ENHANCING SUSTAINABLE HOUSING DEVELOPMENT IN NIGERIA USING COMPRESSED STABILIZED LATERITE BRICKS

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Abstract
Sustaining housing development especially to the low-income group of the society has become a huge challenge in developing countries. Thus, acquisition of indigenous building materials has been suggested as a way out. The paper evaluated the prospects and challenges of Compressed Stabilized Laterite Bricks (CSLBs) as a building material for sustainable housing construction. Field survey was carried out in four local governments namely: Ogbomoso North, Ibadan Southwest, (in Oyo State) Ado-Odo Ota, (Ogun State) and Agege Local Government in Lagos State, Nigeria. Purposive sampling method was adopted which involved the administration of 600 structured questionnaires on randomly selected household heads out of which 541 responded. Data obtained were analyzed using descriptive statistics. The result showed that there is apathy towards acceptability and use of CSLBs for housing construction. It was found out that lack of knowledge about its physical and socio-economic properties and its non-availability in the market was a major determinant of the apathy. The paper concluded that to ensure sustainable housing development via CSLBs, there must be continuous sensitization of the populace by stakeholders through construction of model houses with CSLBs. The paper recommends more funding of researches on fabrication and production of the CSLBs making machines so as to make the product readily available and accessible by the populace.

Keywords: Acceptability, Compressed Stabilized Laterite Bricks, Housing, Housing construction.

1.0 Introduction
The importance of housing in human history cannot be overemphasized. Housing is seen as one of the best indicators of a person's standard of living and of his or her place in society (UNCHS, 1993). Housing and building conditions also reflect the living standards of a society (Venkatarama Reddy, 2004). Thus, the importance of access to adequate and affordable housing took the front burner in the mid 20th century. The most vulnerable in terms of lack of access to decent and affordable housing in developing countries are the low-income group. The population of this group has been on the increase due to rapid urbanization and population. This has led to various researches into development of locally available building materials and construction techniques to enhance access to housing for all. In 1976, the Human Settlements conference in Vancouver gave new impetus to this approach, condemning the transposition of Western building techniques for low-cost housing and recommending the design of technologies suited to climatic, social and cultural contexts (Rigassi, 1985). The conference also recommended the gradual reduction of imports of products and services linked to construction, the drawing up of norms and regulations which covered...
the basic needs of end-users whilst taking account of their economic possibilities.

The acquisition of local building materials and techniques to guarantee access to decent and durable housing for all by the year 2000 was adopted in December 1988 by the General Assembly of the United Nations with the slogan "Global Strategy for Housing to the year 2000". The Assembly proposed relying on a vast formal and informal private sector participation in housing provision. This strategy was aimed at removing the dependence on the public sector for housing provision by exploring the erstwhile ignored wealth of existing human resources and their building cultures and social dynamics.

The building culture of pre-independence Nigeria was an absolute dependence on earth building techniques such as use of adobe bricks (sun-dried bricks) and wattle and daub (mud wall construction). These techniques were predominant in major rural and semi-urbanized towns and cities in Nigeria. These techniques were durable, adequate and accessible enough for them to meet their housing needs. The techniques were also sustainable since they do not deplete the natural resources of the environment neither do their production processes lead to the emission of gases that causes global climate change.

However, rural centers in Nigeria acquired new status as a result of independence on October 1, 1960. This period was immediately followed by the "oil boom" of the 1970 and 1980 which brought about an unprecedented prosperity and development of the nation. There were massive improvements on infrastructural development particularly in state capitals and major cities and towns. Thus, the towns became increasingly urbanized and became an urban-oriented society. The crave for Western building techniques led to the gradual extinction of the erstwhile earth building techniques. Thus, while other countries were developing various earth building techniques to meet the housing needs of their population, the technique became associated with the poor in Nigeria and not fashionable for housing purposes.

The paper appraised the current housing situation in Nigeria. The prospects and challenges of CSLBs as a sustainable building material for housing construction were also examined. The paper found that CSLBs is a sustainable construction material. It is affordable, durable and accessible. It was however observed that there is an apparent apathy towards its acceptability and use. This was traced to lack of knowledge about its physical and socio-economic properties, and its non-availability in the building material markets. Respondents are of the opinion that concerted efforts have to be put in place to sensitize the populace about its sustainability in housing construction. Therefore, the paper recommends encouraging public-private sector participation in construction of prototype houses with CSLBs across the country. In addition, more funding of researches on fabrication and production of CSLBs making machines/presses so as to make the product readily available and accessible by the populace.

