

## Comparative Cost Advantages of Interlocking Stabilized Soil Block and Sandcrete Block for Building Construction in South-West Nigeria

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### Abstract

Interlocking stabilized soil blocks (ISSBs) is undoubtedly one of the contemporary building materials used for building construction works in developing countries. The ISSBs is gaining fast recognition as frontline alternative to Sandcrete blocks for affordable housing development in Nigeria. However, despite the positive reports of United Nations upholding ISSB as an affordable building material for low cost housing in developing African nations, the patronage of ISSBs is low-slung when compared to the conventional Sandcrete blocks (SBs). This study explored the comparative cost advantages of Interlocking stabilized soil blocks and Sandcrete blocks for building construction in Southwestern Nigeria with the view of promoting its usage for affordable housing development. The objectives were; to identify the most common types of Interlocking stabilised soil blocks and Sandcrete blocks used for building construction works in southwestern Nigeria; to analyze the cost of ISSBs for building walling system; to compare the cost of building walling systems with Interlocking stabilized soil blocks and Sandcrete blocks in Southwestern Nigeria. Existing literature on the use of Interlocking stabilised soil blocks (ISSBs) were reviewed. Using qualitative research approaches where Interviews and documentaries was phenomenal; the cost comparativeness of ISSBs and SBs in this study was analyzed using Empirical data's obtained from local construction markets and ISSBs promoters. Findings revealed the cost of ISSBs is relatively cheaper than Sandcrete blocks due to the mortar-less walling systems; the eradication of wall rendering and drastic reduction in the use of cement, concrete, reinforcement and industrial materials. The study recommended that more agencies should be established. Promoters of ISSBs should invests heavily on awareness and sensitization of the populace on the significance of adoption ISSBs for building construction.

**Keywords:** Affordable Housing, Cost Analysis, Interlocking stabilised soil blocks (ISSBs), Sandcrete blocks (SBs)

### Introduction

#### Background Study

Mud or laterite can be described as an eternal material used for building construction works. (Adedeji 2012). Its usage can be traced to the inception of man and the environment. Civilization, inconsistencies in Performances, weather and water hazards on walls and so many discomforts in mud buildings paved way for industrial building materials such as Sandcrete blocks, cements, kilned bricks, steels. As a result, attachment of poverty stigma is prevalent to mud homes in today's environment (Daniel et al., 2018). Meanwhile, the Interlocking stabilised soil blocks; a modern form of brick is gaining fast recognition as an affordable building material with great prospects towards manifestation of an ecofriendly environment (UNHABITAT, 2010). The Interlocking stabilized soil blocks (ISSBs) is an Avant garden technology that allows the blocks or bricks to be formed into walling unit without the need of cement or mortar (Brendenoord et al, 2019). According to research effort by Bales et Al, 2009;

ISSBs can also be regarded as Compressed stabilized earth blocks (CSEBs). Other research efforts (Alagbe, 2010); (Arayela 2005) referred to ISSBs with similar names such as; Interlocking Compressed Earth Blocks (ICEBs); Stabilised Earth Blocks (SEBs). This contemporary building technology in ISSBs employs dry stacked techniques and locally sourced raw material such as sand and laterite to create exquisite and durable bricks with little or no cement. Interlocking stabilized soil block ISSB is created from laterite or earth/mud that has been compressed hydraulically or manually. The Interlocking stabilized soil blocks (ISSBs) is best defined as an interlocking soil block created by compressing earth (or laterite/mud) with cement in an interlocking block machine or press (Venkatarama Reddy, 2015). Research efforts posited that the ISSBs technique demonstrates sustainable improvements on the conventional local and kilned bricks ([www.bolynbricks.com](http://www.bolynbricks.com)).

