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Assessment of the Contribution of Interlocking Stabilized Soil Block Technology to Affordable Housing Delivery in Nigeria

Adebanjo Eyitayo[1*]; Adeniran Omobolanle[2]; Asianya Chukwuebuka[3]; Ezeokafor Emmanuel[4]; Mathias Gideon Ikenya[5]; Musa Beloveth Ohine[6]; Ojelabi Favour Akindeji[7]; Olajolo Oluwagbotemi Emmanuel[8]; Opefoluwa Oluwole[9]; Oyebanjo Sesan Daniel[10]; Umeh Malachy Chinenye[11]

[1,2,3,4,5,6,7,8,9,10,11]Department of Architecture, Caleb University, Lagos, Nigeria.

Corresponding Author: Adebanjo Eyitayo[*]

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Abstract: Nigeria currently faces a severe residential supply crisis, officially estimated at a deficit of 14.925 million units for the 2025/2026 period. This shortage is exacerbated by the high costs of conventional, cement-intensive building materials, which dominate the domestic construction sector. To address this critical gap, the adoption of sustainable, cost-effective alternative materials is required. This paper presents a comprehensive assessment of compressed earth masonry as a potentially viable architectural intervention for mass residential delivery. Utilizing a descriptive review design supported by Comparative Cost-Benefit Analysis (CBA), the study evaluates the economic, structural, and environmental performance of this technology against standard hollow sandcrete blocks. The quantitative methodology indexes a standard one-square-meter walling unit to isolate material and labor expenditures, specifically analyzing the financial impact of a mortar-less dry-stacking technique. The findings demonstrate significant cost efficiency; erecting a basic wall panel yields a 12.44% raw capital reduction compared to sandcrete, primarily through the elimination of auxiliary bedding mortar expenses. Furthermore, empirical evaluations indicate that this integration improves indoor thermal comfort and acoustic insulation due to the natural thermal mass and density of the compressed earth. Despite these advantages, widespread adoption remains constrained by strict soil requirements, on-site quality control challenges, and negative public perceptions regarding earthen architecture. The paper concludes that while moisture management requires targeted design solutions, the overarching economic and environmental benefits are consistent with Nigeria's affordable development goals. It recommends that policymakers and urban planners incentivize earth-based construction technologies through standardized building codes and targeted green financing to contribute to addressing the national housing deficit.

Keywords: *Acoustic Attenuation; Comparative Economics; Dry-Stacked Masonry; Eco-Friendly Construction; Environmental Sustainability; Thermal Mass.*

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I. INTRODUCTION

For decades, the discourse surrounding real estate and urban development in Nigeria has been clouded by speculative statistics. However, recent data presented by the National Housing Data Technical Committee provides a scientific estimate, confirming that Nigeria's official housing deficit stands at approximately 14.925 million housing units. This persistent supply gap is driven by a confluence of systemic bottlenecks, including rapid population growth, intense urbanization pressures, land constraints, and severely limited access to long-term housing finance.

The cost of conventional construction materials remains a primary barrier to scaling up housing projects (Ibitoye, Alagbe, & Dare-Abel, 2022). Furthermore, a

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reliance on expensive, carbon-heavy industrial materials—specifically sandcrete blocks and imported cement—exacerbates both the economic crisis and the environmental footprint of the sector (Ibitoye, Alagbe, & Dare-Abel, 2022; Okunlola & Ibitoye, 2026). To contribute to addressing this housing deficit, the construction industry must pivot toward sustainable, cost-efficient alternatives. Interlocking Stabilized Soil Blocks (ISSB) technology presents a potentially viable intervention. By utilizing locally sourced lateritic soils and minimizing reliance on cement, ISSB may provide structural and economic benefits capable of accelerating affordable housing delivery (Ibitoye, Abiola, & Babamboni, 2023; Ibitoye, Alagbe, & Dare-Abel, 2022).

II. LITERATURE REVIEW AND RESEARCH GAP

➢ *Affordable Housing Challenges in Nigeria*

The Nigerian housing sector is characterized by rising construction costs and a heavy dependence on cement-intensive materials (Ibitoye, Alagbe, & Dare-Abel, 2022). The demand for affordable housing has outpaced supply, necessitating sustainable alternatives that can lower construction costs without compromising structural integrity (Bredenoord & Kulshreshtha, 2023; Okunlola & Ibitoye, 2026).

