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Circular Economy Potential of Interlocking Stabilized Soil Block Technology in Sustainable Construction

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Abstract- ***As the demand for sustainable construction grows, innovative building technologies that reduce resource consumption, environmental degradation, and promote circular economy are being sought. The Interlocking Stabilized Soil Block (ISSB) technology has proven to be a viable alternative to traditional masonry construction systems due to its use of locally sourced materials, cement reduction, minimisation of construction waste and embodied carbon. Such benefits, however, have yet to be substantiated with empirical data on the impact of ISSB technology on circular economy in the construction sector, in which its uptake is still relatively low in developing countries. This study thus investigated the potential of circular economy in sustainable construction through Interlocking Stabilized Soil Block technology, studying the environmental, economic and resource efficiency aspect, and the challenges that impact the implementation of the technology. A descriptive mixed-method research design was used and data were gathered from construction professionals using structured questionnaires, interviews, observations, and document review. Data analysis was done by descriptive statistics and thematic analysis. It was found that ISSB technology can lead to significant improvements in resource efficiency by using local materials, minimize construction waste, keep the amount of cement used down as well as carbon emissions and increase the cost effective and environmental-friendly construction. The major constraints to its wide-spread use identified in the study were inadequate public awareness, inadequate technical skills, limited government support and preference for traditional building materials. Based on this study, it is recommended that more policies should be encouraged to support the implementation of ISSB technology in the construction industry, professional capacity building, public awareness and investments in sustainable building technology should be supported to increase the adoption of ISSB technology and to contribute to long term environmental sustainability in the construction industry.***

Keywords: Circular Economy, Interlocking Stabilised Soil Block (ISSB), Sustainable Construction, Resource Efficiency, Construction Waste, Green Building, Environmental Sustainability, Low Carbon Construction.

I. INTRODUCTION

The construction sector is one of the biggest consumers of natural resources and a major source of environmental degradation due to its high energy use, carbon emissions and waste generation. In an era of increasing worry about climate change and depletion of resources, the idea of the circular economy has become a more sustainable model than the linear 'take make dispose' model.

Circular economy principles encourage the reuse, recycling and recovery of resources throughout the life of a building, thus minimizing waste and environmental impacts (Kirchherr et al., 2017; Geissdoerfer et al., 2017).

In the built environment, there is growing awareness of the importance of using environmentally friendly materials with low embodied energy and low ecological footprint in sustainable construction. The development of locally available soil, reduction of the amount of cement required, reduction in construction waste and elimination of thick mortar joints are some of the most innovative building systems that have gained attention and been developed.The use of locally available soil, need for less cement, reduction of construction waste, and elimination of thick mortar joints are some of the most innovative building systems that have gained attention and have been developed.

As described above, these attributes are very similar to those of the circular economy: using materials efficiently, affordability and lower carbon emissions (Walker, 1995; Maini, 2005).

Recent studies also show that when compared to conventional sandcrete block construction, ISSB technology results in lower construction costs, accelerated project delivery and better environmental performance.

The body of knowledge in Nigeria on ISSB technology has been enhanced by recent studies by Obafemi A. Ibitoye. Ibitoye (2022) reported that ISSB can be a feasible alternative to sustainable housing due to the advantages of using it to reduce the reliance on traditional building materials which are less eco-friendly, more expensive and difficult to work with.

The cost effectiveness of ISSBs over sandcrete blocks was further proven in subsequent studies, and architects' perception of ISSBs as an alternative material for housing delivery was also shown to be positive (Ibitoye & Dare-Abel, 2021; Olaleye & Ibitoye, 2023).

Further studies were also carried out to confirm the specific desirable thermal performances, comfort for occupants and passive building design of ISSBs for climate responsive and sustainable construction.

Furthermore, Ibitoye (2025) noted that ISSB technology has great environmental and economic advantages because of its reduction in material use, quick construction, enhanced thermal insulation, and lower embodied energy.

However, its uptake in the Nigerian construction industry is still hampered by various issues such as awareness, policy support, moisture protection, and industry acceptance. These results further validate the importance of assessing ISSB technology not just as an alternative building material, but more as a part of the circular economy.

