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# Assessment of the Use of Compressed Stabilized Interlocking Earth Block for Building Construction in Nigeria

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**Abstract**
With the increasing pace of technology and the ever growing client's desire for comfort and optimum value for money, the need to diversify and try other materials and methods of building construction that will yield the expected result is necessary. One of such materials is the Compressed Stabilized Interlocking Earth Block (CSIEB) which is gaining popularity among construction professionals in most developing countries. This research therefore assessed its usage for building construction in Nigeria, using a questionnaire survey administered to construction professionals which includes; Architect, Quantity Surveyors, Engineers and Builders. Data gathered were analyzed using percentage, mean item score and correlation analysis. Findings revealed that CSIEB is gaining popularity among construction professionals and the present level of usage is encouraging. Correlation analysis showed that there is a strong relationship between its suitability and respondents' willingness to adopt it for building construction. Findings further revealed that CSIEB is suitable for building construction and most professionals are willing to use it for subsequent projects. Its perceived benefits include; cost effective construction, aesthetically pleasing finish and reduction in cost of maintenance. The study therefore recommends that the use of CSIEB should be encouraged among stakeholders as an alternative to the conventional materials use for building construction in Nigeria.
**Keywords:** Building construction, Compressed Stabilized Interlocking Earth Block, Construction professionals, Nigeria, Suitability.

## 1. Introduction

Man's greatest desire from inception has been that of comfort, this date back to the days where local construction materials and methods were used in building construction. To achieve this desire for comfort, lots of development has been carried out over the years (Olaleye and Sangodina 2001). These developments have allowed for the rise of several modern methods and materials for building construction and the improvement of existing ones. One of such improvement is the Compressed Stabilized Interlocking Earth Block (CSIEB).

CSIEB is made from earth, stabilized with cement (in most cases) and compressed in an interlocking block making machine. Although the use of earth for construction is as old as mans' existence, further improvements have been done to give immense benefits and optimum end user satisfaction through its usage. Deboucha and Hashim (2011) observed that although the stabilized earth blocks have been an area of interest for researchers in the past, its potential as a commercial construction material and the ability to fulfill several functions such as structural integrity, thermal transmittance and durability, makes the material an excellent walling material when compared to other masonry materials used in construction today and this has brought about the resurgence of renewed research interest in recent years. Joseph (2010) observed that using compressed earth blocks, in place of conventional fired bricks, will to a large extent reduce the energy usage and $CO_2$ emissions. Lemougna, Melo, Kamseu, and Tchamba (2011) observed that due to the permeability of stabilized earth blocks to water vapour, earth walls remarkably regulate the humidity of indoor air. Adedeji and Fasakin (2008) also established that when interlocking earth blocks are used for construction, it has unparallel advantages such as shorter period of construction, lesser gang of labour and reduced cost of construction.

With such immense benefit derived from the use of CSIEB, it is important to assess its usage in Nigeria. This study therefore assessed the use of CSIEB for building construction in Ondo and Lagos state, Nigeria with the view of providing better alternative to the conventional materials and methods used for building construction, in order to achieve optimum end user satisfaction. In achieving this, the level of awareness of CSIEB among construction professionals and its usage were assessed, as well as the suitability and willingness to use the material for building construction, and its perceived benefits.

## 2. Literature Review

### *2.1 The Construction Industry in Nigeria*

The construction industry can be seen as a pathway through which societal goals of urban and rural development can be achieved while construction works carried out in the industry cover site acquisition, design, contract, site operations and management (Leibing, 2001). The construction industry has a great impact on the economy of all countries. According to Aibinu and Jagboro (2002), the construction industry in Nigeria occupies an important position in the nation's economy. Olowo-Okere (1985) posited that construction in Nigeria existed as far back

 

as the 1940s when few foreign companies came together under an organized construction contracting in Nigeria and began operation. Since then, Nigeria's economic growth over the last decade according to Isa, Jimoh and Achuenu (2013) has been high and the contribution of construction sector has risen steadily leading to sustainability.

Like its counterpart around the world, the Nigerian construction industry is not static and this is as a result of increasing clients demand, complexity of construction projects, advancement in technology and introduction of new innovations amongst others (Oke, 2009). The constructional professionals are saddled with the responsibility of meeting these increasing demands of the clients through the use of diverse available technology and innovations. Hence, the use of new method of construction and improved materials like CSIEB for construction.

*2.2 Overview of Compressed Stabilized Interlocking Earth Block*

CSIEB is made from hydraulically compressing earth. Earth as a building material has been in use for thousands of years all over the world. According to Olotuah (2002), earth is the indigenous material for house construction in Nigeria. Alagbe (2011) observed that Earth building technique was popular in Nigeria until the arrival 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. The houses served their purpose of providing adequate shelter for the occupants and they were also durable to the extent that some of the buildings dated between 50 and 100 years. The use of earth for building construction according to Adam and Agib (2001) will continue to enjoy patronage as a building material but with varying degrees of improvement in techniques as a result of improved technologies.