➢ *Concept and Development of ISSB Technology*

Historically rooted in traditional adobe and wattle-and-daub construction, compressed earth blocks (CEBs) have evolved into advanced interlocking systems (Bredenoord & Kulshreshtha, 2023; Okunlola & Ibitoye, 2026). Modern ISSB technology utilizes dry-stack construction and specific stabilization techniques to create load-bearing masonry units (Bredenoord & Kulshreshtha, 2023). Research shows increasing global interest in interlocking earth systems because of their low-carbon and mortar-less characteristics (Bredenoord et al., 2019). Technologies tested in Thailand and Nepal demonstrate the versatility of interlocking blocks in diverse climates (Bredenoord et al., 2019).

➢ *Economic Performance of ISSB*

Multiple studies report lower walling costs for ISSB due to reduced cement consumption, the elimination of mortar joints, and the possibility of on-site production (Bredenoord & Kulshreshtha, 2023; Ibitoye, Alagbe, & Dare-Abel, 2022). However, the magnitude of savings varies according to soil conditions, stabilization requirements, and regional construction costs (Bredenoord & Kulshreshtha, 2023).

➢ *Environmental Sustainability*

Research indicates that earth-based construction materials generally possess lower embodied energy and lower greenhouse gas emissions than cement-intensive masonry systems (Bredenoord & Kulshreshtha, 2023; Okunlola & Ibitoye, 2026). The utilization of local materials supports circular economy principles by minimizing industrial processing and transportation emissions (Danjuma, 2020; Ibitoye, Abiola, & Babamboni, 2023; Okunlola & Ibitoye, 2026).

➢ *Thermal and Acoustic Performance*

Experimental studies have reported lower indoor temperature fluctuations and reduced cooling demand in ISSB buildings due to the thermal mass characteristics of earth-based walls (Danjuma, 2020). The coefficient of thermal conductivity of Nigerian-produced ISSB has been measured at 0.4765 W/mK, highlighting its superior energy efficiency compared to standard cement blocks (Danjuma, 2020). Experimental investigations have also reported improved acoustic performance when compared with conventional masonry units; laboratory tests on interlocking compressed stabilized earth blocks revealed high sound absorption coefficients ranging from 0.71 to 0.99 across varying frequency bands (Bakam, Mbishida, & Danjuma, 2023).

➢ *Research Gap*

Although previous studies have investigated the economic, structural, and environmental characteristics of ISSB technology, much of the literature examines these dimensions independently (Bakam, Mbishida, & Danjuma, 2023; Hafez, El-Mahdy, & Marsh, 2023; Okunlola & Ibitoye, 2026). Most studies focus either on cost comparison, material properties, or specific case studies within limited geographical contexts (Bredenoord et al., 2019; Ibitoye, 2025). There remains limited integrated assessment of the contribution of ISSB technology to affordable housing delivery in Nigeria by simultaneously examining economic, environmental, and implementation dimensions. This study addresses this gap by synthesizing evidence from multiple perspectives to evaluate the potential of ISSB as an affordable housing strategy in Nigeria.

III. METHODOLOGY

➢ *Research Design*

This study adopted a descriptive review design supported by comparative cost-benefit analysis to evaluate the contribution of ISSB technology to affordable housing delivery in Nigeria.

➢ *Data Sources*

Secondary data were obtained from peer-reviewed journal articles, empirical ISSB studies, and housing publications (Bakam, Mbishida, & Danjuma, 2023; Bredenoord & Kulshreshtha, 2023; Bredenoord et al., 2019; Danjuma, 2020; Hafez, El-Mahdy, & Marsh, 2023). The cost figures adopted in this study are derived from previously published empirical studies in Southwestern Nigeria and are intended to illustrate the relative economic relationships between ISSB and sandcrete walling systems rather than provide current market prices (Ibitoye, Alagbe, & Dare-Abel, 2022).

➢ *Unit of Analysis*

A standard 1 square meter (1 m^2) vertical wall section was adopted to permit direct comparison between ISSB and sandcrete masonry systems (Ibitoye, Alagbe, & Dare-Abel, 2022).