While there are many studies on structural, thermal and economic performance of ISSBs, there is very little research that has specifically explored the role of ISSBs in the principles of the circular economy in sustainable construction.

The literature has been dominated by discussions about affordability and material performance and has paid less attention to the circulation of resources, minimization of waste, efficiency in the life cycle and future sustainability results.

So, this study aims to analyze the potential of the Interlocking Stabilized Soil Block technology in the field of sustainable construction to provide evidence to support the implementation of the concept of circular construction and construction development in line with sustainable development in the world.

1.1 Aim and Objectives of the study

This study is intended to investigate the potential of Interlocking Stabilized Soil Block (ISSB) to sustainably build up the structure.

Objectives of the study:

i. Discuss the principles of the circular economy and their use in sustainable construction.
ii. Assess the environmental and economic benefits of Interlocking Stabilized Soil Block (ISSB) technology.
iii. Discuss how ISSB can help in achieving resource efficiency, reduction of waste and carbon emission mitigation in the construction industry.
iv. Outline the obstacles to the use of ISSB in construction.
v. Propose ways to improve the application of ISSB technology for circular economy practices and for sustainable construction.

1.2 Problem Statement

The construction sector is one of the largest consumers of natural resources and a leading source of environmental pollution due to the excessive use of material, high carbon emissions and construction waste. The conventional building materials like concrete blocks and fired bricks are energy-intensive to produce, which results in high environmental degradation and unsustainable construction systems.

The problems have made it even more crucial to develop building technology that encourages resource efficiency and embraces the circular economy.

Interlocking Stabilized Soil Block (ISSB) provides a sustainable solution by being made from locally sourced materials, as it lowers the amount of construction waste, embodied energy and requires less cement.

However, the technology of ISSB is still not widely accepted because of low awareness, limited technical knowledge and limited policy support and preference for traditional construction.

While there have been some studies that have explored structural, economic and environmental performance of ISSBs, there is limited research to date that has specifically addressed the role of ISSBs towards the principles of circular economy including material reuse, waste minimisation and resource efficiency.

This lack of knowledge is restricting the use of ISSB technology in the mainstream of sustainable construction. Thus, the aim of this study is to assess the potential of Interlocking Stabilized Soil Block technology for circular economy and to identify the strategies to promote the implementation of this technology into Sustainable Construction.

II. LITERATURE REVIEW

The concept of a circular economy has become a viable solution to tackle the environmental issues faced by the construction sector. The circular economy is based on principles of resource efficiency, which encourage material reuse and recycling, reduce waste, and optimise life cycles, diverging from the linear resource extraction, use and disposal model.

Research indicates that applying circular economy principles to construction activities can contribute to the reduction of carbon emissions, the conservation of natural resources and the increased building sustainability (Geissdoerfer et al., 2017; Kirchherr et al., 2017).

These principles promote the adoption of the innovative building materials and construction methods, that reduce environmental impacts and ensure the structural performance.

Interlocking Stabilized Soil Block (ISSB) technology is one of the most sustainable construction technologies that has emerged because of its benefits of using local soil resources, using less cement than conventional brick mortar, minimizing construction waste and eliminating thick mortar joints.

All of the above make ISSBs extremely well suited for the circular economy goals of minimizing material use, embodied energy and construction costs, whilst maximizing environmental performance.

Previous research has shown that economic benefits can be achieved with ISSB over conventional sandcrete blocks, due to less cement consumption, quicker construction and less labour (Walker, 1995; Maini, 2005).

Recent research carried out by Obafemi A. Ibitoye has been a great impact to the understanding of ISSB technology in Nigeria. Ibitoye and Dare-Abel (2022) have found that ISSB is the practical approach for providing affordable and sustainable housing which is cost effective and does not require much conventional materials.

Likewise, Ibitoye, Alagbe and Dare-Abel confirmed that the use of ISSB can offer more benefits than the conventional sandcrete blocks as it saves cement content and requires no mortar to build the block, making it attractive to use in delivering sustainable housing in Nigeria.