Sandcrete block is the most popular building material in the modern era. Its usage for building construction is widely adopted across the globe. Sandcrete blocks are widely used in Nigeria as walling units and over 90% of houses in Nigeria are being constructed of sandcrete blocks. This is an indication that Sandcrete block is a very important material in building construction industries in Nigeria since most of the physical infrastructures in Nigeria are being constructed with Sandcrete block. Sandcrete blocks are readily available in Southwestern Nigeria. Findings revealed that Sandcrete technology is arguably the backbone of every country's infrastructure development (Anosike, 2011). In southwestern Nigeria, the Sandcrete block moulding industry is one of the most important industrial areas in the building industry and the block production

factory can be found in almost every region in small or large scale. There are many block moulding companies encumbered with the responsibility of satisfying the need of building and infrastructural development in Southwestern Nigeria. The Sandcrete blocks comprise of the mixture of sand, water and mortar (or binder) with appropriate mix ratio (Oyetola and Abdullah, 2006). In the production of Sandcrete blocks, the cement used as a binder, takes a larger percentage of the production cost. Building construction is mostly unaffordable because majority of the components of Sandcrete block and other conventional building materials are industrial and imported. The Nigerian Raw Materials Research and Development Council on accessible indigenous construction materials, emphasized that local building materials should be extremely considered as replacements for the foreign imported ones.

The ISSBs among others such as sundried (Adobe), soil blocks, burned clay bricks/blocks, mud and straw, lime and stonecrete blocks are only a few of the materials that can be employed as alternative to Sandcrete blocks in Nigeria. The fundamental advantage of employing ISSBs for a walling unit is that the interlocking blocks are dry stacked, which means that in a large percentage of the construction, no mortar is required; The ISSBs, lock front and back, top and bottom, removing the requirement for mortar joints in superstructures (Jagdish, 2007). The male and female ridges on the top and bottom, as well as the front and rear, of the ISSBs are referred to be interlocking. These ridges lock into one another to keep the blocks in place (Ganesan et al., 2008).

### **Problem Statement**

The issue of housing shortage is a vital concern in developing African nations. The housing problems are not limited to urban regions alone, but expand across rural and suburban areas. Mud is globally described as a sustainable and efficient building material but its usage in construction works is attributed to building projects in the rural areas and city suburbs (Ega and Job, 2011). In order to provide affordable housing in Nigerian cities and suburbs, the need for optimum utilization of locally available or produced building materials cannot be overshadowed (Adegun and Adedeji, 2017). Due to high rate of inflation of cement and other conventional building materials, it is imperative to adopt building materials that would require the use of little or no cement for housing projects. Mud/laterite houses thermal comfort and improved indoor air quality to the occupants of the building (Afolami and Oyebamiji, 2017). Hence, it is regarded as building material with low carbon emission. Although, Nigeria recorded about 17 million housing deficit in 2015 (Anugbum and Osudike, 2020) the need to maximize the use of low cost materials for housing projects is important. Hence, by comparing

the cost of production and construction of building walling systems with interlocking stabilised soil blocks (ISSBs) and Sandcrete blocks (SBs) respectively for housing projects in Southwestern Nigeria is indispensable towards establishing the reason for pervasive adoption of alternative building materials.

### **Research Questions**

In order to study the comparative cost advantages of interlocking stabilized soil block and Sandcrete Block for building walling systems in Nigeria, the following are the questions the study poised to answer:

- What are the most common types of Interlocking stabilized soil blocks and Sandcrete blocks used for building construction works in southwestern Nigeria;
- What are the cost of building walling systems with Interlocking stabilized soil blocks and Sandcrete blocks in Southwestern Nigeria

### **Aim and Objectives**

The aim of the research is to study the comparative cost advantages of Interlocking Stabilized Soil Blocks and Sandcrete Block for building walling systems towards recommending its widespread adoption for affordable housing in southwestern Nigeria. The objectives are;

- Identify the most common types of Interlocking stabilized soil blocks and Sandcrete blocks used for building construction works in southwestern Nigeria.
- Compare the cost of building walling systems with Interlocking stabilized soil blocks and Sandcrete blocks in Southwestern Nigeria.

