings to become a symbol of the poor rural dwellers. This poor image of earth buildings (which is more of a social psychology and bias against traditional earth buildings) is continually posing a major hindrance to the acceptance of improved earth building technologies for qualitative housing in many developing countries. It has become a stigma that requires definite steps to deal with, in order to create the enabling environment for incorporating improvements in earth building technologies into on-going housing programmes. These are some of the measures being advocated here which are anchored on the author's practical field and research exposures in blending the good in our traditional earth building heritage and surviving practices with standard construction practices (Nwankwor, 2008, & Gana, Nwankwor & Tika, 2019). The recommendations will result is a synergy between technological advancements and traditional practices within the earth building industry to provide quality housing for rural dwellers and rehabilitation of several Internally Displaced Persons (IDPs) in Nigeria.

Key Words: Earth-building; Building capacity; Socio-psychological change; Acceptance and Quality low-cost housing.

INTRODUCTION

In many African countries earth-material(mud) represents one of the most ancient building materials used to build man-made shelters. Through practice and experience, these earth building practices have survived till date in these countries. By the turn of the 19th century, however, the discovery of Ordinary Portland Cement and its wide utilization with steel based metals for high quality building works(Ige, 2013) brought about a near total neglect of earthen/natural building practices in many parts of the African continent. By this development earth building practices became only popular among the rural and low income dwellers. This wide acceptance of cement- and steel-based structures coupled with its inherent structural advantages of strength, durability and flexibility in use diverted the interest of traditional earth builders away from our traditional earth building heritage, practices and techniques. This increased attention of the society towards cement- and steel-based houses quickly lead to the development of cement and steel material based building codes/standards (the BS Standards & the Nigerian Building Codes) which was quickly applied in Nigeria and other African countries. By this development cement- and steel material-based structures came to be accepted as standard in Nigeria and most other developing African countries. On the other hand earth building practices which had developed naturally over the years hardly had any guiding standards, except for those local traditions related to choice of soil types, construction methods, and localised stabilization and wall reinforcement techniques.

However, in the last 50 to 60 years, especially years after the Second World War (the era of advancing industrialization which was fast sweeping through the globe), researches within the building industry began to discover some weaknesses in the material quality of these standard building materials, amongst which are asbestos roofing sheets and cement itself. These weaknesses relate to their toxic contents, noise pollution and overall increasing cost of producing such buildings. It was also within the same period (the 1950s) that researchers and earth building experts started to develop science and technology based improvements in the quality of the earth materials through stabilization with cement and lime, (Maini, 2002). On the other-hand, earth material design builders were also working on ways to improve both the aesthetics and the structural qualities of the earth building to make them more flexible and acceptable. According to Kennedy (2002), while this interest in natural building surged in the industrialised western world many ancient roots in traditional practices had already been lost in favour of capital- and energy-intensive building methods. This author also believes that an increasing surge of interest in our traditional earth building heritage will also revive respect and acceptance of the timeless ideals in our traditional earth-building practices among various communities and localities.

Tackling the Challenges of Cement-and-Steel-based Buildings Materials

Presently there is a growing demand for quality housing for the majority of the world's population racing against slowing down in global economic growth. These two competing phenomenon have indirectly shot the current cost of building an average standard house beyond the reach of the average in-come earner in many developing countries, including Nigeria. Secondly the cost of cement- and steel-based materials which form the bulk of these standard building materials have also continued to rise unabated, (Mojekwu, Idowu & Sode, 2013). The good news however, is that this growing world population, which is constantly exerting tremendous pressure on available quality human shelter coupled with rising environmental

changes, has over the last few decades had gradually started shifting concerns within the construction industry from share standardization of materials and practices towards sustainability, reduction in cost of house production, environmental friendliness, capacity utilization and acceptability of methods and materials, (Howe ,1992)

One of the major developments from this shift in concern within the construction industry is the cement stabilized earth blocks(CSEB) technology seen as a major breakthrough in earth building practices. This development came by way of researches into ways of improving the strength and durability qualities of the earth material and this had resulted in an appreciable reduction in the overall cost of house production (Burrough, 2002). This cement stabilized earth block(CSEB) technology seen as a major cushioning effect for the production of low-cost quality houses is gradually gaining grounds in many parts of Nigeria, especially within the Sahel region, and many other African countries, (Daniel & Benjamin, (2018). The development and introduction of this cement stabilized earth blocks (CSEB) into the earth building industry has radically improved the structural qualities and flexibility of our predominantly round shaped traditional earth buildings, (UNESCO, 2012; Ghasemi & Ayatollahi, 2018).

