



doi:10.5281/zenodo.18767314

# **Design, Fabrication And Construction Of U-Block Mould And Production Of U-Blocks As An Instructional Material For Teaching Building Technology**

Ighodaro, J. I.<sup>1</sup>, Ndah, H. O.<sup>2</sup> & Zakari, O. S.<sup>3</sup>

<sup>1,2,3</sup>Department of Building Technology

School of Secondary Education (Technical)

Federal College of Education (Technical), Ekiadolor, Benin City, Edo State, Nigeria

## **ABSTRACT**

The effectiveness of Building Technology education in Nigerian tertiary institutions largely depends on the availability and utilization of appropriate instructional materials that support experiential learning and practical skill acquisition. However, persistent shortages of conventional formwork materials, high costs, and sustainability concerns have constrained effective teaching of reinforced concrete construction. This study therefore focused on the design, fabrication and construction of a U-block mould and the production of U-blocks as instructional materials for teaching reinforced concrete beams and lintels in Building Technology programmes. A design-and-development research approach was adopted. A steel mould was designed and fabricated using mild steel plates, after which U-blocks were produced using a sandcrete mix ratio of 1:8 (cement to fine aggregate). The produced blocks were cured for seven days and assessed based on workability, dimensional accuracy, durability and instructional suitability. Findings revealed that the fabricated mould produced uniform and durable U-blocks suitable for repeated classroom and workshop use. The U-blocks enhanced students' understanding of reinforcement placement, concrete infill procedures and beam construction processes, while reducing material wastage, preparation time and reliance on conventional timber formwork. The study concludes that U-blocks are effective, sustainable and cost-efficient instructional materials for Building Technology education. It recommends the integration of U-block systems into practical courses in Colleges of Education and related technical institutions to improve experiential learning and align instructional practices with modern construction techniques.

**Keywords:** U-block, instructional material, Building Technology, mould fabrication, technical education.

## **INTRODUCTION**

Building Technology is a primary focus of Technical and Vocational Education and Training (TVET) programs. The objective is to equip students with the academic knowledge, practical skills, and professional dispositions necessary for effective performance in the construction industry. The topic is crucial for national advancement as it cultivates mid-level technical personnel capable of contributing to residential construction, infrastructure development, and the implementation of sustainable building practices. In Nigeria, Building Technology is instructed in Colleges of Education (Technical), Polytechnics, and Universities. The courses encompass topics such as block fabrication, concrete utilisation, form construction, reinforcement incorporation, building methodologies, and site management (Okoye & Arimonu, 2016; Ayonmike & Okeke, 2020).

The efficacy of Building Technology education, as a practice-oriented discipline, is heavily dependent on the availability, adequacy, and utilisation of appropriate instructional materials. Instructional materials offer concrete representations of theoretical concepts and enhance students' understanding by enabling visualisation, manipulation, and direct engagement with real construction components (Clark & Lyons, 2019). Kolb (2021) emphasised that experiential learning promotes improved cognitive processing and lasting memory when learners actively interact with physical objects rather than relying solely on verbal explanations.

Multiple studies demonstrate that Nigerian postsecondary institutions frequently face deficits in modern teaching resources and workshop facilities, particularly in technical and vocational programs (Akanmu et al., 2022; Okorie et al., 2023), despite the recognised importance of instructional materials. This issue has been attributed to constrained finances, escalating construction material costs, inflation, and conflicting institutional interests. The COVID-19 epidemic generated more challenges for the economy, which made institutional budgets increasingly tighter and made it tougher to purchase supplies for hands-on learning (Ogunode & Aiyedun, 2021).

In teaching how to build using reinforced concrete, teachers often employ traditional timber and steel formwork technologies to show how to create beams, lintels, and columns. But these systems are pricey, entail a lot of labour, don't last long, and aren't good for the environment because they waste materials and use up too much wood (Alengaram et al., 2019; Zhang et al., 2023). As a result, a lot of schools either don't allow practical demonstrations or focus too much on theory, which makes it tougher to master skills and stay current in the profession.

U-blocks are masonry units that are made to have a U-shaped cross-section and are supposed to be used as stay-in-place formwork for reinforced concrete beams, columns, and lintels. U-blocks stay in place permanently when the concrete is poured, unlike temporary formwork options. This saves down on building time, labour expenses, and material waste while also boosting dimensional correctness and structural performance (Solbet Lubartów S.A., 2022). Recent research reveal that U-block systems augment construction efficiency, minimise environmental effect, and enhance site safety by lowering formwork handling (Marina & Petrova, 2025; BigRentz, 2024).