1.1 Trend of Housing Needs and Supply in Nigeria
Nigeria has a population of 140,003,642 according to the report of the 2005 National Population Census (FRN, 2007). The average population density according to (UNDP, 1999) is approximately 124 persons per square kilometer, making Nigeria one of the most densely populated countries in the world. Access to decent and affordable housing to this large population is a daunting challenge which has made housing
an issue of national importance. It has been established that the poverty level of most Nigerians made it difficult for them to own houses (Daramola et al, 2005) since land and construction costs are mostly beyond their means.

One of the major challenges confronting sustainable housing provision in Nigeria apart from the socio-economic factor is dearth of accurate statistics on housing needs and supply. This ought not to be so because research finding by Nubi (2000) shows that an average urban dweller spends between 40-60% of his income on house rent. Few statistics available paint a gloomy picture of the housing situation in Nigeria. Various researchers had projected the housing needs to be between 5000 units to 729,000 housing units annually using various parameters such as national level projection and an estimate of 9 units annually per 1000 population.

Records of housing supply over the decades shows that, there was a plan to deliver 202,000 housing units to the public between 1975 and 1980, but only 28,500 units, representing 14.1% was achieved. Between 1981 and 1985, out of 200,000 housing units planned to be delivered, only 47,200 representing 23.1% was constructed (Ademiluyi and Raji, 2008). In the National Rolling Plan of 1990-92, government promised to increase housing supply from 4.8 million to 5.9 million by 2000. The 1991 housing policy estimated that 700,000 housing units are to be built annually if housing deficit is to be cancelled. In summary, it was stated that between 1973 and 2006, the Federal Housing Authority (FHA) built only 30,000 housing units nationwide (Akeju, 2007). The FHA estimated that it constructed a total of about 10,000 new housing units annually. Furthermore, to meet ever-growing demand, the country needs ten times more or at least 100,000 new housing units annually (Adejumo, 2009). The current housing deficit in Nigeria is thus estimated at between 12 million and 16 million homes (Peterside, 2007).

1.2 Historical Overview of Earth Building Technology

Earth is the most basic, and the most ubiquitous, building material known to man (Walker and McGregor, 1996). It has the benefit of being easily worked using the simplest of agricultural tools, yet it is capable of fulfilling the most demanding of roles. Earth as a building material involves a construction technique utilizing soil (usually sub-soil) in combination with other materials.

Earth as a building material has been used for thousands of years by civilizations all over the world. According to Pollock (1999), the use of earth as a building material dates back to at least the Ubaid Period in ancient Mesopotamia (5000 – 4000 B.C.). Ancient monumental structures which are still objects of tourist attraction such as ancient temples, fortifications, and pyramids as well as part of the Great Wall of China were built with soil. Earth still continued to enjoy patronage as a building material but with varying degrees of improvement in techniques as a result of improved technologies. Many different techniques have been developed in using earth as a construction material. It was observed that the methods used vary according to the local climate and environment as well as local traditions and customs (Adam and Agib, 2001).

Earth building technique was popular in Nigeria until the influx of cement blocks into the country immediately after independence. Most pre-independence houses were built of earth building
techniques of mud wall or sun-dried bricks. Thus, the central core of the towns constitute of houses built with these techniques. The houses range from bungalows to one or sometimes two storey buildings. The houses served their purpose of providing adequate shelter for the inhabitants. They were also durable to the extent that some of the buildings dated between 50 and 100 years. The durability is also dependent on regular maintenance.

Plate 1: House Built of Mud Wall Technique

Plate 2: House Built of CSLBs

Source: Field Study (2008)

It can be summarized therefore that an understanding and appreciation of traditional earth building can inform innovative and appropriate uses of earth in new construction. This knowledge is expedient since it has been suggested that at least 50% of the world’s population still live in earth houses (Easton, 1996). The utilization of earth in housing construction is one of the oldest and most common methods used by a larger percentage of the developing countries’ population (Arunala and Gondal, 2007). It is the most readily available and cheap material found everywhere. It is easy to work with, requires less skills and as such, it encourages and facilitates unskilled individuals and groups of people to participate in their housing construction on self-help basis. It offers a very high resistance to fire and provides a comfortable built living environment due to its high thermal and heat insulation value.

