Challenges and Opportunities in Adopting Hydraform Technology for Special Needs School Construction in Osogbo

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Abstract-Amid growing demand for environmentally responsible and inclusive infrastructure in developing countries, this research explores the challenges and opportunities associated with adopting Hydraform brick technology for the construction of special needs schools in Osogbo, Nigeria. Hydraform bricks, known for their thermal efficiency, sustainability, and cost-saving potential, present a viable alternative to traditional building materials. Despite these advantages, widespread implementation remains limited due to barriers such as material scarcity, high initial costs, labour skill gaps, and inadequate policy support. A descriptive survey method was employed to gather data from 137 built environment professionals, including architects, engineers, and builders. The results show generally positive perceptions of Hydraform bricks, especially in relation to Osogbo's climate and the material's long-term economic and environmental benefits. However, professionals also identified critical limitations affecting scalability and practical use. The study recommends targeted interventions, including localized production facilities, skill development initiatives, public awareness campaigns, and supportive regulatory frameworks. These strategies are essential to unlocking the full potential of Hydraform technology in achieving sustainable, inclusive educational infrastructure in Nigeria.

Index Terms- Hydraform bricks Sustainable construction Special needs schools Inclusive design Building materials. Osogbo, Nigeria

I. INTRODUCTION

The demand for sustainable and inclusive educational infrastructure is rising globally, particularly in developing nations like Nigeria, where rapid urbanization continues to outpace the growth of resilient and accessible public facilities. Special needs schools face even greater challenges, as they must not only meet basic construction standards but also address complex requirements related to accessibility, sensory comfort, and long-term affordability. In this context, the search for alternative building materials that are cost-effective, environmentally friendly, and locally adaptable has brought Hydraform brick technology into focus.

Hydraform bricks are interlocking compressed earth blocks produced through a hydraulic pressing process that combines soil, sand, and stabilizing agents such as cement. Unlike conventional fired clay bricks, Hydraform blocks are not kiln-baked, significantly reducing energy consumption and carbon emissions (Surwade & Kamal, 2023). Their interlocking mechanism minimizes the use of mortar, accelerates construction timelines, and enhances structural integrity all while offering excellent thermal and acoustic insulation (Adedeji, 2011; Victor & Ayobami, 2023). These characteristics make Hydraform a promising solution for educational buildings that require durable, low-maintenance, and climate-responsive performance.

While the benefits of Hydraform technology have been demonstrated in housing and general institutional projects across Africa, its application in constructing special needs schools remains underexplored, particularly in Nigeria. Previous studies have evaluated its cost-effectiveness and mechanical performance (Aligamhe et al., 2020; Jayasinghe & Mallawarachchi, 2009), but few have assessed its compatibility with inclusive design standards or gathered feedback from construction

professionals actively working in this niche. The nuanced requirements of special needs environments such as barrier-free access, sensory-friendly spaces, and long-term durability demand that any construction technology be evaluated not only for its technical merit but also for its adaptability to specialized educational settings.

In Osogbo, the capital of Osun State in Southwest Nigeria, these challenges are particularly pressing. Despite a growing need for inclusive education infrastructure, many schools continue to rely on traditional building materials that are too costly, environmentally damaging, or ill-suited to the needs of students with disabilities. Hydraform bricks, with their potential for local sourcing and environmental performance, offer an alternative pathway but their real-world application remains limited due to perceived barriers including high initial investment, skill gaps among labourers, and regulatory uncertainties.

This study aims to investigate the challenges and opportunities associated with the adoption of Hydraform technology in the construction of special needs schools in Osogbo. By drawing on empirical data collected from built environment professionals including architects, engineers, and builders the research identifies key factors influencing adoption, evaluates Hydraform's perceived strengths and limitations, and offers context-specific recommendations to promote its effective use in inclusive school design.

II. STUDY AREA

Osogbo capital of Osun lies on coordinates 7°46′ North 4°34′East with an area of 47kmsq. According to the 2006 Population and Housing Commission Census, the city has a population of 156,694 people. Osogbo shares boundary with Ikirun, Ilesa, Ede, Egbedore and Iragbiji and is easily accessible from any part of the state because of its central nature. It is about 48km from Ife, 32km from Ilesa, 46km from Iwo, 48km from Ikire and 46km from Ila-Orangun. Osogbo is a commercial and industrial centre. The city experiences a tropical climate with distinct wet and dry seasons. The climate is characterized by moderate temperatures and significant rainfall, which influences construction practices and material selection.