CSIEB is an interlocking earth block made from the compression of earth (laterite) mixed with cement and compressed in an interlocking block machine, hence the name. In production, the soil must be free of dirt in order to achieve a fine finished product. The soil is mixed with cement in predetermined ratios by hand or in a pan mixer and water added at an average proportion, making sure that the mixture is not watery. The mixture is loaded into the block making machine in which it is hydraulically compressed. It takes an approximate 15-20 seconds per block, after which the compressed block is then stacked and left to cure (Hydraform, 2004).

CSIEB has a recessed under surface called the Bed underneath and a raised top surface called a Ridge. The ridge of one interlocking block is designed to key into the bed of another, thereby providing a perfect lock (Bansal, 2010). Kintingu (2009) argued that the stability of the wall built from the CSIEB is not provided by the locking mechanism but by the width and weight of the block, while Bansal (2010) observed that compressed stabilized blocks has proven to be suitable for the construction of load bearing walls, framed structures, boundaries etc. because of its strength and stability.

*2.3 CSIEB for Building Construction*

The use of CSIEB for building construction follows the principle of dry stacking. In dry stacking construction, the interlocking blocks are laid without mortar thereby leading to considerable savings in cost associated with mortar. This method of construction according to Uzegbo and Ngowi (2003) has existed in Africa for thousands of years. Pave and Uzoegbo (2010) observed that ancient dry-stack masonry consisted of robust construction and huge structural elements which were both material and time consuming construction process. At the time, attention shifted from dry-stack construction to research on new materials and applying new methods of construction. Adewole (2008) stated that these research activities ultimately led to the development of the interlocking block technique, which is gaining popularity in most developing countries around the world. According to Ngowi (2005), over twenty three different dry-stack systems are currently being commercialized. These include: the Sparlock system, Maccano system, Sparfil system, Haener system and the popular Hydraform system (Anand and Ramamurthy, 2003).

Today the application of these various dry-stack constructions extends from rural community houses, urban and suburb applications in medium-sized social and commercial buildings such as schools, hospitals, offices, shops and stores (Pave and Uzoegbo, 2010) The first documented usage of the CSIEB masonry in Nigeria according to Olusanya (2001) was that of a 60-unit housing estate experimented in 1991 at the University of Lagos, Lagos.

Adedeji and fasakin (2008) observed that professionals in the building industry showed high preference for the use of interlocking masonry unlike the conventional types and this is because of the shorter period of setting, higher strength, reduced number of labour involved in its operation and overall 65% reduction in cost of masonry works. Also, the level of suitability of interlocking block as an innovative and alternative material to the conventional blocks used for construction is very high.

*2.4 Benefits of the Use of CSIEB for Building Construction*

In construction, CSIEB is produced using soil on site and topsoil is then used to replace the pits created by the

 

excavated soil, so that the surrounding landscape is not disturbed. The blocks require no burning, thus destructive deforestation is avoided, and they are cured under plastic sheeting so, very little water is needed. In addition to the water and tree-saving benefits, CSIEB can be locally manufactured, reducing transport pollution and carbon footprint. A total of 93-95% of the blocks are made from compressing the surrounding soil and only 5-7% cement is needed, significantly reducing the cost per square meter of wall. As a result of the interlocking mechanism of the blocks, there is no mortar required in 75% of the structure (Hydraform, 2004).

Lemougnan et al. (2011) also observed that stabilized earth blocks have immense environmental benefits such as the reduction of the amount of cement used in global building processes and consequently the amount of $CO_2$ emitted and energy used for construction. Several researches have also proven that the use of stabilized earth blocks for building construction can give immense benefits based on its characteristics such as: high aesthetic nature, shorter period of operation, lesser gang of labour, reduced cost of construction, low cost of raw material, suitability for masonry construction, reduction in cost of finishes and maintenance, time saved during construction, availability of materials, adaptability of blocks to tropical climate, better quality construction, less wastage, versatility (all other elements such as doors, windows and slabs used in the conventional system can be used with it), genuine eco-friendliness and overall cost effectiveness (Adewole,2008; Adedeji and Fa 2012; Taiwo and Adeboye 2013; Bansal, 2010; Hydraform, 2004).

