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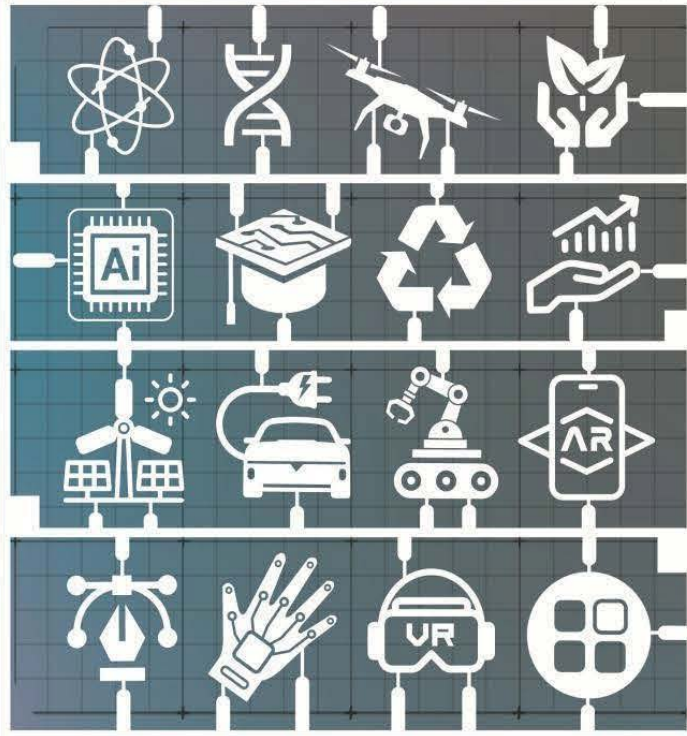
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THE 15TH INTERNATIONAL INVENTION, INNOVATION & DESIGN COMPETITION 2026

E-BOOK OF

EXTENDED ABSTRACT

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THE 15th INTERNATIONAL
INVENTION, INNOVATION &
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LOCKBLOCK: THE MORTARLESS WALL REVOLUTION

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ABSTRACT

The Malaysian construction industry continues to face productivity challenges due to labour-intensive practices, prolonged installation time, and material inefficiencies associated with conventional mortar-based blockwork systems. This study presents the development of a mortarless interlocking blockwork (lockblock) system aimed at reducing construction time, eliminating mortar usage, and improving installation efficiency. The proposed innovation integrates three key concepts: interlocking geometry, dry-stack assembly, and lightweight material composition within an Industrialised Building System (IBS) framework. A structured design thinking methodology was adopted, comprising empathise, define, ideate, prototyping, and testing stages. The research involved a desk study of existing interlocking systems, identification of their limitations, and the development of an improved modular block design using AutoCAD and SketchUp. A 1:3 scaled prototype (200 mm × 100 mm × 100 mm) was produced using lightweight foamed concrete with a target compressive strength of 7 MPa. The results indicate that the system significantly improves installation efficiency, reduces dependency on skilled labour, enhances site cleanliness, and shortens construction duration by eliminating mortar curing time. The lightweight properties further improve handling while maintaining adequate structural performance for low-rise applications. Overall, the innovation demonstrates strong potential for sustainable and efficient construction aligned with SDG 9 and SDG 11.

Keyword: *mortarless interlocking block; lightweight aerated concrete; compressive strength; dry-stack masonry; industrialised building system (IBS)*

1. INTRODUCTION

The rapid growth of Malaysia's construction sector has increased demand for faster, safer, and more sustainable construction methods. Conventional blockwork installation remains labour-intensive, time-consuming, and heavily dependent on mortar application and curing processes. These factors frequently contribute to project delays, labour shortages, material wastage, and inconsistent workmanship quality. The reliance on mortar introduces several inefficiencies, including prolonged curing time, dependency on weather conditions, and the need for skilled labour to ensure proper alignment and finishing. Furthermore, heavy concrete blocks contribute to worker fatigue and potential safety risks. These limitations highlight the need for an improved blockwork system capable of accelerating construction while maintaining structural reliability. This study proposes a mortarless interlocking blockwork system that integrates geometric precision, lightweight materials, and modular prefabrication principles. The innovation aligns with IBS objectives by promoting off-site production, standardisation, and productivity enhancement. The system aims to: reduce installation time, eliminate mortar and curing processes, improve ease of assembly, reduce labour dependency and/or enhance sustainability performance. By combining mechanical interlocking geometry with lightweight form concrete materials, the proposed system offers a viable alternative to conventional masonry construction for low-rise and residential applications.

2. METHODOLOGY

2.1 Desk study

A desk study was conducted to obtain comprehensive insights from previous research and documented case studies related to mortarless interlocking blockwork systems. This approach enabled a thorough understanding of various interlocking technologies developed globally. By analysing existing systems, the strengths and limitations of past implementations were identified, allowing this study to avoid common shortcomings while building upon proven design approaches.

2.2 Prototyping process

The prototyping phase involved the development of a physical model to simulate the behaviour and performance of the mortarless interlocking blockwork system under practical conditions.