Osogbo has several educational institutions, including primary, secondary, and tertiary schools. However, there is a notable need for specialized educational facilities that cater to students with special needs. Existing schools often lack the necessary accessibility features and sustainable building practices. Construction Practices: The construction industry in Osogbo, like many parts of Nigeria, faces challenges such as high material costs, limited access to sustainable building materials, and the need for improved construction techniques. The use of alternative materials like Hydraform bricks presents an opportunity to address these challenges.

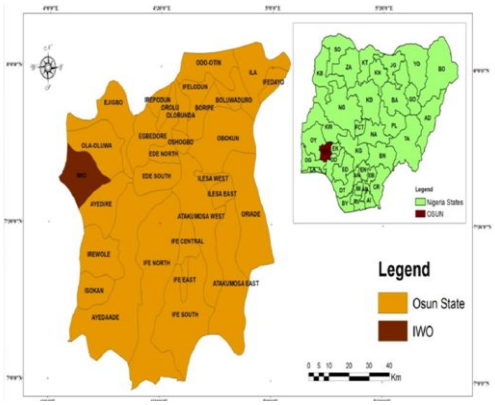


Figure 1: Map of Nigeria indicating Osun state with Osogbo as the capital.

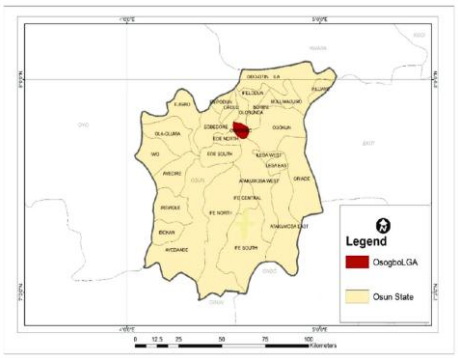


Figure 2: Map of Osun state indicating Osogbo L.G.A

III. LITERATURE REVIEW

Challenges and Opportunities in Using Hydraform Bricks

The adoption of Hydraform bricks in Nigeria faces significant challenges that hinder widespread use while also presenting valuable opportunities for sustainable construction, particularly in educational settings.

Challenges in Using Hydraform Bricks

i. Economic Barriers: One of the primary challenges is the initial investment required for establishing production facilities for Hydraform bricks. The costs associated with machinery, training, and setting up a production facility can be considerable. Many contractors and educational institutions operate under tight budgets, making this financial outlay daunting. Additionally, limited access to financing options exacerbates this issue, as small-scale builders often struggle to secure loans or grants to invest in new technologies (Ogunbanjo et al., 2021).

ii. Market Perception: Market perception plays a critical role in the adoption of Hydraform bricks. Stakeholders within the construction industry, including architects and clients, may view these bricks as unproven or inferior compared to traditional materials. This skepticism often arises from a lack of awareness regarding the benefits of Hydraform bricks, including their sustainability and cost-effectiveness. Without comprehensive educational initiatives to inform industry professionals about the advantages and performance of Hydraform technology, adoption rates may remain low (Obi et al., 2022).

iii. Quality Control Issues: Quality control also presents a significant barrier. Variability in soil composition and production techniques can lead to inconsistencies in the strength and durability of Hydraform bricks. Without standardized production processes and rigorous quality assurance measures, stakeholders may fear potential failures, which could further deter adoption. Establishing industry standards is essential to build trust in the reliability of Hydraform bricks (Nwankwo et al., 2021).

iv. Technical Knowledge Gaps: The lack of technical knowledge among local builders is another critical factor influencing the adoption of Hydraform bricks. Many builders lack the skills and experience necessary for effective production and construction. This gap in expertise can lead to improper application and compromise the structural integrity of buildings. Comprehensive training programs are vital to equip construction professionals with the necessary knowledge (Akanbi et al., 2023).

v. Regulatory and Policy Challenges: Inconsistent building regulations and a lack of supportive policies can create uncertainty for stakeholders considering the use of alternative building materials. Advocacy for policies that recognize and support sustainable building practices is crucial for fostering an environment conducive to the adoption of Hydraform bricks (Ogunleye et al., 2022).