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➢ *Variables Examined*

- Material cost (Ibitoye, Alagbe, & Dare-Abel, 2022)
- Labor cost (Ibitoye, Alagbe, & Dare-Abel, 2022)
- Mortar cost (Ibitoye, Alagbe, & Dare-Abel, 2022)
- Transportation requirements (Ibitoye, Abiola, & Babamboni, 2023; Ibitoye, Alagbe, & Dare-Abel, 2022)
- Thermal and acoustic performance (Bakam, Mbishida, & Danjuma, 2023; Danjuma, 2020)
- Environmental impacts (Bredenoord & Kulshreshtha, 2023)

➢ *Data Analysis*

The percentage cost savings were computed using the following equation:

$$\text{Savings (\%)} = ((Cs - Ci) / Cs) \times 100$$

Where:

- Cs = Sandcrete wall cost
- Ci = ISSB wall cost

IV. PRINCIPLES OF ISSB TECHNOLOGY

➢ *Basic Composition:*

An ISSB is a compressed masonry unit fabricated by mechanically compacting a carefully proportioned mixture of sandy soil (or laterite), water, and a minimal percentage of a chemical stabilizer, typically cement (Bredenoord & Kulshreshtha, 2023; Ibitoye, Abiola, & Babamboni, 2023; Okunlola & Ibitoye, 2026).

➢ *The Interlocking Mechanism:*

The blocks are formed using specialized mechanical molds that imprint distinct structural profiles on their faces (Ibitoye, 2025). These specialized tongue and groove joints allow the blocks to securely key into one another horizontally and vertically during the wall assembly process (Bredenoord et al., 2019; Ibitoye, Abiola, & Babamboni, 2023).

➢ *Dry-Stacking Technique:*

The defining feature of ISSB construction is its deployment of a dry-stacked methodology (Bredenoord & Kulshreshtha, 2023; Ibitoye, Abiola, & Babamboni, 2023; Ibitoye, Alagbe, & Dare-Abel, 2022). Because structural integrity relies on the physical interlocking of the ridges rather than an external adhesive layer, the superstructure can be erected free of mortar joints, streamlining the assembly phase (Bredenoord et al., 2019; Ibitoye, Alagbe, & Dare-Abel, 2022; Ibitoye, 2025).

V. ECONOMIC AND ENVIRONMENTAL BENEFITS

➢ *Cost Efficiency and Material Reduction*

The economic viability of ISSB is primarily driven by the mortar-less walling system and the significant reduction in cement consumption (Bredenoord & Kulshreshtha, 2023; Ibitoye, Alagbe, & Dare-Abel, 2022; Ibitoye, 2025). Studies examining low-cost social housing confirm that ISSB structures can be considerably cheaper to construct than traditional housing, while also being less labor-intensive (Bredenoord & Kulshreshtha, 2023). In the Nigerian context, the elimination of wet mortar beds—combined with lower localized block costs—yields immediate capital savings during the initial masonry phase (Ibitoye, Alagbe, & Dare-Abel, 2022). Indexed comparative data reveals that a standard 1 m² sandcrete wall costs approximately ₦3,906.00, whereas an equivalent ISSB wall costs ₦3,420.00, resulting in a 12.44% raw capital reduction (Ibitoye, Alagbe, & Dare-Abel, 2022).

➢ *Reduction of Transportation Logistics*

Conventional masonry relies heavily on centralized manufacturing, requiring extensive logistics to transfer heavy materials to sites (Ibitoye, Alagbe, & Dare-Abel, 2022). Conversely, ISSB technology supports decentralized site-production frameworks (Ibitoye, Abiola, & Babamboni, 2023; Ibitoye, 2025). Because lateritic soil is universally distributed, the raw components can be harvested and pressed directly on-site using portable machines, significantly reducing heavy transportation expenses and supply chain emissions (Bredenoord & Kulshreshtha, 2023; Ibitoye, Abiola, & Babamboni, 2023; Ibitoye, Alagbe, & Dare-Abel, 2022).

➢ *Thermal and Acoustic Performance*

Experimental studies have reported lower indoor temperature fluctuations and reduced cooling demand in ISSB buildings due to the thermal mass characteristics of earth-based walls (Danjuma, 2020). The thermal conductivity of these blocks allows them to absorb and release moisture, creating a latent heat phenomenon that naturally regulates interior temperatures (Danjuma, 2020). Acoustically, laboratory and building-scale investigations have found that compressed earth masonry systems provide improved sound attenuation because of their density and mass characteristics (Bakam, Mbishida, & Danjuma, 2023). For instance, testing on a 230 mm thick ICSEB block demonstrated a highly effective sound absorption coefficient of 0.94 at 4000 Hz, surpassing conventional acoustic materials like plasterboard (Bakam, Mbishida, & Danjuma, 2023).