Presently, development in earth building production techniques range from the most rudimentary, manual and craft-based to the most sophisticated, mechanized and industrial (Houben et al 1994). A lot of new generation manual, mechanical and motor-driven presses have also been invented leading to the emergence of a genuine market for the production and application of the compressed earth block (Rigassi, 1985; Guillaud, Odul, & Joffroy, 1985).

1.3 The Potentials of CSLBs as a Sustainable Alternative for Affordable Housing

The term "Compressed Stabilized Lateritic Bricks" (CSLBs) is used in this study as a generic name to cover a wide range of derivative building materials from laterite/soil/earth in which a stabilizer or soil additive has been added to alter the properties of the soil and to improve its engineering properties including compaction, density, bearing strength and safety (i.e. – fire). The addition of a stabilizer differentiates it particularly from compressed earth bricks (CEBs) and from other traditional earth building technologies – whether moulded into a brick or compressed in machines.

CSLB is a product of scientific research. It is a scientific improvement upon the
traditional earth building technique. Its applicability becomes advantageous when stabilizing additives, technical assistance, and machinery are available and affordable. The CSLB being moulded in steel forms comes out in very regular shape and size, and much denser. According to Bush (1964), comparative tests of unstabilized and stabilized soils show that both dry and wet strengths of cement stabilized soils (CSLBs) are stronger and more water resistant than the best unstabilized soils. CSLBs are safe alternatives to masonry (Arunala and Qundal, 2007). Their founding also revealed that CSLBs are low cost and can be designed to be earthquake resistant. Furthermore, their study revealed that CSLBs have excellent insulating properties - reducing heating and cooling costs. In addition, CSLBs are inexpensive, strong, made with locally available materials and are dimensionally uniform. Workers with little prior building knowledge and experience can be used for the wall construction. They are resistant to sound transmission, fire, insect damage and durable if properly protected. Little energy is needed for their production compared to other wall systems and soil is an environmentally friendly material.

1.4 Advantages and Limitations of CSLBs for Affordable Housing
The viability and sustainability of CSLBs for affordable housing construction has been established from the previous section. It can be concluded that it is durable, cheap and affordable. It was also found to be fire resistant and environmental friendly. The advantages and limitations of CSLBs as a building material for affordable housing are summarized in Table 1

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Limitations</th>
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<tr>
<td>• Soil is available in large quantities in most regions.</td>
<td>• Reduced durability - If not regularly maintained and properly protected, particularly in areas affected by medium to high rainfall.</td>
</tr>
<tr>
<td>• Cheap and affordable - in most parts of the world soil is easily accessible to low-income groups.</td>
<td>• Low tensile strength - Poor resistance to bending moments, to be used only in compression e.g. bearing walls, domes and vaults.</td>
</tr>
<tr>
<td>• Ease of use - usually no very specialized equipment is required.</td>
<td>• Low resistance to abrasion and impact - If not sufficiently reinforced or protected.</td>
</tr>
<tr>
<td>• Suitable as a construction material for most parts of the building.</td>
<td>• Low acceptability amongst most social groups - considered by many to be a second-class and generally inferior building material.</td>
</tr>
<tr>
<td>• Fire resistant - non-combustible with excellent fire resistance properties.</td>
<td>• On account of these problems - earth as a building material lacks institutional acceptability in most countries and as a result building codes and performance standards have not been fully developed.</td>
</tr>
<tr>
<td>• Beneficial climatic performance due to its high thermal capacity, low thermal conductivity and porosity.</td>
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</table>
Despite the advantages of CSLBs in providing affordable housing for the populace, particularly for the low-income group, it has been observed that there is not a wide-spread use of the material which is a function of its acceptability. It has been observed that many pay rent to live in houses built of mud but plastered with cement, while they consider it as degrading to build their own houses with earth building techniques of which CSLBs is a scientific improvement. This paper thus examined the apathy towards acceptability and use of CSLBs for housing construction by the urban populace.

2.0 Materials and Methods

2.1 The Study Area

The study was carried out in four local government areas of selected States in Southwest Nigeris. A purposive sampling method was adopted in selecting the States and the local government areas (LGAs) used for the study. The selected LGAs are Ogbomoso North, Ibadan Southwest in Oyo State, Ado-Odo Ota in Ogun State and Agege Local Government in Lagos State. Ogbomoso North was selected being a typical suburban city with a rich tradition of earth building technology. Ibadan Southwest was selected as it represents a transition from the sub-urban to an urban city but still with a tradition of earth building technology. Agege LGA in Lagos State represents a densely populated metropolitan city while Ado-Odo Ota in Ogun State was selected being a developing urban city absorbing masses from the unpopulated neighbouring Lagos State. The ease of access to materials of production was also considered in the selection of the study areas. It is assumed that the material of production will be more available in the hinterlands but scarce in the city. Hence the following sequential order was adopted starting from the most to the least in terms of material availability; Ogbomoso North, Ado-Odo Ota LGA, Ibadan Southwest and Agege LGA.