Opportunities for Using Hydraform Bricks

i. Growing Demand for Sustainable Materials: Despite these challenges, substantial opportunities exist for promoting the use of Hydraform bricks in Nigeria. With increasing awareness of environmental sustainability, there is a growing demand for eco-friendly construction materials. Hydraform bricks, made from locally sourced soil and produced with less energy, align well with this trend. Educational institutions can advocate for sustainable practices, potentially attracting funding and support from governmental and non-governmental organizations focused on sustainability (Oni et al., 2021).

ii. Government Initiatives: Government initiatives aimed at promoting sustainable building practices can facilitate the adoption of Hydraform technology. By aligning with these initiatives, stakeholders can access resources that support the transition to more sustainable materials. Engaging with government agencies can also help secure funding for projects utilizing Hydraform bricks (Ademola et al., 2022).

iii. Community Engagement and Education: Community engagement is essential in overcoming the knowledge gap surrounding Hydraform technology. Implementing training programs to educate builders and engineers about the production and application of Hydraform bricks can foster a supportive environment for adoption. Empowering local communities with knowledge about

sustainable construction methods can enhance acceptance and utilization of Hydraform technology (Adetola et al., 2023).

iv. Collaborative Partnerships: Collaboration among educational institutions, governmental bodies, and non-governmental organizations can create synergies that promote the use of Hydraform bricks. Such partnerships can facilitate knowledge sharing and joint initiatives aimed at demonstrating the effectiveness of Hydraform bricks in construction. Showcasing successful case studies can build momentum for broader adoption of this sustainable technology.

Strategies for Overcoming Challenges and Future Development in Using Hydraform Bricks

The integration of Hydraform bricks into construction, particularly for educational facilities in Nigeria, requires targeted strategies to enhance adoption. One predominant economic barrier is the initial investment required for setting up production facilities and training personnel. Public-private partnerships can play a crucial role in addressing these financial hurdles. By collaborating with governmental bodies, private enterprises can gain access to funding opportunities that mitigate initial costs associated with Hydraform technology. Initiatives such as low-interest loans, grants, and subsidies can help contractors invest in production equipment and training programs (Ogunbanjo et al., 2021).

i. Awareness and Educational Initiatives: To further enhance adoption, it is essential to implement awareness and educational initiatives targeted at construction sector stakeholders. Organizing comprehensive training programs, workshops, and seminars that focus on the benefits and applications of Hydraform technology can significantly shift perceptions among builders and architects. Studies indicate that stakeholders exposed to practical demonstrations and success stories of Hydraform brick usage tend to be more inclined to adopt these materials in their projects (Obi et al., 2022).

ii. Standardized Production Protocols: Establishing standardized production protocols and quality assurance mechanisms is vital for ensuring the reliability of Hydraform bricks. The development of comprehensive guidelines and certification programs can standardize quality across different production sites. Implementing a certification system for manufacturers could instill confidence among consumers and builders regarding the performance and durability of Hydraform bricks (Nwankwo et al., 2021).

iii. Vocational Training Programs: Addressing technical skill gaps through targeted vocational training programs is essential for optimizing the use of Hydraform bricks. Collaboration between educational institutions, industry professionals, and local governments can facilitate skill development in the production and application of these bricks. Enhanced training can improve builders' and engineers' competencies, increasing the overall quality of construction projects that utilize Hydraform bricks (Akanbi et al., 2023).

iv. Policy Advocacy: Engaging in policy advocacy to create a supportive regulatory environment for sustainable building materials is crucial. Advocacy efforts aimed at influencing government policies can lead to the implementation of incentives for using Hydraform bricks in construction, such as tax credits and expedited permitting processes for eco-friendly projects (Ademola et al., 2022).

v. Community Involvement: Finally, fostering community engagement in the construction process presents significant social and economic benefits. Involving local communities in the production and application of Hydraform bricks can create job opportunities and stimulate local economies. Community-driven projects that utilize Hydraform technology not only serve as educational platforms but also enhance social cohesion as communities work together towards common goals (Adetola et al., 2023). This participatory approach can empower communities, instilling a sense of ownership and pride in sustainable building practices, ultimately leading to greater acceptance and support for Hydraform bricks.

IV. RESEARCH METHODOLOGY

Research Design

This study employed a descriptive survey design to explore the challenges and opportunities associated with the adoption of Hydraform bricks in constructing special needs schools in Osogbo, Nigeria.

Study Area and Population

The study was conducted in Osogbo, Osun State, Nigeria, a region experiencing growing demand for inclusive and sustainable educational infrastructure. The target population consisted of registered built environment professionals including architects, builders, and engineers—actively engaged in construction projects within the study area. These professionals were selected due to their relevant expertise in material selection and school design.