Capacity Building in Public Perception of Improved Earth Building Structures

Several researches and conferences – local and international - have demonstrated capacity improvements in the design, material quality and construction practices within the earth building industry (Saikumar et el, 2019; Gana, Nwankwor & Tika, 2019 [a & b]; Nwankwor, and Gowon 2018; Danso, 2017; Colley & Erdogmus, 2015 and Fathy, 1983). These developments can only become beneficial when they translate from the comfort of research laboratories and drawing tables down to the field among needy communities. Then theories would have marched field application and practical realities to solve teething housing problems among the teaming populations in the developing countries.

In line with these improvements on the quality of earth-materials for quality housing, my major concern in this paper is that Earth-builders while focusing on alternative sustainable, environmentally friendly and quality low-cost housing should harness enough energy towards building capacity and positive change in public perception of earth-buildings. Some of the aspects of our earth-building heritage that require capacity building to enhance a positive change in public perception and acceptance of earth-buildings are presented below under six important components of our earth-building heritage as follows:.

i. **Harmonization of Research Findings:**

A lot of researches on materials, design and process improvement and adaptation to local environments have been and is still being conducted worldwide by individuals and other related institutions and agencies, (Gana, Nwankwor & Tika, 2019b; Ghasemi & Ayatollahi, 2018; Maini, 2002). Some of these researches have come out to be a repeat of earlier or part of already concluded studies somewhere else. Others have been pure academic exercises of no practicable reality reference or any field practicability of such findings. A few others run contrary to already established standard practices and findings.

Research findings that do not practically add any improvement to our earth building heritage/development are better left for further classroom exercises. For instance, while Colley and Erdogmus (2015) conducted an excellent study on the Effects of Cement Stabilization and Fibers on the Water Resistance of Compressed Stabilized Earth Blocks to demonstrate their beautiful effects on the durability and compressive strength of CSEBs, the

mix proportions of soil to cement at between 6% to 10% does not give much of the economic advantage of low-cost quality building materials pursued in CSEB technologies, especially in developing countries like Nigeria. This is because the percentage of cement in the mix proportions are almost the same as that of normal cement-sand (Sandcrete) blocks in Nigeria, which currently getting out of reach of the low income earners .

There is every need for various individual researchers and/or research agencies/institutions to come together in order to develop a network databank for the collation and harmonization of concluded and on-going research programmes on earth building heritage practices evolving technologies. This will not only remove the *chaff from the wheat*, but will also build strong bases for the development of national/regional/international standards of practice within the earth building industry. Universal quality product, process or service generally derives from a uniformly accepted standard/code of practice and quality control measures. Harmonizing research findings in earth building will eventually result in a uniform standard of practice within the earth building industry thereby building greater confidence in the prospective earth builders and house owners, (Craven, 2001; Walker & Morris, 2002).

ii. **Design Architecture (Aesthetics) of Earth Buildings**:

The primary concern in the architecture of earth buildings is commonly focused on improving its traditional aesthetics, arrangement/organization of the component parts of the building. This is one major area that is affecting the level of acceptance or non-acceptance of earth buildings in modern housing schemes. In many parts of Nigeria and other developing African countries, the predominant design structure of the traditional earth buildings remains the round shaped, rammed earth or adobe designs or the rectangular shaped wattle-and-daub, thatch roof design (Ezeji and Nwankwor, 2008).

The round shaped design has three major inherent characteristics that make it obsolete and difficult to incorporate in modern design architectures, namely,

a. The traditional circular-shaped designs do not allow for effective partitioning of the enclosed floor area into other rooms. In addition this round-shaped design also makes it near-impossible and inconvenient to provide access to other rooms in the case of partitioning the circular floor area into rooms.
b. The traditional circular-shaped designs require a much larger diameter to make for enough useable floor space as against other design arrangements. For example a floor area of 3.60m x 3.60m (i.e. 12.96m^2) can only give a 10.183m^2 useable floor area (i.e. $\prod r^2$ = 10.183m^2) in a round-shaped building design. This will result in a practically small useable floor space as against a rectangular or square design with the same 12.96m^m space (i.e. 4.20m x 3.085m or 3.60 x 3.60m) which will give comfortable standard room sizes, (see fig 1). The green spaces by the four corners are wasted in a circular shaped design, while the entire space forms the floor area in a rectangular/square-shaped design.