2.2 Data Collection

A random sampling technique was used in data collection. The sample frame adopted for the field study was 600 household heads. The instrument of research was the questionnaire designed with the primary objective of eliciting the following information from the respondents; to examine the relationship between peoples' knowledge of CSLBs and the influence this may have on its acceptability for housing construction; to ascertain whether low cost implication of a walling material is a determinant in its choice for building construction; and to examine the role of public-private partnerships in the promotion of CSLBs for low-cost housing. A total of 100 questionnaires were randomly distributed to household heads in each of the LGAs. 551 valid questionnaires were returned at the end of the exercise. The data obtained from the field exercise was analyzed and presented using descriptive statistical method.

3.0 Results and Discussions

The result of the field survey (Figure 1) shows that there is a high aspiration for self home ownership among the respondents (85%). This high aspiration for self home ownership is a confirmation that housing is seen as one of the best indicators of a person's standard of living and of his or her place in society (UNCHS, 1993). The study
assumed that this situation could have aided the acceptability and use of CSLBs in the study areas. However, the reverse is the case. Durability was identified as one of the major factors that will be considered in the acceptability and use of a walling material for their houses. Therefore, 84.9% of the respondents attested to the fact that CSLBs are highly durable for housing construction. This was supported in a similar study by Adefeji & Fasakin (2007). Though their survey was targeted at professionals in the building industry in four out of the six geopolitical zones in Nigeria, their result revealed that CSLBs are highly durable and suitable for housing construction.

Conversely, Baiiche et al. (2008) in a case study in Zambia shows that earth buildings are perceived as not durable. Furthermore, it was discovered that 54.2% of respondents have the knowledge that CSLBs are as durable as the widely used concrete blocks while 28.2% are not sure. Thus, it is evident that a substantial number of persons are still not knowledgeable about the physical and socio-economic properties of the material, hence the low patronage of it in housing developments. This could be due to not being able to differentiate between CSLBs and other earth building construction as identified in Baiiche et al. (2008).

![Figure 1: Assessment of Factors affecting Acceptability of CSLBs for Affordable Housing](image)

The research investigated further other factors that could be responsible for the acceptability and use of CSLBs in enhancing sustainable housing development. Adequacy of promotion of use of CSLBs by stakeholders was evaluated. Respondents (71.8%) believed strongly that the public-private sector being the drivers of the building industry have done little in promoting its use. Conversely, it is seen that adequate promotion of the building technique (77.1% respondents) and knowledge of the physical and socio-economic properties of CSLBs (83.3%
respondents) are strong factor in enhancing its acceptability. This is in support of the view of Bella (2007) in a study carried out in Algeria. He identified the negative role played by the professionals towards the promotion of traditional building materials as the bane of its acceptability and use. This study also shows that 67.2% of respondents believed that the use of CSLBs for building construction is not associated with the poor. Finally, 71.1% of respondents believed strongly that its comparative low cost advantage will be a strong factor that will enhance its acceptability and use for affordable housing construction by the urban populace.

4.0 Conclusion
This study has explored the possibility of enhancing sustainable housing development in Nigeria through the acceptability and use of CSLBs. The study identified that there is high aspiration for self-home ownership among the respondents. However, it was observed that this aspiration is not commensurate with the acceptability and use of CSLBs for housing construction. Factors responsible for acceptability and use were evaluated. The study identified that respondents think that CSLBs is as durable as the widely accepted and used sandcrete blocks. Furthermore, the study identified that respondents are knowledgeable of the socio-economic implications of use CSLBs but the lack of promotion of its use by stakeholders in the building industry in Nigeria is a major hindrance in its acceptability and use. In view of these findings, it is therefore recommended that continuous sensitization of the populace by stakeholders (public and private sector participants in the building industry) through construction of model houses with CSLBs across the six geopolitical zones of the country. Furthermore, the paper recommends more funding of researchers on fabrication and production of the CSLBs making machines so as to make the product readily available and accessible by the populace.

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