### **Justification of Research**

Today's society accommodates both precedential and unpredictable environmental challenges that infused great havoc and concern for all. The climate change, the quantitative and qualitative housing problems, the economic situations, cost of building materials among others are alarming. Despite the notable growth in the development of Interlocking Stabilised Soil Blocks buildings across Nigeria, the number ISSBs buildings are relatively low compared to conventional Sandcrete blocks. The Interlocking Stabilised Soil Blocks (ISSBs) system has a pronounced prospect and is one of the most patronized building materials in tropical climates. Laterite or mud which is an essential component of ISSB can be found in vast quantities in Nigeria. Hence, there is large deposition of laterite in the southwest Nigeria (Orosun, 2020). There are several construction companies that primarily specializes in promoting the use of Interlocking stabilised Soil Blocks in Southwestern Nigeria.

### **Scope of the Study**

This study will also investigate the research work and development in respect to building constructed with Interlocking Stabilised Soil Blocks in selected cities of Southwestern Nigeria. The research is limited to Southwestern Nigeria because it provides explicit resources needed to execute the investigations.

### **Theory of Perception**

Computational theories of perception can be applied not only to human vision but also to other species, by considering what information an animal needs from light in order to guide its activities (Saji, December 2014). Most clients who bring projects to construction companies don't really have the right perception of most of the building materials used for construction, building materials like types of bricks, roofing sheets and so on. The major factor that is plausibly affecting the usage of Interlocking stabilized soil blocks in the construction market is the poor perception of Interlocking stabilized soil blocks by the populace. Architects and other built environment professionals cannot dictate to clients on their choice of building material but they have the right to advise through their specifications. The clients need to have the right perception of building materials and their advantages.

**Materials and Method**

**Types OF Sandcrete Blocks**

The major types of Sandcrete Blocks in Southwestern Nigeria can be classified based on their form(s) and size(s);

- **Hollow Sandcrete Blocks (HSBs)**
- **Solid Sandcrete Blocks (SSBs)**

**Hollow Sandcrete Blocks**

Hollow blocks are rectangular masonry blocks that are created holes in them. The hollow-core reduces the weight and the cross-sectional area of the block to a large extent. The blocks can be molded into different sizes such as; 450mm x 225mm x 125mm (popularly called 5 inches) and 450mm x 225mm x 150mm (popularly known as 6 inches) and 450mm x 225mm x 225mm (popularly known as 9 inches) for both load bearing and non load bearing walls. (See fig. 1.0)

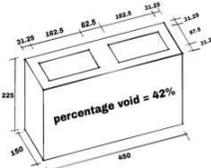
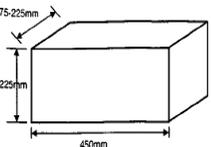
<b>Types of ISSBs based on form and size</b>			
Type	Sizes	Form	
1) Hollow Sandcrete blocks	a). 225mm x 225(H)mm x 450mm b). 150mm x 225(H)mm x 450mm c). 125mm x 225(H)mm x 450mm		
2) Solid Sandcrete blocks.	a). 225mm x 225(H)mm x 450mm b). 150mm x 225(H)mm x 450mm c). 100mm x 225(H)mm x 450mm		

Table 1.0: showing Types of ISSBs based on form and size Source: field study

**Solid Sandcrete Blocks**

Solid blocks are rectangular masonry blocks that are created without holes in them. The blocks can be molded into different sizes such as; 450mm x 225mm x 125mm (popularly called 5 inches) and 450mm x 225mm x 150mm (popularly known as 6 inches) and 450mm x 225mm x 225mm (popularly known as 9 inches) for retaining walls and load bearing walls only (See fig. 1.0)

**Types of Interlocking stabilised Soil Blocks**

The major types of Sandcrete Blocks in Southwestern Nigeria can also be classified based on their form(s) and size(s);

- **Hollow Interlocking stabilised Soil Blocks (HISSBs)**
- **Solid Interlocking stabilised Soil Blocks (SISSBs)**

**Hollow Interlocking stabilised Soil Blocks (HISSBs)**

The **HISSBs** are four-sided masonry blocks that are created holes in them. The hollow-core reduces the weight and the cross-sectional area of the block to a large extent. It also provides allowance for reinforcement to improve structural stability of the building walling systems. The holes can also accommodate plumbing and electrical services pipes where necessary “See Plate 2.1”.