## 3. Research Method

The aim of this paper is to assess the use of compressed stabilized interlocking earth blocks for building construction in Nigeria. In achieving this, a survey design was used. This involved the use of 60 questionnaires, distributed to construction professionals in Lagos and Ondo state. The premise for the selection of these 2 states is that, Lagos state has the highest number of building construction works and construction professionals within the country, while Ondo state has high number of earth constructed buildings. Out of the 60 questionnaires distributed, 57 were returned and found fit for analysis. Percentage was used to determine the level of awareness of CSIEB among the selected professionals, while correlation analysis was carried out to see the relationship between its suitability and respondents willingness to adopt it as a building construction material. The suitability and level of willingness of respondents to use CSIEB was then analyzed using frequency and percentage. Mean Item Score (MIS) was used to analyze the perceived benefits as observed by the selected professionals. MIS was employed for two purposes which are: ranking and determination of significance of different factors of the collected data. The premise of decision for the ranking is that the factor with the highest MIS is ranked 1$^{st}$ and others in such subsequent descending order.

## 4. Results and Discussion

### *4.1 General Information of Respondents*

Respondents profile showed that majority of the respondents sampled are Quantity surveyors and Engineers with each having 28.1% while Architects and builders form 24.6 and 19.3% of the total population. 29.8% of the respondents have between 0 to 5years working experience, 35.1% of respondents have between 6 to10 years working experience while 24.6%, 7% and 3.5% have between 11 to 15, 16 to 20 and 21 to 30 years of experience respectively. This shows that 70.2% of the respondents have between 6 to 30 years working experience, thus, response gotten from the respondents can be relied upon as answers were given based on experience.

### *4.2 Awareness of CSIEB among Construction Professionals*

Result shows that 89.5% of the respondents are aware of CSIEB for building construction, while 10.5% are not. This high awareness rate can be attributed to the vast years of experience of the respondents in the construction field. Result also shows that 66.7% of the respondents have moderate knowledge of CSIEB and its method of construction, while 22.8% have vast knowledge about it. Figure 1 below shows that out of the 89.5% respondents that stated their awareness and knowledge of CSIEB, 29 (50.9%) have been involved in between 1 to 10 CSIEB projects, while 6 (10.5%) have been involved in between 11 to 20 and 16 (28.1%) have not been involved in any. Thus, a total of 61.4% have been involved in at least 1 construction project where CSIEB was used. This encouraging percentage (61.4%) experienced in its usage can be attributed to the increasing level of awareness among professionals as observed by Adedeji and Fasakin (2008) where the level of usage was low as a result of low level of awareness among construction professionals.

 

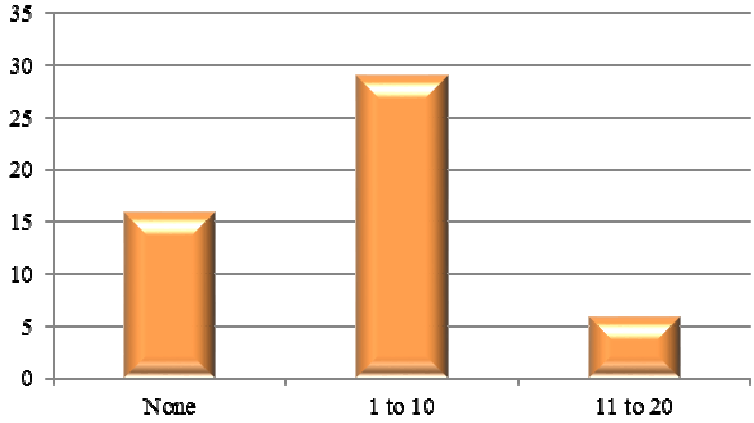


Figure 1: Number of CSIEB construction carried out by respondents

*4.3 Suitability and Willingness to use CSIEB*

The hypothesis here is that the respondents' willingness to use CSIEB is dependent on its suitability for building construction, while the null hypothesis is that respondents' willingness to use CSIEB is not dependent on its suitability. Using SPSS, Correlation is significant at the 0.01 level (2-tailed) as shown in table 1 below. This shows that the willingness of the respondents to use CSIEB for future construction work is largely dependent on the suitability of the material for building construction.

Table 1: Correlation between suitability of CSIEB and respondents willingness

| | | **Suitability** | **Willingness** |
|---|---|---|---|
| **Suitability** | Pearson Correlation | 1 | .419** |
| | Sig. (2-tailed) | | .002 |
| | N | 51 | 51 |
| **Willingness** | Pearson Correlation | .419** | 1 |
| | Sig. (2-tailed) | .002 | |
| | N | 51 | 51 |

**. Correlation is significant at the 0.01 level (2-tailed).

Result in table 2 shows that out of the 89.5% of the respondents that are aware of the use of CSIEB, 50.9% of the respondents believe it is suitable for building construction, while 26.3% and 12.3% believe the material is moderately suitable and very suitable respectively. Base on this suitability, 38.6% of the respondents are willing to use it for building construction while 12.3% are very willing.