In addition to its structural advantages, U-blocks show significant promise as educational tools in Building Technology education. Their design enables visible demonstration of reinforcing application, concrete filling procedures and load transfer mechanisms, making them suited for repeated classroom and workshop use. However, despite their rising application in modern building practice, U-blocks are rarely exploited as instructional resources in Nigerian tertiary institutions. Most universities continue to depend on improvised timber formwork, which is costly, unsustainable and often unavailable in sufficient quantities for effective instruction.

This gap between industry experience and classroom training underlines the need for new, durable and cost-effective instructional resources that can boost practical teaching and learning in Building Technology. Against this background, the present work focuses on the design, fabrication and building of a U-block mould and the manufacturing of U-blocks as instructional tools for teaching reinforced concrete construction in Colleges of Education. The study aligns with the objectives of the Tertiary Education Trust Fund (TETFund) Institutional Based Research (IBR) intervention, which seeks to promote applied research, strengthen instructional delivery and address funding-related challenges affecting teaching and learning in Nigerian public tertiary institutions.

### **Problem Statement**

The quality of practical training in Building Technology courses in Nigerian tertiary institutions has been substantially affected by the ongoing shortage of instructional resources. Conventional timber and steel formwork widely used for teaching reinforced concrete building are becoming expensive, difficult to maintain and environmentally unsustainable due to deforestation and material wastage (Alengaram et al., 2010; Akanmu et al., 2022). As a result, many schools are unable to provide enough hands-on learning experiences for students.

Furthermore, the unavailability of alternative instructional models such as U-blocks limits students' exposure to modern construction techniques being used in the building sector. This gap between classroom learning and industry practice adds to graduates' poor practical competence and decreased employability. There is therefore a considerable need to develop permanent, reusable and cost-effective instructional resources that can boost practical teaching and learning in Building Technology.

### **Aim and Objectives of the Study**

The aim of this study is to design, fabricate and construct a U-block mould and produce U-blocks as instructional materials for teaching Building Technology in tertiary institutions.

The specific objectives are to:

1. Design and fabricate a functional and durable steel mould suitable for U-block production.
2. Produce U-blocks using appropriate sandcrete mix ratios for instructional purposes.
3. Assess the workability, dimensional accuracy and durability of the produced U-blocks.
4. Evaluate the effectiveness of U-blocks as instructional materials for teaching reinforced concrete beams and lintels.

### **Research Questions**

The study was guided by the following research questions:

1. What design and fabrication features are required for an effective U-block mould?
2. What materials and production procedures are involved in manufacturing U-blocks?
3. How workable and durable are the produced U-blocks when used for instructional purposes?
4. To what extent can U-blocks enhance the teaching and learning of reinforced concrete construction in Building Technology?

## **Literature Review**

### **Concept and Development of U-Blocks in Construction**

U-blocks, commonly referred to as channel blocks or lintel blocks, are specialist masonry units defined by a continuous U-shaped cavity designed to allow steel reinforcement and in-situ concrete. They are commonly employed as permanent formwork for reinforced concrete beams, lintels, ring beams and bond beams in masonry building. Unlike typical temporary formwork methods, U-blocks remain in position following concrete application, therefore constituting an integral element of the structural system and boosting construction efficiency (BigRentz, 2025).

The invention of U-blocks originated from the aim to overcome challenges related with traditional lumber and steel formwork, including high material cost, labour effort, dimensional errors and environmental concerns. Early applications of U-blocks concentrated on lintel construction in low-rise masonry buildings, where they provided a suitable manner of casting reinforced concrete pieces without breaking formwork (Queypo, 2005). Over time, improvements in concrete technology and block manufacturing procedures have resulted to improved U-block designs with enhanced strength, dimensional stability and compatibility with modern construction regulations.

Standardized geometry is one of the defining elements of U-blocks. According to Marina and Petrova (2025), the regular proportions of U-blocks ensure correct alignment of masonry courses, minimise construction tolerances and enhance the quality of reinforced concrete elements. Their analysis found that U-shaped concrete blocks provide an optimal compromise between structural strength and reduced dead load, particularly in low-rise and medium-rise buildings. The reduced self-weight of U-blocks aids to reducing foundation loads while retaining appropriate load-bearing capabilities.