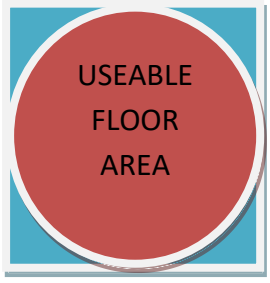

Fig. 1

c. In the circular-shaped design it is not easy to extend the overall span above 4.20m diameter without an intermediate support, as this will create a major roofing problem. Such extension will also result in an additional problem of how to support the wooden roof trusses that would be longer than 3.60m to avoid sagging/breakage without an intermediate support. On the other hand incorporating such intermediate supports is mostly seen as an unnecessary obstruction to the already limited room space/vision.

Modern earth building designs must do away with these round shaped designs, except as an aesthetic attachment to the structure, in preference to other more flexible designs in modern architecture. This will add impetus to the acceptability of earth buildings in modern housing programmes,(UNESCO, 2012; Kennedy, 2002; Maini, 2002 & Fathy, 1983).

In the wattle-and-daub design, a large amount of wooden members are required to form the wattle skeleton. This alone invariably restricts such buildings to only rural forestry settlements where bush sticks are still relatively available. This wooden skeleton usually get decayed or infested by termites within a period of four to five years, under the best maintenance conditions. The demand for a large amount of sticks/wooden members that would hardly last beyond five years, is another avenue for environmental degradation. This wattle-and-daub design needs to be completely done away with for the more efficient and durable cement stabilized earth block (CSEB) structures incorporating steel reinforcements, based on modern architectural designs requirements. These will save the building owners the extra cost of the wood in wattle-and-daub skeleton.

The adaption of more modern/flexible architectural design changes would not only improve the overall structural qualities of the earth buildings but also the general aesthetic quality of such buildings. This will go a long way in erasing the negative impression earth-buildings have acquired over the long years of wholesale adoption of cement/steel based buildings as standard. This socio-psychological stigma against earth buildings have been a major hunt on the acceptance of modern earth buildings among many communities in Nigeria, in spite of the known improvements so far achieved, (Daniel & Benjamin, 2018; Dobson, 2004).

iii. **Training and Workmanship:**

Under the traditional earth building system, expertise and training of future builders remained restricted as family trade/craftsmanship. Training was purely through the apprenticeship system, where the father taught the son and master craftsman teaches his apprentices, all through observation and participation. This training method grossly restricts the number of adherents and makes it difficult to meet the labour demands even within the rural communities. To engender public acceptance and capacity in earth building, there is need to ensure that those who are interested, even to experiment on earth buildings for various purposes must be able to find the skilled labour to accomplish this. This writer believes that one of the major avenues to popularise earth building for modern construction purposes, is through the incorporation of the trade/courses into our technical and technological college curricula. This will not only popularise the manpower training but also produce competently trained practitioners for prospective earth building owners at various levels of the economy, (Daniel, & Benjamin, 2018).

One enviable quality of our traditional earth building practice, which we advocate must not be lost in the phase of modernization and technological advancements, is the community help approach to house construction and ownership, (UNCHS, Habitat; 2001, Ifeka, 2004). This ensures that with little material resource, the average/low income earner can tap on the labour resources of their community to build their own houses. This approach also brings to fore the direct involvement of the house owner from the design to the actual ownership, while at the same time creating jobs for the teaming unemployed youths of developing countries. The efficacy of this community help approach to house production is highly advocated by United Nations Habitat programmes/schemes as a result of their benefits to the communities and the economy of its application, (UNCHS, Habitat; 2001)

iv. Exemplary Demonstration of the Benefit.

The time has come when researchers and earth building proponent in developing countries, must begin to show the good in their advocacy through practical demonstrations in building their own houses with earth materials, beginning even with chicken pens and fences to standard earth homes. The advocacy must move beyond semantics and pseudo specimen structures and models to community utility structures showcasing the qualities and benefits of building with earth materials. When people begin to see earth building advocates make good use of the earth buildings, members of their community will begin to appreciate better the advantages of earth-buildings, thereby placing orders for such quality buildings for their own use. This is a very practical way to advocate and campaign for the popular acceptance of earth buildings within and beyond our localities,(Saikumar et el 2019; Nwankwor & Eric, 2018; UNESCO, 2012 & UNCHS Habitat, 2001).