Sampling Technique and Sample Size

A multi-stage sampling technique was employed:

Stage 1: Purposive selection of Osogbo as the study location due to its regional significance and the availability of professionals working on local infrastructure.

Stage 2: Random sampling of professionals from the 2024 registers of their respective professional bodies:

Architects Registration Council of Nigeria (ARCON) -- 32 architects

Council of Registered Builders of Nigeria (CORBON) --68 builders

Council for the Regulation of Engineering in Nigeria (COREN) 10 structural engineers and 27 civil engineers

A total of 137 respondents participated in the study, comprising:

Data Collection Methods

Primary Data

Structured Questionnaires: These were administered to gather quantitative data on respondents' views regarding Hydraform bricks. Items addressed factors such as material performance, cost implications, sustainability, and perceived adoption challenges.

Secondary Data

Literature Review: Scholarly publications, government reports, and technical documents were reviewed to provide context for sustainable building practices and Hydraform technology.

Online Databases and Archives: Additional data was sourced from professional repositories and construction-industry reports to support the interpretation of primary findings.

Data Analysis

Quantitative responses from questionnaires were analyzed using descriptive statistics, including frequencies, percentages, means, and weighted averages. This approach ensured a comprehensive understanding of the opportunities and constraints affecting adoption.

V. FINDINGS

Challenges and Opportunities of Using Hydraform Bricks for School Construction in Osogbo, Nigeria.

Table 1 presents the evaluation of challenges and opportunities of using Hydraform bricks for school construction in Osogbo, Nigeria. The responses from built environment professionals provide insights into the availability, feasibility, adaptability, and economic impact of Hydraform bricks in the region. The highest level of agreement is recorded for the statement that there are challenges in adapting local construction practices to incorporate Hydraform bricks, which received a Total Weighted Value (TWV) of 622 and an average weighted mean score of 4.54. This shows a significant concern among professionals regarding the need for specialized skills and construction techniques when using Hydraform bricks in Osogbo.

Conversely, the statement that there are more opportunities than challenges in using Hydraform bricks for school construction received a TWV of 520 and a mean score of 3.80, showing a generally positive perception despite the existing difficulties. This reveal that while challenges exist, they can be overcome through proper training, policy interventions, and industry adaptation. Regarding local climate suitability, the statement that the local climate in Osogbo is suitable for Hydraform brick construction scored a TWV of 590 and an average weighted mean score of 4.31, showing strong professional consensus that environmental conditions in Osogbo favor the use of Hydraform bricks.

On the other hand, the availability of Hydraform bricks in Osogbo received a lower agreement level (TWV = 459, average weighted mean score = 3.35), showing moderate concerns about accessibility and supply chain limitations. Similarly, the availability of labor for Hydraform brick construction was perceived as feasible (TWV = 533, mean score = 3.89), reinforcing the idea that labor adaptation is possible with proper training. The economic benefits of Hydraform bricks were acknowledged, with the statement that Hydraform bricks contribute to local economic development by creating jobs scoring a TWV of 591 and an average weighted mean score of 4.31. This shows that while some professionals see potential job creation, others believe that the specialized nature of Hydraform construction limits employment opportunities compared to traditional methods.

One of the most significant challenges highlighted is the cost of transportation of Hydraform bricks in Osogbo, which scored a TWV of 555 and a mean score of 4.05, showing that logistical challenges remain a barrier to widespread adoption. Additionally, the insufficient local supply of Hydraform bricks for large-scale construction received a TWV of 377 and an average weighted mean score of 2.75, showing that material shortages pose a considerable constraint to expansion efforts.

The findings reveal that Hydraform bricks hold potential for school construction in Osogbo, particularly due to their climate suitability, adaptability, and economic benefits. However, challenges related to skill adaptation, availability, and transportation costs need to be addressed to fully capitalize on these opportunities. A key implication is the need for capacity building and training programs to help local construction professionals adapt their techniques to accommodate Hydraform bricks. Additionally, investment in local production facilities will help reduce transportation costs and increase the availability of Hydraform bricks for large-scale construction projects.