Recent study has further underlined the improved composite action achieved when U-blocks are used in conjunction with reinforced concrete. Zhang, Li and Chen (2023) found that U-block systems enhance load distribution efficiency and structural continuity between masonry walls and reinforced concrete beams. This composite nature promotes resilience to cracking and deformation, especially under service loads. Similarly, Alengaram et al. (2021) noted that permanent formwork solutions such as U-blocks boost structural integrity by providing adequate concrete confinement and reinforcing position.

The appeal of U-blocks has extended beyond structural performance considerations to encompass building speed and sustainability. BigRentz (2024) discovered that U-block systems considerably save construction time by eliminating the demand for building, stripping and reusing temporary formwork. This decrease in building phases eliminates on-site errors and enhances productivity, particularly in resource-constrained places. Additionally, U-blocks help to sustainable construction practices by reducing timber consumption and minimizing formwork-related waste, which coincides with worldwide environmental sustainability goals (Solbet Lubartów S.A., 2022; Ogunbiyi et al., 2022).

In recent years, U-blocks have received significant recognition in Europe, Asia and portions of Africa as important components of modern masonry systems. Their adaptability to diverse architectural typologies and compatibility with insulating materials further strengthen their usefulness in contemporary building (Marina & Petrova, 2025). These features identify U-blocks as technically competent, economically practical and ecologically responsible construction components ideal for both industry use and instructional utilisation in Building Technology education.

### **Structural and Economic Advantages of U-Block Systems**

One of the most noteworthy advantages of U-block systems is in their capacity to decrease the necessity for interim formwork during reinforced concrete construction. By serving as stay-in-place moulds, U-blocks simplify the construction process and reduce the number of sequential operations necessary on site. Queypo (2005) has reported that U-blocks considerably minimise personnel costs, building time and formwork-related charges. Although this study was conducted over a decade ago, recent research has consistently verified these findings in modern architectural contexts.

Alengaram et al. (2019) showed that permanent formwork solutions, including U-blocks, boost site productivity by avoiding repeating formwork erection and demolition tasks. Their investigation indicated that such solutions decrease construction waste, lower material losses and enhance productivity, particularly in resource-constrained places where experienced people and formwork materials are rare. Similarly, Zhang et al. (2023) said that U-block systems contribute to better construction accuracy by retaining consistent dimensions and perfect alignment of reinforced concrete parts, therefore minimising rework and associated costs.

From a structural performance perspective, U-blocks enhance the composite action between masonry walls and reinforced concrete beams. Marina and Petrova (2025) found that U-block systems provide greater load transmission and structural continuity, resulting in better resistance to cracking and deformation under service loads. The permanent confinement given by the U-block shell provides appropriate positioning of reinforcement and uniform concrete compaction, which contributes to increased durability and long-term structural performance (Alengaram et al., 2021).

Economically, the implementation of U-block systems offers both direct and indirect cost benefits. Direct cost reductions result from lower expenditure on timber or steel formwork, while indirect savings are realised through shorter construction durations, reduced manpower demand and minimized material wastage. BigRentz (2024) revealed that projects utilising permanent formwork technologies gain large reductions in overall construction costs, notably in low-rise and medium-rise buildings. These economic advantages make U-blocks especially ideal for educational institutions and public sector enterprises operating under budgetary limitations.

In addition to economic benefits, U-blocks aid sustainable construction practices by cutting reliance on timber formwork and minimizing construction waste. Solbet Lubartów S.A. (2022) observed that U-block systems integrate with global sustainability goals by enabling responsible material use and lowering deforestation associated with conventional formwork. Ogunbiyi et al. (2022) further reported that sustainable masonry solutions contribute to decreased embodied energy and reduced environmental impact during the building lifecycle.

U-block systems also increase site safety by eliminating formwork-related risks. The absence of deconstruction operations minimises the probability of accidents linked with falling materials, unstable formwork and manual handling injuries. BigRentz (2024) stated that enhanced site safety is a key advantage

of permanent formwork systems, particularly in circumstances where safety compliance and supervision may be limited. These safety considerations further underscore the usefulness of U-blocks for both construction practice and instructional application in construction Technology education.

Overall, the structural efficiency, economic viability, sustainability and safety advantages of U-block systems position them as a viable alternative to conventional temporary formwork. Their utilisation not only boosts construction outputs but also provides a practical and cost-effective instructional resource for teaching reinforced concrete construction in technical and vocational education programmes.