It must also be noted that, because most of the researcher and advocates are college lecturers/teachers and independent individuals, their exemplary demonstration will be highly limited by resources. College departments and faculties of building and other related institutions and agencies need to become active partners in this advocacy taking advantage of their knowledge of the growing scarcity of quality human shelter and their association with the on-going advances in earth building construction. These organizations and agencies should be encouraged to incorporate earth buildings in their training and in the construction of their local buildings such as work-shades and standard classrooms as demonstrated at the Department of Industrial Technical Education, University of Nigeria, Nsukka, Enugu State, Nigeria. Various agencies involved in the Millennium Sustainable Goals, should be encouraged to support and collaborate with earth building advocates to include earthen structures as part of the areas for funding assistance. This will not only give practical impetus to the use of earth materials for standard buildings and popularise its use but indirectly provide fund for field demonstration of the *good* in our earth building heritage.

v. Policy and Funding Issues

The harmonization of research findings coupled with field/community-based demonstrations of advances in earth building construction, will lead invariably to best practices in material selection and construction methods. When this is achieved, backed with growing public acceptance of earth buildings for modern construction purposes, the road to standardization of practices and eventual development of codes of practice in Nigeria and other developing countries would have been narrowed greatly. As we attain this level in our

advocacy, various governments would need to get involved at the national and regional levels through relevant professional bodies and agencies and committees to as a matter of necessity develop quality performance-based codes/standards for the industry, (Walker & Morris, 2001; Craven 2006).

Secondly, various governments, non-governmental organizations and agencies need to be involved as a matter of policy in the funding of researches, seminars, training workshops and conferences towards an effective earth building development as alternative means of providing low-cost quality housing for the teaming populations in the developing world. Governments should be approached and encouraged to come up with clear policies for the incorporation of earth buildings within the various countries' housing schemes as they aspire to achieve their Millennium Sustainable Goals of Housing for All. By this approached the various governments while meeting their political projections of Housing for All, would also be providing the necessary funding for this advocacy for alternative means of providing quality housing for their citizens.

vi. **Public Enlightenment.**

One of the known inevitable promotional strategies for marketing new/improved products is through massive public enlightenment campaigns. Stakeholders in our earth building heritage, preservation and development, and green house building proponents should bring themselves together to mount a massive promotion campaign through the mass media, leaflets, posters and conferences to enlighten the general public on the environmental and health friendliness, cost benefits and community help enhancement qualities of earth building practices. Governments and other relevant agencies should be encouraged to sponsor field researches/demonstrations and community based earth building projects to get the communities involved in meeting their need for quality housing, (Daniel, & Benjamin, 2018; Ifeka, 2004).

Stakeholders in earth building heritage and development the Nigerian and other developing countries should be encouraged to form umbrella bodies at institutional, zonal, regional, and national levels with affiliations with relevant international organisations to be able to organise well publicised training workshops, seminars and conferences for both traditional earth builders and new entrants into the trade/profession, (Njoku, Feb. 1, 2015). During such programmes, quality posters and handbills of surviving earthen structures and new/refurbished earthen structures of significance across the globe should be exhibited to form a major part of such programmes showcasing the synergy in its health and environmental benefits and structural quality improvements of earth buildings, (Daniel, & Benjamin, 2018; Nwankwor, 2007), .

Conclusion

It is my premise in this paper that, by widening contacts among stakeholders in earth building and comparing techniques, historical antecedents, current demands of urban housing and promotion of partnership for a sustainable earth building development, we can speak with one voice pushing forward a united front to build capacity for increased positive public perception/acceptance of modern earth buildings. As these earth building practitioners get closer analyzing various research findings on traditional earth building models, studying trends in rural and urban housing developments they can formulate functional rural and urban housings

programmes. Such programmes which blend historical antecedents with modern design architecture would be able to integrate various expert experiences and technical know-how to develop widely acceptable earth building practices and codes that meet relevant building standards.

It is also important in this conclusion, to state that by blending the various improvements/breakthroughs in earth building practices which are based on scientific researches and technical advancements in our earth building heritage, a major improvement in the technical quality of earth buildings will result. Such resultant earth buildings which combine the benefits of our traditional experience and technical advances, adapting existing relevant building standards will eventually result in high quality, low-cost, sustainable, environmentally and health friendly houses for the generality of the teaming populations in the developing world. This development will invariably bring about wider acceptance of these quality earth structures thereby enhancing the capacity for house ownership within our communities.

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