Table 1 Evaluation of Challenges and Opportunities of Using Hydraform Bricks for School Construction in Osogbo, Nigeria Index

Statement	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)	Total Frequency (f)	TWV	TWV/f	Range
The availability of Hydraform bricks in Osogbo is sufficient for large-scale school construction.	18	14	35	42	28	137	459	3.35	0.56
The local climate in Osogbo is suitable for the use of Hydraform bricks in construction.	5	2	15	39	76	137	590	4.31	-0.4
There are challenges in adapting local	0	0	9	45	83	137	622	4.54	-0.63

construction practices to incorporate Hydraform bricks.									
Hydraform bricks are readily available for use in Osogbo, Nigeria.	16	8	28	33	52	137	508	3.71	0.2
Training of local labour to use Hydraform bricks is a feasible option for Osogbo.	12	5	25	39	56	137	533	3.89	0.02
Hydraform bricks are a viable alternative for construction in Osogbo compared to traditional materials.	0	0	22	42	73	137	599	4.37	-.0.46
There are more opportunities than challenges in using Hydraform bricks for school construction in Osogbo.	16	8	20	37	56	137	520	3.80	0.11
The cost of transportation for Hydraform bricks in Osogbo is a significant challenge.	10	3	23	35	66	137	555	4.05	-0.14
Hydraform bricks contribute to local economic	5	2	19	30	81	137	591	4.31	-0.4

development in Osogbo by creating jobs.									
There are insufficient local suppliers of Hydraform bricks in Osogbo for large-scale construction.	45	22	15	32	23	137	377	2.75	1.16
								39.08/10	
								3.91	0.07

Source: Author's Field Survey, 2025

Biggest Challenge in Using Hydraform Bricks for Construction in Osogbo

The data in Figure 1 presented the respondent response to what is the biggest challenge in using Hydraform bricks for construction in Osogbo. The challenges identified include the limited availability of materials, lack of skilled labour, high initial costs, and local climate issues. Among these, the most significant challenge varies across different

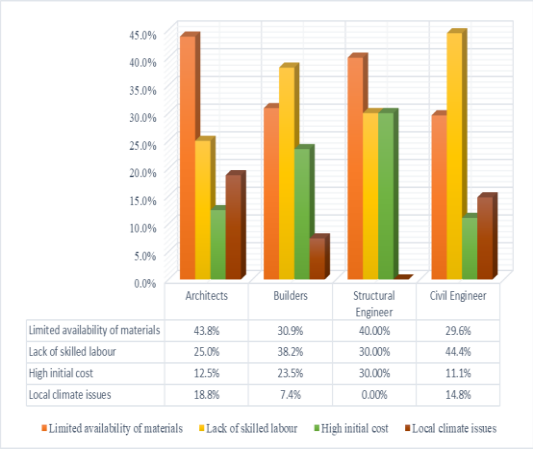
professional groups, showing diverse perspectives on the practical difficulties of using Hydraform bricks.

The limited availability of materials was highlighted as a major concern, particularly among architects (43.8%) and structural engineers (40.0%). This reveal that sourcing Hydraform bricks and their required materials is difficult in the region, hindering widespread adoption. Builders (30.9%) and civil engineers (29.6%) also acknowledged this issue, showing that supply chain limitations could impact project feasibility. The lack of skilled labor emerged as another key challenge, especially among civil engineers (44.4%) and builders (38.2%). This shows that while Hydraform bricks offer potential benefits, the specialized skills required for their proper handling and construction might be lacking in

Osogbo. Structural engineers (30.0%) and architects (25.0%) also recognized this challenge, emphasizing the need for targeted training and capacity-building initiatives to enhance workforce competency.

High initial costs were a notable concern, particularly among builders (27.3%) and structural engineers (30.0%). While Hydraform bricks may offer long-term cost benefits, the upfront expenses associated with production, transportation, and construction could be a deterrent. Architects (12.5%) and civil engineers (11.1%) rated this challenge lower, showing that cost concerns might be more relevant to those directly involved in the procurement and budgeting aspects of construction projects. Local climate issues were identified as a minor challenge, with architects (18.8%) and civil engineers (14.8%) acknowledging potential environmental factors that could affect the performance of Hydraform bricks. However, structural engineers did not consider climate a major issue (0.0%), revealing that the material is structurally suitable for the region. Overall, the findings reval that while Hydraform bricks offer promising advantages, their adoption in Osogbo faces significant challenges related to material availability, workforce skills, and initial costs.