### **Thermal and Environmental Performance of U-Blocks**

Beyond their structural efficiency, U-block systems have demonstrated significant thermal and environmental performance advantages, particularly when integrated with insulation materials or lightweight concrete infill. In modern construction, thermal efficiency is a critical design consideration due to rising energy costs and increasing emphasis on sustainable building practices. U-blocks, by virtue of their hollow geometry, provide opportunities for thermal enhancement that are not readily achievable with solid masonry units.

Zhang, Li and Chen (2023) reported that insulated U-block systems significantly improve thermal performance by reducing heat transfer through masonry walls and reinforced concrete beams. Their study showed that the incorporation of insulation materials within the U-shaped cavity reduces thermal bridging commonly associated with reinforced concrete elements. This reduction in heat flow contributes to improved indoor thermal comfort and reduced reliance on mechanical heating and cooling systems, particularly in residential and educational buildings.

Similarly, Marina and Petrova (2025) highlighted that U-blocks enhance energy efficiency when combined with lightweight concrete or insulation infill materials. Their findings indicated that the thermal resistance of masonry assemblies incorporating U-blocks was higher than that of conventional reinforced concrete beam systems. The improved thermal behavior was attributed to the presence of air voids and insulating materials within the block cavity, which act as barriers to heat transfer.

From an environmental perspective, U-block systems contribute to sustainable construction by reducing the demand for temporary timber formwork and associated material waste. Solbet Lubartów S.A. (2022) emphasized that the use of permanent formwork systems such as U-blocks minimizes deforestation and promotes responsible material usage. Ogunbiyi et al. (2022) further noted that sustainable masonry systems that eliminate or reduce temporary formwork significantly lower embodied energy and carbon emissions over the building lifecycle.

Life-cycle assessment studies have also shown that U-block systems offer long-term environmental benefits. BigRentz (2024) reported that permanent formwork systems reduce construction-related waste generation and improve material efficiency, resulting in a lower overall carbon footprint compared to traditional construction methods. These benefits are particularly relevant in developing countries, where construction waste management remains a significant challenge.

In addition, the durability and reusability of U-blocks contribute to environmental sustainability in educational settings. When used as instructional materials, U-blocks can be repeatedly utilized for teaching demonstrations without significant deterioration, reducing the need for frequent replacement of materials. This aligns with the principles of sustainable education infrastructure and resource conservation (Akanmu et al., 2022).

Overall, the thermal and environmental performance of U-block systems positions them as environmentally responsible construction components that support energy efficiency, resource conservation and sustainable development. Their integration into both construction practice and Building Technology education offers a dual benefit of improving building performance while promoting environmentally conscious instructional practices.

### **Instructional Materials and Experiential Learning in Building Technology**

Instructional tools are vital to effective teaching and learning in technical and vocational education, particularly in subjects such as Building Technology where practical competence is a primary learning objective. Instructional materials include actual models, tools, equipment, real construction components and

simulated work conditions that facilitate the conversion of academic information into practical abilities. Their implementation boosts students' comprehension of construction processes, improves psychomotor skill development and promotes professional readiness (Clark & Lyons, 2019).

Experiential learning theory provides a robust theoretical basis for the use of instructional materials in technical education. Kolb (2021) underlined that learning is most effective when students actively engage in practical experiences, reflect on those experiences, develop new knowledge and apply it in real-world conditions. In Building Technology, experiential learning allows students to interface directly with building materials such as blocks, reinforcement bars and formwork systems, thereby improving their capacity to understand drawings, comprehend structural behavior and perform construction tasks successfully.

Empirical study have frequently demonstrated a beneficial link between the availability and successful utilization of instructional resources and students' academic performance and skill acquisition in technical education programmes. Ayonmike and Okeke (2020) found that students who were exposed to hands-on educational materials outperformed their peers educated mostly through theoretical techniques in terms of practical competence and problem-solving ability. Similarly, Okorie et al. (2023) observed that good workshop facilities and teaching aids considerably increase students' involvement, confidence and employability abilities in technical institutions.

In the context of Nigerian tertiary institutions, the effective use of instructional materials in Building Technology is generally limited by insufficient funds, inadequate facilities and growing costs of building supplies. Ogunode and Aiyedun (2021) showed that financial issues and economic volatility have reduced institutions' capacity to furnish consumable materials required for practical training. As a result, many lecturers resort to lecture-based teaching methodologies, which limit students' exposure to real construction scenarios and contradict the aims of technical and vocational education.