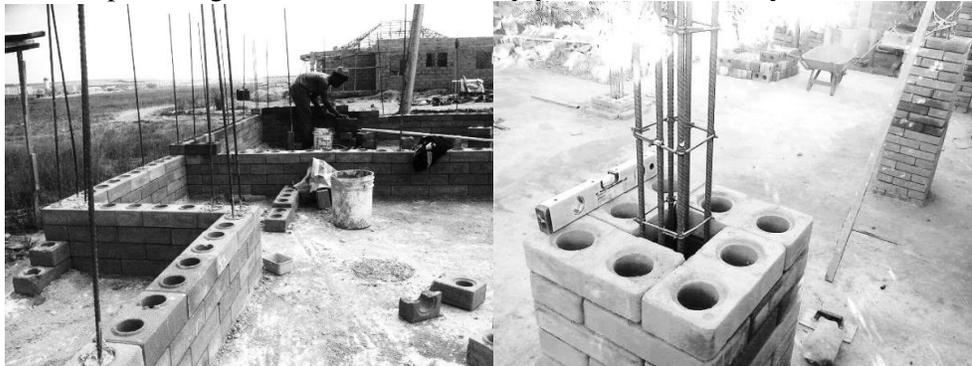


Plate 2.1: Showing reinforcement in ISSBs Source: Field study

**Solid Interlocking stabilised Soil Blocks (SISSBs)**

The SISSBs are four-sided masonry blocks that are created without holes in them. The blocks can be molded into different sizes. “see Table 1.”

Types of ISSBs based on form and size			
Type	Sizes	Form	
1). Hollow (HISSBs)	a). <b>Wide Format</b> HISSBs 230mm x 230mm x 130mm(H)		
	b). Long/ <b>Straight</b> HISSBs 130mm x 260mm x 130mm(H)		
2). Solid (SISSBs)	a). <b>Wide Format</b> SISSBs 230mm x 230mm x 130mm(H)		
	b). Long/ <b>Straight</b> SISSBs 130mm x 260mm x 130mm(H)		

Table 1.1: showing Types of ISSBs based on form and size Source: field study

**Other types of ISSBs but not common in Southwestern Nigeria**

Other Types of ISSBs based on form and size		
Type	Sizes	Form
1). Solid / Hollow (HISSBs)	a). <b>Curve Format</b> HISSBs 230mm x 230mm x 130mm(H)	
2). Solid (SISSBs)	a). <b>Patterned</b> SISSBs 230mm x 230mm x 130mm(H)	

Table 1.2: showing Types of ISSBs based on form and sizeSource: field study

**Findings and Discussion**

**Descriptive Comparison between ISSBs and Sandcrete Blocks**

This session discusses general comparative findings about characteristics of ISSBs and SBs from the fields. Three Promoters of ISSBs were interviewed. The following are the summary of there observations

Characteristics of ISSBs or SBs	ISSBs	SBs
a) Main raw material is soil or laterite with an addition of cement	Yes	No
b) There is little or no wastage in production	Yes	No
c) Cures faster	Yes	No
d) Easy to produce	Yes	
e) Faster speed of construction	Yes	No
f) Flexible to use by Unskilled	Yes	No
g) Aesthetically Appealing	Yes	No
h) Better in thermal quality	Yes	No
i) Better in indoor air quality	Yes	No

j) Low energy induction	Yes	No
k) Reusable	Yes	No
l) Easily maintained	Yes	No
m) Consumes a lot of cement	No	Yes
n) Requires skilled professionals only	No	Yes
o) Compared to ISSB, concrete blocks take a longer time to build	No	Yes
p) Readily available materials	No	Yes
q) Blocks are abundantly available in the local market	No	Yes