Figure 1 What Is the Biggest Challenge in Using Hydraform Bricks for Construction in Osogbo



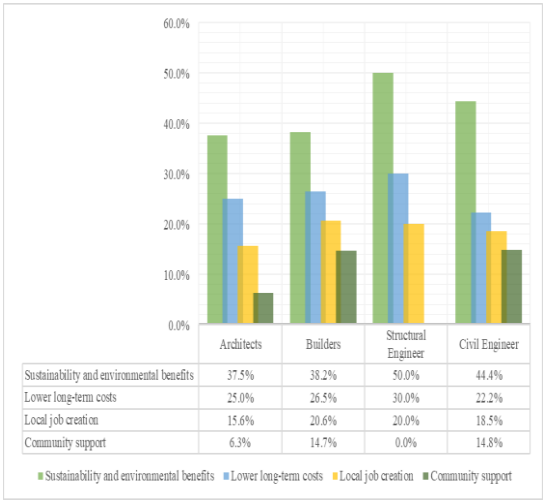
Source: Author's Field Survey, 2025

What is the most significant opportunity for using Hydraform bricks in Osogbo

The data in Figure 2 presented the respondent response to what is the most significant opportunity for using Hydraform bricks in Osogbo. The responses are categorized based on different construction professionals, including architects, builders, structural engineers, and civil engineers. Among the identified opportunities, sustainability and environmental benefits emerged as the most significant, receiving the highest ratings from structural engineers (50.0%) and civil engineers (44.4%). Architects (37.5%) and builders (38.2%) also acknowledged sustainability as a major advantage. This show that Hydraform bricks are perceived as an eco-friendly option, due to their energy-efficient production process and reduced environmental impact compared to conventional building materials.

Lower long-term costs were another notable opportunity, particularly emphasized by structural engineers (30.0%) and builders (26.5%). This reveal that while initial construction costs might be a consideration, the long-term economic benefits, such as reduced maintenance and operational expenses, make Hydraform bricks an attractive choice. However, civil engineers rated this factor lower (22.2%), implying that cost savings may vary depending on project specifications and requirements. Local job creation was also recognized as an important opportunity, with responses ranging from 15.6% (architects) to 20.6% (builders) and 20.0% (structural engineers). This shows the potential for Hydraform brick production and construction to generate employment opportunities within the local community, contributing to economic development. Additionally, community support was mentioned as a minor opportunity, with builders (14.7%) and civil engineers (14.8%) acknowledging its relevance, whereas structural engineers did not consider it a significant factor (0.0%). Overall, the data show that the use of Hydraform bricks in Osogbo presents multiple opportunities, primarily in sustainability and cost efficiency.

Figure 4.4 What is the Most Significant Opportunity for Using Hydraform Bricks in Osogbo



Source: Author's Field Survey, 2025

CONCLUSION

This study investigated the challenges and opportunities associated with the adoption of Hydraform brick technology in the construction of special needs schools in Osogbo, Nigeria. Findings reveal a generally positive perception among built environment professionals regarding the sustainability, climate suitability, and long-term cost efficiency of Hydraform bricks. However, several barriers continue to hinder their widespread use. These include limited availability of the bricks and their raw materials, lack of skilled labor, high initial investment costs, and inconsistent market acceptance.

While the Hydraform system offers strong potential to enhance accessibility and environmental performance in educational buildings, its practical implementation remains constrained by technical, economic, and policy-related factors. The results indicate that addressing these constraints through strategic capacity building, local production expansion, and targeted policy reforms could significantly increase adoption and unlock the full benefits of this sustainable construction technology. As Nigeria seeks inclusive and environmentally responsible solutions for its growing educational infrastructure needs, Hydraform bricks represent a viable alternative—provided that systemic challenges are appropriately addressed.

RECOMMENDATIONS

Based on the findings, the following recommendations are proposed:

1. Establish Local Production Facilities Investment in localized Hydraform brick production centers in Osogbo would reduce transportation costs, improve material availability, and stimulate regional economic development.
2. Implement Vocational Training Programs Structured training and certification programs should be developed for builders, artisans, and engineers to address skill gaps and ensure proper application of Hydraform technology.
3. Raise Public and Professional Awareness Awareness campaigns targeting construction professionals and policymakers should be conducted to shift perceptions and highlight the proven benefits of Hydraform bricks in sustainable and inclusive school construction.
4. Promote Further Research and Monitoring Continuous academic and field-based research should monitor the long-term performance of Hydraform-based structures in special needs settings, to provide a feedback loop for future policy and design decisions.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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