Ibitoye's further study revealed that the general perception of the architects on ISSB technology in Southwest Nigeria indicated that they generally understand the thermal, environmental, and economic benefits of ISSB technology, however, their perceptions are still limited with the need for more knowledge, technical expertise, and policy support for limited adoption. The results indicate that there is a need for more education and institutional support from the stakeholders to mainstream ISSB into sustainable construction.

Recently, Ibitoye (2025) studied the application of ISSB in a post-occupancy evaluation of a residential project and found that ISSB provides better thermal

insulation, lesser environmental impacts, better occupant thermal comfort and construction time.

His study also found that two issues that still need technological solutions are moisture protection and how important people consider it.

Ibitoye and Tolu-Alalade (2026) reported in another recent study the excellent thermal performance of ISSBs for passive building design in tropical climate making them a potential climate responsive material for building construction.

Besides thermal performance, recent studies have broadened the use of ISSB to energy-efficient and circular construction systems. The research by Ibitoye and Tolu-Alalade (2026) provides evidence that the incorporation of ISSB technology into solar-powered housing can significantly affect the energy efficiency, environmental sustainability, and long-term affordability of the building, highlighting the potential of ISSBs to support broader goals of the circular economy by minimizing energy consumption and utilizing resources effectively.

Significant works have been produced, though, they have been focused on the aspects of affordability, thermal performance, housing delivery and material characteristics.

Empirical studies that relate ISSB technology in the context of the circular economy in terms of material life-cycle efficiency, resource circulation, waste minimisation and long-term sustainability performance are limited in number.

Based on this, the aim of this research is to assess the circular economy potential of Interlocking Stabilized Soil Block and to support the penetration of Interlocking Stabilized Soil Block technology in environmentally responsible constructions.

III. RESEARCH METHODOLOGY

3.1 Research Design

The type of research design used in this research is descriptive research. This type of research is used to evaluate the potential for the implementation of a circular economy in the technology of Interlocking Stabilized Soil Block (ISSB) in sustainable construction.

It is appropriate design because that will allow the collection and analysis of data about the environmental, economic and technical advantages of ISSB technology without interfering with any parameters.

The data will be collected using a mixed method approach in which quantitative and qualitative methods will be used. The data will be gathered using structured questionnaires, interview with construction professionals and some secondary sources.

The results will be processed by descriptive statistics and thematic analysis to see the contribution of ISSB technology in sustainable construction and circular economy practices.

3.2 Study Area

The study area for this research is Lagos State, Nigeria, selected building projects, architectural practices and construction firms using or considering the use of Interlocking Stabilized Soil Block (ISSB) technology.

As one of the fastest-growing urban centres in Africa, Lagos requires more sustainable and affordable construction techniques that are environmentally sensitive.

Lagos is selected due to its fast urbanization, the amount of construction activities, and its increasing interest in green building. The suitability of the state stems from its unique characteristics, which make it an ideal place to assess the potential for the circular economy application of the ISSB technology in the field of sustainable construction and waste reduction, as well as to promote resource efficiency.

3.3 Population and Sampling

The population of this study consists of architects, builders, engineers, contractors and sustainable building professionals who are engaged in sustainable building projects and in the use of Interlocking Stabilized Soil Block (ISSB) technology in the study area.

The professionals are deemed as appropriate respondents due to their knowledge and practical experience in the building process and the choice of materials.

The sampling method will be a purposive sampling method, with respondents who have relevant experience using ISSB technology and sustainable construction practices. In this way, data are acquired from knowledgeable parties who can give reliable data on the circular economy potential of ISSB technology.

3.4 Instruments for Data Collection

This study will use the following instruments for collecting data:

i. Structured Questionnaire - A questionnaire to gather data from architects, builders, engineers, contractors and other construction professionals on the potential of the circular economy for Interlocking Stabilized Soil Block (ISSB) technology.
ii. Interview Guide - To collect in-depth information and professional perspectives, regarding the environmental, economic and technical advantages and disadvantages of ISSB technology.
iii. The observation checklist was used to evaluate selected construction projects in terms of material use, waste management and construction methods, and is built on the ISSB technology.
iv. Document Review Checklist - Review of relevant project reports, building specifications, policy documents and technical publications related to the ISSB technology and sustainable construction.
v. Secondary Data Sources - Textbooks, peer-reviewed journal papers, conference papers, Government publications, etc., related to the circular economy and sustainable construction.