Table 1.2: showing characteristics of ISSBs and SBsSource: field study

### Promoters of Interlocking Stabilised Soil Blocks in Southwestern Nigeria

There are several identified promoters of Interlocking stabilised blocks in Southwestern Nigeria identified by this study. These promoters can be grouped into several categories each of which plays relevant role towards promoting ISSBs. They includes;

- a) The Client
- b) The Professionals
- c) The Industries

The Client in this study is a person using the services of a professional or organization. He or she is the Home owner.

The Professionals in this study is the Architects, builders or other allied professionals in the building industry.

#### The Industries

The Construction Companies or factories that specializes in the use of Interlocking stabilised soil blocks for building construction in SWN. They are;

- i. Bolyn Construction Company limited, Ikorodu, Lagos state and
- ii. Ipinle Earth synergy, Redemption Camp, Ogun state Nigeria.
- iii. Dura bricks, Irele, onto state
- iv. Earth building system limited, Lekki phase 1, Lagos
- v. Middle brook farm
- vi. Domkinut steel fabrication ltd, osogbo, abuja
- vii. Credit bureau investment sapele road, Benin, near Onto state
- viii. Ecologic brick, lagos Ibadan
- ix. Global brick solution, Osogbo
- x. Brick home construction ltd

**Comparative unit prices of ISSB and SB in the local construction markets**

Characteristics of ISSBs or SBs	Cost of ISSBs	Cost of SBs	Cost of ISSB using Size ratio ISSB=SB/4
a) Hollow form	<b>N80.00</b>	<b>N300.00</b>	<b>N240.00</b>
b) Solid form	<b>N90.00</b>	<b>&gt; N300.00</b>	<b>N270.00</b>

Table 1.3: showing Comparative unit prices of ISSB and SB in the Local constructionmarkets.

Source: field survey

**Observatory Analysis**

- Unit size of Sandcrete block SB = Unit size of ISSB (SB/4)
- The Average size of SB is 225x450x225(H)
- While the Average size of ISSB is 230x230x130(H)Unit size comparison
- Unit size of Sandcrete block SB = Unit size of ISSB (SB/4)There four (4) unit of an average ISSBs is 1unit of SBs

**3.3 Comparative cost of walling systems with ISSB and SB**

Characteristics of ISSBs or SBs	ISSBs	SBs
1. Unit Cost of block	N80.00	N300.00
2. Quantity required for 1sq.M	36nos.	10nos.
3. Cost of Block in masonry works per 1sq.M	<b>N2880</b>	<b>N3,000</b>
4. Cost of labor in masonry work per 1sq.M	N15/Block x N36 = <b>N540.00</b>	N70/block x N10 = <b>N700.00</b>
5. Cost of mortar	N0	<b>N206.00</b>
6. Cost of plastering	Not assessed but not necessary	Not assessed but necessary
<b>Total cost /sq.M</b>	<b>N3, 420.00</b>	<b>N3, 906.00</b>

Table 1.3: Comparative cost of walling systems with ISSB and SBSource: field survey

**Cost of Mortar**

Materials for mortar are cement, sharp sand and water

Cement:

For 1bag of cement, 50 blocks can be formed into wallsAverage Cost of 1bag of cement is N4, 000. 00

1bag = 50blocks

10blocks will form 1 meter square of wall = N4, 000. 00 ÷ 70blocks = N58, 00  
Cost of cement in mortar per 1sqm. = N58. 00

Sand:

1 head pan of sand is N370

4 head pan per 1bag =N1, 480.00 10blocks

(1sqm) = N1, 480.00 ÷ 10blks

Cost of sand per sq.M in mortar is N148. 00

Cost of mortar /sq.M:

N1, 160. 00 + N80. 00 = **N206. 00**

## 5.0 CONCLUSION

With The Interlocking stabilised Soil blocks elimination of Plaster Work saves time and money as compared to Sandcrete wall construction. By designing smooth finished bricks, plastering work can be completely eliminated. Also, the ISSBs technique requires unskilled and Fewer Labors thus minimizes cost and Time while skilled labors are required for constructing walls with Sandcrete blocks. With SBs, more skills are required to check the water level, spirit level, and other skilled works. Findings revealed the cost of ISSBs is relatively cheaper than Sandcrete blocks due to the mortar-less walling systems; the eradication of wall rendering and drastic reduction in the use of cement, concrete, reinforcement and industrial materials. The study recommended that more agencies should be established. Promoters of ISSBs should invests heavily on awareness and sensitization of the populace on the significance of adoption ISSBs for building construction.

## References

- Adedeji, Y. (2012). Sustainable housing provision: preference for the use of interlocking masonry in housing delivery in Nigeria. . *Scientific & Academic Publishing (SAP): Architecture Research* , 2(4), 55-59.
- Adegun, O. B., & Adedeji, Y. M. (2017 ). Review of economic and environmental benefits of earthen materials for housing in Africa. *Frontiers of Architectural Research*, 6(4), 519- 528.
- Afolami, A., & Oyebamiji, I. (2017). Users' Perception and thermal comfort of residents in an estate built with laterite interlocking blocks, Ekiti State, Nigeria. *1st international conference of the school of Management Technology*, (p. p.193). Federal University of Technology, Akure, Nigeria: Obamuyi, T.M; Fadare, S.O; Dada, A.D; Fakokunde, T.O & Abayomi, M.A (Eds.). Management, technology and sustainable development,.
- Anugbum, O., & Osudike, F. I. (2020 ). Critical examination of the problems and prospects of housing in Nigeria using a legal frame work. . *Journal of Commercial and Contemporary Law*, 72\_84.
- Bales, C., Donahue, C., Fisher, M., Mellbom, A., & Pearson, A. (2009). Interlocking compressed Earth Blocks: from soil to structure. Senior Project. California Polytechnic State University, California.
- Bredenoord, J., Park, J., & Kim, K. (2020). The significance of community training centers in building affordable housing and developing settlements. *Sustainability*, 12(7), 2952.
- Daniel, A.A, Benjamin G. K, and Tali, J. O. 'Adopting Stabilized Earth Construction to address Urban Low-cost Housing Crisis in Jos, Nigeria,' *Journal of Ergonomics Studies and Research*. Vol.1 no.1; pp. 1-10, 2018.

- Ega, A. E. and Job C. (2011) ‘Traditional earth plasters and renders in Nigeria: A preliminary study,’ Journal of Environmental Sciences University of Jos. Vol. 15: pp.1-6, 2011.
- Oyelami, C.A. and Van Roy, J.L (2016). A review of the use of lateritic soils in the construction/development of sustainable housing in Africa: A geological perspective. Journal of African Earth Sciences, 119: 226–237
- Venkatarama Reddy, B. (2015). Design of a manual press for the production of compacted stabilized soil blocks. *Current Science*, vol.109, no. 9.
- Anosike, N.M. and Oyebade, A.A. (2012). Sandcrete Blocks and Quality Management in Nigeria Building Industry Journal of Engineering Project and Production Management
- Jagadish, K. (2007). *Building with Stabilized Mud*. New Delhi, Bangalore: I.K. International Publishing House Pvt. Ltd.
- Ganesan, K., Rajagopal, K., Thangavel (2008). Rice husk ash blended cement: assessment of optimal level of replacement for strength and permeability properties of concrete Constr. Build. Mater. 22 (8) pp. 1675-1683
- Al-Saji, A. (2014). Bodies and Sensing: On the uses of Husserlian phenomenology for feminist theory, *Continental Philosophy Review*