2.2.1 Conceptual Design

The design process began with the development of an interlocking geometry using a tongue-and-groove configuration created in AutoCAD software. This interlocking mechanism was intended to enhance structural stability while simplifying installation. Additional features, such as alignment grooves, were incorporated to ensure consistent positioning and accurate assembly during construction. Dimensional planning was carefully carried out to ensure modularity and compatibility with standard construction practices.

2.2.2 Modelling and Simulation

AutoCAD and SketchUp software were utilised to produce detailed 2D and 3D models of the interlocking block. The mould design was developed in AutoCAD based on the finalised geometry and fabricated using polystyrene. High precision in mould production was essential to preserve the interlocking features and ensure proper fit during assembly. Additionally, the assembly process was simulated using SketchUp to visualise block interaction, stacking behaviour, and potential alignment issues prior to physical production.

2.2.3 Block Production

A scaled mock-up block measuring 200 mm × 100 mm × 100 mm (1:3 scale of the actual size 600 mm × 200 mm × 200 mm) was produced using a custom-designed polystyrene mould (see Figure 1). The block was developed using lightweight foamed concrete with a targeted compressive strength of 7 MPa, suitable for non-load-bearing and low-rise applications. The mix composition consisted of Ordinary Portland Cement (OPC), fine aggregate (sand), water, and a synthetic-based foaming agent (Noraite PA-1) to achieve a target density range of approximately 1300–1500 kg/m³. A typical mix proportion included a cement-to-sand ratio of 1:1.5 and a water–cement ratio of 0.45. The concrete mixture was batched and mixed thoroughly before being poured into the prepared mould. The blocks were allowed to set and were demoulded after initial hardening. Subsequently, the specimens were cured for 7 days under controlled conditions to achieve sufficient strength for handling.



Figure 1 Production prototype sample

2.3 Testing Phase

The developed prototypes were subjected to a series of mechanical and functional tests to evaluate their performance and suitability for construction applications. Compressive strength testing was conducted in accordance with ASTM C140/C140M and BS EN 772-1 to verify the target strength of 7 MPa. The specimens were tested using a compression testing machine, where load was applied gradually until failure. Dimensional accuracy was assessed based on ASTM C140 and BS EN 772-16 standards. Measurements of length, width, height, and interlocking groove dimensions were conducted to ensure compliance with tolerances. Furthermore, assembly efficiency was evaluated by constructing a small mock-up wall using the developed blocks. The assessment focused on installation time, ease of alignment, stability during stacking, and labour requirements. A small-scale load-bearing assessment was also performed in reference to BS EN 1996 (Eurocode 6) to evaluate structural stability under vertical loading.

3. FINDINGS

Compressive strength testing was conducted in accordance with ASTM C140/C140M and BS EN 772-1 at 7 and 28 days. The mortarless interlocking blocks achieved an average compressive strength of approximately 6.0 MPa at 7 days and 7.2 MPa at 28 days, successfully meeting the targeted design strength of 7 MPa. The results confirmed that the developed blocks achieved the targeted strength, demonstrating their suitability for partition walls and low-rise structures. Dimensional inspection following BS EN 772-16 confirmed that all specimens maintained tolerances within ± 2 mm. The tongue-and-groove interlocking geometry functioned effectively during mock-up wall assembly, ensuring proper horizontal and vertical alignment without mortar application. The average dry density of the blocks ranged between 1,350–1,450 kg/m³, representing a significant reduction compared to conventional dense concrete blocks. This lightweight characteristic improved handling and reduced manual lifting strain while maintaining adequate structural stability for low-rise and non-load-bearing applications. Assembly trials demonstrated approximately 30–40% reduction in installation time, primarily due to the elimination of mortar mixing and curing processes. The dry-stack system enabled faster construction progress and reduced dependency on skilled labour.

Table 1 Compressive strength results

Curing Age	Compressive Strength (MPa)	Mean (MPa)	Standard Deviation (MPa)	Coefficient of Variation (%)
7 Days	5.9, 6.1, 6.0, 5.8, 6.2	6.00	0.15	2.50
28 Days	7.0, 7.3, 7.1, 7.4, 7.2	7.20	0.16	2.22

Table 2 Installation time comparison

Parameter	Conventional Blockwork	Mortarless Interlocking Block
Mortar Mixing	Required	Not required
Curing Time	24–48 hours	Not required
Skilled Labour Requirement	High	Moderate

Average Installation Time (per m ²)	1.0–1.2 hours	0.6–0.8 hours
Site Cleanliness	Wet works present	Dry process

4. CONCLUSION

This study successfully developed and demonstrated a mortarless interlocking blockwork system that addresses major inefficiencies of conventional masonry construction. The integration of interlocking geometry, lightweight aerated concrete materials, and dry-stack assembly significantly enhances construction productivity, reduces labour dependency, and improves site safety. The prototype validation confirms that the system is structurally stable for low-rise applications and offers considerable potential within IBS-based and residential construction markets. Although further structural certification and large-scale testing are required for commercial implementation, the innovation presents a practical and sustainable alternative to traditional blockwork systems.

Overall, the mortarless interlocking blockwork system represents a promising advancement toward faster, cleaner, and more efficient construction practices in Malaysia and similar developing construction markets.

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