Recent studies have underlined the importance for inventive and locally manufactured educational materials that are durable, reusable and cost-effective. Akanmu et al. (2022) claimed that the development of local instructional materials might greatly enhance teaching efficacy while reducing dependence on expensive imported equipment. In Building Technology education, instructional materials such as U-blocks offer particular advantages because they resemble authentic construction components used in industry and may be reused for several demonstrations without substantial deterioration.

Furthermore, the utilisation of authentic construction components as instructional materials promotes industry relevance and curriculum conformity. According to Okoye and Arimonu (2016), bridging the gap between classroom instruction and industry practice is crucial for developing competent graduates capable of matching labour market demands. The incorporation of U-blocks into Building Technology training promotes experiential learning by enabling students to visualize reinforcement application, concrete casting procedures and structural load pathways in reinforced concrete elements.

Overall, instructional materials remain vital to experiential learning and skill acquisition in Building Technology. The introduction of novel materials such as U-blocks not only increases teaching effectiveness but also ties technical education with contemporary construction practices and sustainability concerns. This underscores the importance of research-driven instructional material development, such as the present study, in improving the quality and relevance of Building Technology education in Nigerian tertiary institutions.

### **Review of Related Empirical Studies**

Empirical research on the application of U-block systems and instructional materials in construction and technical education has grown in recent years as scholars seek to link industry practice with classroom learning. The following studies provide insight into structural performance, sustainability, and pedagogical efficacy under settings applicable to this study:

Zhang, Li and Chen (2023) conducted an experimental assessment of the thermal and structural performance of insulated U-block masonry structures. Using controlled laboratory tests and thermal modeling, the study studied temperature gradients, heat transport, and load distribution across masonry assemblies integrating U-blocks with insulating infill. The results indicated that U-block systems drastically reduced heat transmission

compared to traditional masonry with timber formwork, leading to greater energy efficiency in building envelopes. Structurally, the inclusion of continuous cavities strengthened the composite action between masonry and reinforced concrete, resulting in improved resistance to service loads.

This empirical analysis provides persuasive evidence that U-blocks contribute not merely to mechanical performance but also to thermal comfort and energy optimization, harmonising with global sustainability goals. The methodology combining physical testing with numerical modeling boosts the study's validity and creates a replicable foundation. However, the study was limited to low-rise assemblies and did not assess long-term endurance under changing environmental circumstances, underlining a topic for further research.

Okorie, Eze and Nwankwo (2023) evaluated the influence of workshop facilities and instructional materials on skill acquisition among Building Technology students in Nigerian tertiary institutions. Employing a mixed-methods design, the researchers provided structured questionnaires and conducted performance assessments on practical tasks such as block placing, formwork assembly and reinforcement details.

The findings revealed that students with access to acceptable teaching materials and functional workshop facilities fared substantially higher on practical tests than their counterparts with restricted materials. Moreover, children reported stronger confidence and deeper conceptual understanding when allowed hands-on interaction with real products. This study empirically verifies the theoretical assumption that instructional materials are important for practical learning in technical education.

Despite its rigorous design, the study was geographically limited to a few institutions in southern Nigeria, suggesting the need for broader, multi-site research to increase generalizability. Nonetheless, this experiment underlines the pedagogical significance of physical teaching aids like U-blocks in bridging the gap between theory and practice.

In a recent structural study, Marina and Petrova (2025) assessed the load distribution characteristics and seismic resistance of U-block systems in low and medium-rise buildings. Through full-scale structural testing and finite element analysis, the authors established that U-block masonry with reinforced concrete infill has outstanding stiffness attributes and energy dissipation capacity under cyclic loading circumstances.

The research adds factual proof to the rising knowledge that U-block systems are not only cost-effective but also structurally reliable, with performance characteristics that meet or surpass stipulated construction criteria in many jurisdictions. This method is particularly important to regions with moderate seismic activity and interacts with sustainable design imperatives by boosting efficient material utilisation.

A drawback of this study was its concentrate on seismic loads; future studies should extend the analysis to additional load conditions such as wind uplift and impact loading. Additionally, including instructional goals tied to these structural characteristics would offer a more comprehensive educational framework.

Ogunbiyi, Oladapo and Akinradewo (2022) did a life-cycle assessment (LCA) to estimate the environmental effects of permanent formwork systems integrating U-block masonry, comparing them to typical timber and steel formwork. Utilizing cradle-to-grave research, the study assessed embodied energy, global warming potential and garbage generation.