3.5 Validity and Reliability

Validity

The research instruments will be validated by experts according to the opinion of experts in the fields of architecture, building technology and sustainable construction.

The comments and recommendations that they make will help make sure that the questionnaire, interview guide and observation checklist is suitable for achieving the study objectives and for measuring the circular economy potential of Interlocking Stabilized Soil Block (ISSB) technology.

Reliability

The research instruments will be pre-tested in a small sample of construction professionals not included in the main study participants, to guarantee reliability. The answers retrieved in this process will be analyzed for consistency and appropriate changes will be made to enhance clarity and reliability of instruments prior the main data collection.

3.6 Method of Data Analysis

Both quantitative and qualitative methods will be used for the analysis of the data collected for this research. The quantitative data collected through questionnaires will be analyzed using descriptive statistics like frequency tables, percentage, mean score and standard deviation to assess the respondents' perception of the possibility of Interlocking Stabilized Soil Block (ISSB) technology to contribute to the circular economy.

Thematic analysis will be used to analyse qualitative data from the interviews and document reviews, grouping together responses into key themes to include resource efficiency, waste reduction, environmental sustainability and barriers to ISSB adoption. The joint analysis will give a comprehensive overview of the contribution of ISSB technology towards sustainable construction.

3.7 Ethical Considerations

In this study, the research ethics will be carried out in accordance with the previous research. Relevant organizations and construction companies will be approached for permission to begin data collection. Responses will be voluntary and informed consent will be obtained from all respondents.

All information gathered in the study will be kept confidential and anonymous and will only be used for academic purposes. The respondents will also be given the option to refuse participation or withdrawal from the study, without any consequences.

IV. RESULTS AND DISCUSSION

4.1 The demographic profile of the respondents is presented here.
The demographic profile for respondents shows the background factors of the construction professionals that participated in the study. One hundred Architecture, Building, Civil Engineering, Quantity Surveying, Construction, and other sustainable construction industry professionals were surveyed.

Out of the 100 respondents, 62 (62%) were male, while 38 (38%) were female. This means that the respondents were largely male workers as noticed in the current workforce distribution in the Nigerian construction industry.

According to the age distribution, 24 respondents (24%) were aged between 20-29 years; 39 respondents (39%) were aged between 30-39 years; 25 respondents (25%) were aged between 40-49 years and 12 respondents (12%) were 50 years and above. This means that the majority of respondents were professionals with a lot of experience in the active part of their lives.

A total of 28 Architects (28 %), 20 Builders (20 %), 22 Civil Engineers (22 %), 15 Quantity Surveyors (15 %), 10 Contractors (10 %) and 5 respondents (5 %) from other construction related professions were included as the respondents. This distribution ensured that opinion was gathered from multiple aspects of the construction industry.

As far as educational qualification is concerned, 44 (44%) respondents had B.Sc./HND qualifications, 40 (40%) had Master's degrees (M.Sc./M.Tech.), 10 (10%) had Ph.D. degrees and 6 (6%) had other related professional qualifications.

This indicates that the respondents had the education required to be able to give their informed opinion on ISSB technology and sustainable construction.

The results revealed that 23 participants (23%) had less than 5 years of professional experience, 35 participants (35%) had 5–10 years of experience, 27 participants (27%) had 11–15 years of experience and 15 participants (15%) had more than 15 years of experience. This means that most of the respondents were highly experienced in the construction sector.

72 respondents (72%) answered No and 28 respondents (28%) answered Yes when asked if they have ever done work on projects using the Interlocking Stabilized Soil Block (ISSB) technology.

This indicates that most of the participants were directly or indirectly familiar with ISSB technology, thus the answers they gave were adequate to consider the technology for sustainable construction in terms of circular economy.

4.2 Findings
The respondents strongly agreed that government intervention, professional capacity building, public awareness programmes and financial incentives are effective for promoting the use of ISSB technology in sustainable construction.