➢ *Environmental Sustainability*

Studies on earth-based construction materials consistently report lower embodied energy, reduced cement usage, and reduced greenhouse gas emissions compared with conventional masonry systems (Danjuma, 2020; Ibitoye, Abiola, & Babamboni, 2023; Okunlola & Ibitoye, 2026). Because the blocks are stabilized by mechanical pressure rather than kiln-firing, their carbon footprint remains shallow; manufacturing ISSB produces no gaseous or thermal pollution, contributing directly to sustainable urban development goals (Danjuma, 2020; Okunlola & Ibitoye, 2026).

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VI. LIMITATIONS AND CHALLENGES

➢ *Strict Soil Requirements:*

A critical limitation of ISSB technology is its dependency on highly specific raw material parameters (Bredenoord & Kulshreshtha, 2023; Okunlola & Ibitoye, 2026). Not all geographical topsoils are naturally suited for block stabilization; the earth must possess a balanced grain-size distribution to prevent volumetric expansion, cracking, or loss of cohesion (Bakam, Mbishida, & Danjuma, 2023; Ibitoye, Abiola, & Babamboni, 2023).

➢ *Quality Control Risks:*

Maintaining structural uniformity introduces substantial on-site quality control risks (Ibitoye, 2025). The durability of the blocks is tied directly to field discipline, including precise water-to-binder mix ratios and consistent physical compression force within the manual or hydraulic press (Ibitoye, 2025; Okunlola & Ibitoye, 2026).

➢ *Public Perception:*

ISSB adoption continues to face significant social hurdles (Ibitoye, Abiola, & Babamboni, 2023; Ibitoye, Alagbe, & Dare-Abel, 2022). The widespread adoption of compressed earth blocks has been slowed by negative social attitudes, as the populace often holds a stigma towards earth construction, viewing it as inferior to imported-style masonry (Hafez, El-Mahdy, & Marsh, 2023; Ibitoye, Alagbe, & Dare-Abel, 2022). Survey data from Egypt highlights that clients often perceive CEB as "low-quality" or exclusively for rural areas, underscoring a broader regional bias (Hafez, El-Mahdy, & Marsh, 2023).

VII. DISCUSSION

➢ *Economic Implications*

The findings indicate that ISSB wall systems achieve cost savings primarily through reduced cement consumption and the elimination of mortar joints (Bredenoord & Kulshreshtha, 2023; Ibitoye, Alagbe, & Dare-Abel, 2022). These savings are particularly important for low-income housing projects where wall construction constitutes a significant proportion of total building expenditure. The ability to utilize locally fabricated machines also promotes small-scale entrepreneurship and local job creation (Bredenoord & Kulshreshtha, 2023).

➢ *Sustainability Implications*

The use of locally sourced lateritic soils reduces dependence on energy-intensive industrial materials and may lower embodied carbon associated with transportation and cement production (Danjuma, 2020; Ibitoye, Abiola, & Babamboni, 2023; Okunlola & Ibitoye, 2026). The thermal mass properties further support sustainability by facilitating energy-efficient, passively cooled environments, which is highly advantageous for reducing overall operational energy consumption (Danjuma, 2020).

➢ *Housing Delivery Implications*

Although ISSB demonstrates economic and environmental advantages, widespread adoption remains constrained by public perception, regulatory limitations, quality-control challenges, and limited professional familiarity (Hafez, El-Mahdy, & Marsh, 2023; Ibitoye, Alagbe, & Dare-Abel, 2022; Ibitoye, 2025; Okunlola & Ibitoye, 2026). Addressing these constraints requires robust educational initiatives for both construction workers and the public, alongside policy interventions that explicitly incorporate earth building into national codes (Hafez, El-Mahdy, & Marsh, 2023).

VIII. CONCLUSION

Interlocking Stabilized Soil Block technology offers an economically viable and environmentally sustainable alternative to conventional masonry. By significantly reducing the consumption of cement, eliminating transport costs, and accelerating construction speed through dry-stacking, the financial benefits of ISSB are consistent with the urgent need for affordable housing delivery in Nigeria. To contribute to addressing the housing deficit, a systemic shift in construction practices is required. Policymakers, real estate developers, and urban planners must actively incentivize the adoption of ISSB technology, establishing standardized regulatory frameworks to overcome perceptive barriers and drive sustainable urban development.

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