Findings indicated that U-block systems greatly cut carbon emissions and embodied energy during the lifecycle of a structural component. The study also underlined the reduced waste associated with permanent formwork, as U-block solutions minimise the requirement for periodic timber manufacture and disposal. This empirical analysis confirms sustainability arguments frequently stated in technical literature and gives quantitative indicators that can promote policy and curricular integration.

However, the study did not examine the educational implications of these environmental benefits, giving an opportunity for future research to associate environmental performance with instructional outcomes in technical education.

### **Summary of Literature**

The reviewed literature highlights the multidimensional significance of U-block systems and instructional materials within both construction practice and technical education. Empirical investigations into U-block technology reveal strong evidence of structural, thermal, economic and environmental advantages that extend beyond traditional formwork solutions. Zhang, Li and Chen (2023) demonstrated that insulated U-block

systems not only improve structural performance but also enhance thermal efficiency by reducing heat transfer in masonry assemblies. Their findings align with the increasing emphasis on energy-efficient construction, especially in regions with high thermal loads.

In a complementary structural investigation, Marina and Petrova (2025) established that U-block systems contribute to improved load distribution and resilience in low and medium-rise buildings. Their study empirically supports the notion that U-blocks offer superior composite action between masonry and reinforced concrete, enhancing overall stability and reducing deformation under service loads. Together, these studies provide a robust technical basis for promoting U-block adoption in contemporary construction, particularly where sustainable and efficient building practices are prioritized.

From a pedagogical perspective, Okorie, Eze and Nwankwo (2023) provided compelling evidence that the availability and use of instructional materials significantly affect students' practical skill acquisition in Building Technology programmes. Their mixed-methods findings showed that students exposed to functional workshop materials and hands-on modelling not only performed better in practical assessments but also exhibited higher levels of confidence and conceptual understanding. This reinforces the importance of aligning construction education with industry-relevant materials and practices, a point echoed by Kolb (2021) and Clark & Lyons (2019) in theoretical frameworks on experiential learning.

Environmental and sustainability dimensions receive empirical support from Ogunbiyi, Oladapo and Akinradewo (2022), who quantified the lifecycle benefits of permanent form

## **MATERIALS AND METHODS**

The study adopted a design-and-development research approach, which is appropriate for the fabrication and evaluation of instructional construction materials. The materials utilized for the study included mild steel plates, welding electrodes, cement, fine aggregates, water, and reinforcement bars. The fabrication and production processes were carried out using welding machines, cutting machines, grinders, measuring tapes, and moulding equipment.

### **Fabrication of the U-Block Mould**

The U-block mould was fabricated using mild steel plates cut to specified dimensions in accordance with standard U-block sizes. The cut components were assembled and welded to form a rigid mould structure. Thereafter, grinding and surface finishing were carried out to eliminate sharp edges and to achieve smooth surfaces and dimensional accuracy. The mould was designed to allow easy demoulding and to withstand repeated use during block production.

### **Production of U-Blocks**

U-blocks were produced using a sandcrete mix ratio of 1:8 (cement to fine aggregate), which is commonly adopted for non-load-bearing and instructional construction elements. The constituent materials were thoroughly mixed to achieve uniformity before being placed into the steel mould. Manual compaction was applied to ensure adequate density. The blocks were demoulded immediately after compaction and subsequently cured for **seven (7) days** using water curing to enhance strength development.

### **Construction of U-Block as Formwork for Beams and Lintels**

The produced U-blocks were used as formwork units for beams and lintels. This involved preparing the U-blocks to receive reinforcement bars and cast-in-place concrete during construction activities.

### **Preparation of Mix for U-Block Production**

A sandcrete mix with a ratio of **1:8** was prepared, consisting of one part cement to eight parts fine aggregates. The mix proportion was selected and studied to improve the strength of the U-block, enhance its bonding capability with cast-in-place concrete, and increase production yield.

### **Prototype Production and Modular Dimensions**

Prototype U-blocks were produced with modular dimensions of 225 mm height, 450 mm length, and 25 mm wall thickness on both sides, with a 175 mm internal opening provided for reinforcement placement.

### **Technical and Physical Characteristics**

The technical characteristics of the U-blocks produced were determined as follows:

- A 50 kg bag of cement produced approximately 25 blocks for the 225 mm × 450 mm U-block and 30 blocks for the 150 mm × 450 mm U-block.
- The maximum weight of each block was 15.3 kg.
- Mortar adhesive consumption was approximately 10 kg/m<sup>2</sup>.