Table 2: Suitability / Willingness to Use CSIEB for building construction

| **Suitability** | **Frequency** | **Percentage** | **Willingness** | **Frequency** | **Percentage** |
|---|---|---|---|---|---|
| Not suitable | - | - | Unwilling | - | - |
| Rarely suitable | - | - | Rarely Willing | 2 | 3.5 |
| Moderately suitable | 15 | 26.3 | Moderately Willing | 20 | 35.1 |
| Suitable | 29 | 50.9 | Willing | 22 | 38.6 |
| Very suitable | 7 | 12.3 | Very Willing | 7 | 12.3 |
| **Total** | 51 | 89.5 | **Total** | 51 | 89.5 |
| Not Stated | 6 | 10.5 | Not Stated | 6 | 10.5 |
| **Total** | 57 | 100.0 | **Total** | 57 | 100.0 |

This implies that all the 89.5% respondents that stated their awareness of the use of CSIEB for building construction believe it is suitable (from moderately suitable to very suitable) for building construction. This (Suitability) in turn affects the respondents' willingness to use same for as proven by the correlation analysis carried out. Also, out of 89.5% respondents that stated their awareness of the use of CSIEB for construction, 86% ascertain their willingness (from moderately willing to very willing) to use the material for construction while only 3.5% were rarely willing. This shows that the willingness level of professionals to use CSIEB is growing as predicated by Adedeji and Fa (2012).

*4.4 Perceived Benefits of the Use of CSIEB in Building Construction*

Result in table 3 below shows that the aesthetic nature of CSIEB ranked highest with a mean score of 4.00,

 

followed by low cost of material, suitability of material for construction and reduction in cost of finishes/maintenance with a mean score of 3.94, 3.88 and 3.85 respectively. Versatility of the CSIEB ranked least on the list with a mean score of 2.46. This means that the respondents believe that almost all the identified benefits can be derived from the use of CSIEB for building construction, with the aesthetic nature, low cost of raw material used for production, suitability of material for construction and reduction in cost of finishes and maintenance being the major ones. This is in agreement with Ngowi (2005) and Taiwo and Adeboye (2013) which stated that the use of interlocking blocks for building construction is highly cost effective. Findings further corroborate Adedeji and Fasakin (2008) assertion that the high level of acceptability of the stabilized interlocking earth blocks is as a result of its cost effectiveness, accessibility and suitability.
The versatility of CSIEB is the least benefits derived from its usage as it has a mean score of 2.46. This can increase with time if the material is used more often for building construction.
Table 3: Perceived benefits of the use of CSIEB in building construction

| **Benefits** | **Mean** | **Ranking** |
|---|---|---|
| Aesthetic nature of CSIEB | 4.00 | 1 |
| Low cost of raw material | 3.94 | 2 |
| Suitability of the system | 3.88 | 3 |
| Reduction in cost of finishes/maintenance | 3.85 | 4 |
| Time saving during construction | 3.69 | 5 |
| Availability of raw materials | 3.67 | 6 |
| Cost Effectiveness of the overall building system | 3.62 | 7 |
| Adaptability of CSIEB to tropical climate | 3.61 | 8 |
| Better quality construction | 3.58 | 9 |
| Less wastage | 3.52 | 10 |
| Use of reduce labour | 3.37 | 11 |
| Genuine eco-friendliness | 3.21 | 12 |
| Versatility of the CSIEB | 2.46 | 13 |

## 5. Conclusion and Recommendation

Thus far, the study has been able to ascertain the level of awareness of CSIEB among construction professionals in Ondo and Lagos state Nigeria, its suitability for building construction as it affects the willingness of professionals in using same, and the perceived benefits of its usage.

The study revealed that CSIEB is gaining popularity among construction professionals. An encouraging level of usage is presently being achieved, while the willingness of professionals to use it for building construction is dependent on the level at which they deem it suitable for building construction. Study further revealed that most professionals in the construction industry believes CSIEB is suitable for building construction hence they are willing to use same for subsequent constructions projects. Also the use of CSIEB for building construction will give a cost effective construction, aesthetically pleasing finish and reduction in cost of finishes and maintenance.

The study therefore recommends that the use of CSIEB should be encouraged among stakeholders as an alternative to the conventional building materials used in building construction due to its enormous benefits. The use of CSIEB by the government for construction of public buildings such as schools, hospitals and markets can also serve as a means of increasing the awareness of this material among stakeholders and the public in general, hence increasing the level of usage.

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**Figure 2**: CSIEB used for the construction of a caring heart mega school, Famese, Isokan, Akure, Ondo state
Source: Field survey (2015)