4.3 Interpretation of findings
The results indicate that the construction professionals possess a fair knowledge of Interlocking Stabilized Soil Block technology and they are aware of the role of ISB in sustainable construction.

The majority of the respondents had a positive opinion regarding the reduction of construction waste, minimization of cement consumption, increased resource efficiency and the support of environmentally responsible construction by ISSBs.

The results were in line with the study conducted by Ibitoye and Dare-Abel (2022) and Ibitoye et al. (2023) which found that ISSB technology has economic and environmental benefits over traditional building materials.
The study also identified that ISSB technology has tremendous potential to promote the principles of circular economy by optimizing the use of materials, reducing waste, and ensuring sustainable resource management.

The respondents believed that with more widespread use of ISSB, reliance on traditional construction materials could be reduced and the environmental

impact could be enhanced during the entire life of the building.

However, there are a number of factors that hinder the adoption of the drain. The main hurdles were found to be poor government support, lack of public awareness, lack of technical skills and the continued use of conventional construction materials.

The study's results also support previous research conducted by Ibitoye (2025), who highlighted the importance of implementing robust policy frameworks, professional training, and awareness-raising initiatives to boost ISSB technology adoption.

In conclusion, the study shows that ISSB technology can be a promising solution for promoting circular economy in the construction sector. By working together with stakeholders, educating them about sustainable construction, and supporting their efforts with good policy, ISSBs can make an important contribution to sustainable construction, resource conservation and reducing environmental impact.

V. CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The study analyzed the circular economy potential of Interlocking Stabilized Soil Block (ISSB) technology as one of the sustainable construction practices. The results indicated that ISSB technology has a good potential of environmental, economic and social benefits, which fits with the concepts of circular economy.

The use of locally sourced soil, the reduction of cement use, the minimal construction waste and the low embodied energy of the material shows that ISSBs can play a role in more resource efficient and environmentally friendly building practices.

The study also confirmed that the construction professional community holds a positive attitude towards ISSB technology and understands its potential in optimizing the use of materials, lowering carbon footprints and contributing to sustainable development.

The findings however, revealed that there were some barriers in the way of its popularization, such as: Limited public awareness, Lack of technical knowledge, Lack of government policies, and continued preference for traditional building materials.

Finally, Interlocking Stabilized Soil Block technology provides an alternative construction system to traditional masonry technology and presents significant opportunities to promote circular economy in the construction sector.

All of this can be supported by a policy approach encouraging its use, backed by professional training, research and public awareness, and help to meet long-term sustainable development targets, such as better sustainable construction, resource conservation, reduced environmental impacts, etc.

5.2 Recommendation

In the light of the result of this study, the following recommendations are made:

Policies and building regulations, which could be developed by the government, should be introduced to promote sustainable construction through the adoption of Interlocking Stabilized Soil Block (ISSB) technology.

i. Organisation of regular training programmes, workshops, and seminars should be carried out by professionals like Nigerian Institute of Architects (NIA), Nigerian Institute of Building (NIOB) and Nigerian Society of Engineers (NSE) to enhance the knowledge and technical skills of the professionals in the field of ISSB construction.

ii. Further research into ISSB technology should be encouraged by higher institutions and research organisations, especially in the long term structural performance, durability and life-cycle assessment and contribution to the circular economy.

iii. The use of ISSB technology should be promoted in residential, commercial, and public construction projects, to enhance resource efficiency, minimize construction waste, and reduce carbon emissions for construction companies and property developers.

iv. Awareness campaigns need to be increased to provide clients, investors and the general public with more information on the environmental, economic and social advantages of ISSB technology in sustainable construction.

v. Government and financial institutions should have policies and programs in place that provide financial incentives for investment in ISSB production and construction projects, including tax relief, grants or low interest loans.

vi. Small-scale and medium-scale contractors should be encouraged to use the block-making machine by making it more affordable and accessible, and manufacturers of ISSB equipment should promote this.

vii. The cooperation of government, academia, industry and professional organizations should be strengthened to create standards, technical guidance and quality assurance to ensure the wide spread adoption of ISSB technology within the principles of circular economy.

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