#### **Equipment Used**

The equipment used for the study included block-making equipment, masonry tools, and manual moulds.

#### **Production Process**

##### **Batching and Mixing**

Aggregates and cement were batched by weight and mixed using a mattock, shovel, or mechanical mixer until a homogeneous mixture was obtained. Water was then added gradually to achieve workable consistency. In hot climatic conditions, the fresh mix was protected from direct sunlight to prevent rapid moisture loss.

##### **Moulding**

The prepared mixture was placed into steel mould boxes or a moulding machine and compacted manually. Demoulding was carried out immediately after compaction.

##### **Curing**

The demoulded blocks were covered with plastic sheets for the first 24 hours. Thereafter, the blocks were cured by immersion in water tanks or by regular water spraying for a period of seven (7) days to ensure adequate hydration.

##### **Storage**

After curing, the blocks were stored in a dry and covered area, protected from direct sunlight. The blocks were allowed to mature for two (2) weeks before use.

##### **Installation Technique**

The installation technique followed laying procedures outlined by SOLBET. The U-blocks were laid using either thin mortar or traditional mortar, ensuring that both horizontal and vertical joints were fully filled. Prior to laying, the base was cleaned and leveled in the same manner as conventional blocks. Block sizes were checked for uniformity, and appropriate tools were prepared.

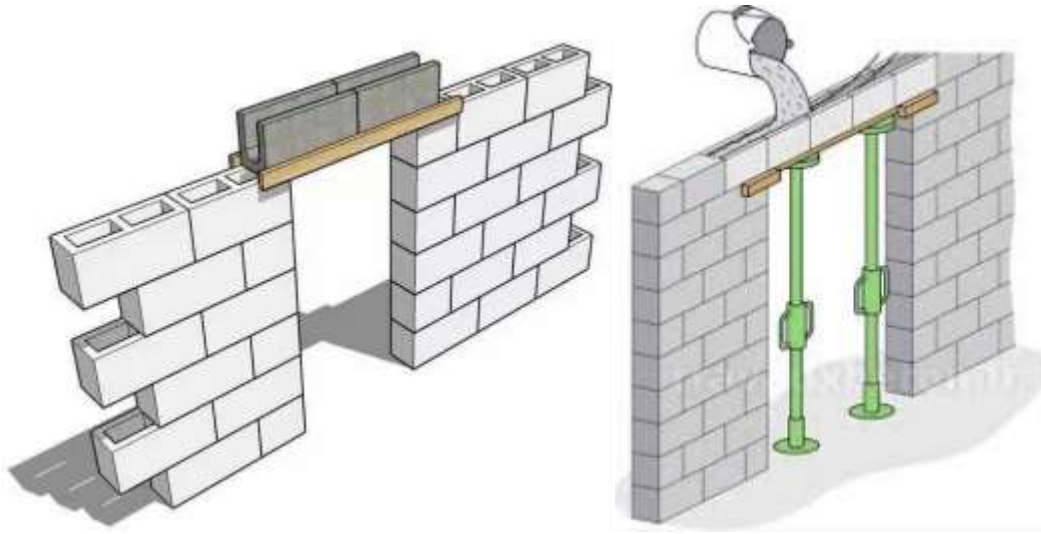
During installation, care was taken to handle the blocks gently to prevent chipping or breakage. A thin layer of block adhesive was applied to the base and edges of the U-blocks using a notched trowel to ensure firm bonding. Proper alignment and leveling were maintained using a spirit level and string line, with adjustments made promptly before mortar setting. The system was noted to be economical and environmentally friendly within the built environment.

**Note:** The U-block does not function as a structural wall element on its own. During concrete casting, temporary assembly support was provided to ensure stability until concrete binding was completed.

##### **Application**

The U-blocks can be applied in selected constructions as follows:

1. As fence, roof and building beam/lintel



## RESULTS AND DISCUSSION

The fabricated U-block mould produced uniform blocks with consistent dimensions and smooth surfaces. The U-blocks exhibited good workability during handling and installation, making them suitable for classroom and workshop demonstrations. The curing process improved the strength and durability of the blocks, enabling them to withstand repeated use during teaching.

The use of U-blocks as instructional materials enhanced students' understanding of reinforcement placement, concrete infill and beam construction processes. Compared to conventional timber formwork, the U-blocks reduced material wastage and preparation time. These findings align with earlier studies by Queypo (2005) and Solbet Lubartów S.A. (2022), which reported improved efficiency and sustainability with U-block systems.

## CONCLUSION

This study successfully designed, fabricated and constructed a U-block mould and produced U-blocks suitable for use as instructional materials in Building Technology. The U-blocks demonstrated adequate workability, durability and instructional effectiveness. Their adoption in teaching reinforced concrete construction can significantly enhance practical learning while reducing reliance on conventional timber formwork. The study supports sustainable construction education and aligns with the objectives of TETFund's Institutional Based Research programme.

## RECOMMENDATIONS

1. U-blocks should be integrated into Building Technology practical courses in Colleges of Education and Technical Colleges.
2. Further studies should examine the structural performance of U-blocks under different loading conditions.
3. Institutions should encourage local fabrication of instructional materials to reduce cost and

## REFERENCES

- Akanmu, A. A., Fasina, S. O., Salisu, U. O., Adeyemo, L. A., & Olorunfemi, S. O. (2022). Challenges of technical vocational education in Nigeria: Implications for skill acquisition. *Journal of Education and Practice*, 13(4), 45–56.
- Alengaram, U. J., Mahmud, H., & Jumaat, M. Z. (2010). Utilization of industrial by-products in concrete. *International Journal of Physical Sciences*, 5(8), 1231–1239.

- Alengaram, U. J., Mahmud, H., Jumaat, M. Z., & Shirazi, S. M. (2019). Sustainable construction materials in reinforced concrete systems. *Construction and Building Materials*, 215, 889–899.
- Alengaram, U. J., Mahmud, H., & Jumaat, M. Z. (2021). Structural performance of permanent formwork systems in reinforced concrete construction. *Construction and Building Materials*, 287, 123045.
- Ayonmike, C. S., & Okeke, B. C. (2020). Instructional materials and students' skill acquisition in technical education programmes. *Journal of Technical Education Research*, 12(2), 88–97.
- BigRentz, Inc. (2024). *Concrete block types and applications in modern construction*. BigRentz Engineering Resources.
- BigRentz, Inc. (2025). *U-blocks and lintel blocks in reinforced concrete construction*. BigRentz Construction Insights.
- Clark, R. C., & Lyons, C. (2019). *Graphics for learning: Proven guidelines for planning, designing, and evaluating visuals in training materials*. John Wiley & Sons.
- Kolb, D. A. (2021). *Experiential learning: Experience as the source of learning and development* (2nd ed.). Pearson Education.
- Marina, A., & Petrova, N. (2025). Performance evaluation of U-shaped concrete blocks in low- and medium-rise construction. *Journal of Construction Materials and Structures*, 18(2), 101–115.
- Marina, A., & Petrova, N. (2025). Structural evaluation and seismic performance of U-block masonry systems in low- and medium-rise construction. *Journal of Construction Materials and Structures*, 18(2), 101–115.
- Ogunbiyi, O., Oladapo, A. A., & Akinradewo, O. (2022). Life-cycle assessment of permanent formwork systems in sustainable construction. *Journal of Sustainable Construction Engineering*, 7(1), 33–47.
- Ogunode, N. J., & Aiyedun, T. G. (2021). COVID-19 and funding challenges of tertiary education in Nigeria. *International Journal of Educational Administration*, 9(1), 23–35.
- Okorie, U. C., Eze, T. I., & Nwankwo, C. A. (2023). Impact of instructional materials on practical skill acquisition in Building Technology: A mixed-methods study. *African Journal of Technical Education*, 6(1), 57–69.
- Okoye, R., & Arimonu, M. O. (2016). Technical and vocational education in Nigeria: Issues and challenges. *Journal of Education and Practice*, 7(3), 113–118.
- Queypo, R. P. (2005). U-block precast concrete for low-rise buildings. *UNP Research Journal*, 14, 55–63.
- Solbet Lubartów S.A. (2022). *U-blocks as stay-in-place formwork systems*. Solbet Technical Publications.
- Zhang, Y., Li, H., & Chen, X. (2023). Sustainable masonry and formwork alternatives in reinforced concrete construction. *Construction and Building Materials*, 356, 129–141.
- Zhang, Y., Li, H., & Chen, X. (2023). Thermal and structural performance of insulated U-block masonry systems. *Construction and Building Materials*, 356, 129–141.