International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Experimental Investigation of Full-Scale Interlocking Block Masonry Wall: A Crack Pattern Assessment

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A B S T R A C T

This study presents an experimental investigation of full-scale interlocking block masonry wall, with a particular focus on crack patterns that develop under applied loading. The primary aim of the research is to evaluate the structural behavior of dry-stacked interlocking block masonry when confined, and to identify the sequence and distribution of cracks that govern its performance. The experimental program involved constructing and testing full-scale wall specimens subjected to gradually increasing loading conditions. Detailed observations were made regarding the initiation and propagation of cracks, the influence of confinement on crack control, and the overall stability of the masonry system.

The findings demonstrate that the interlocking block masonry system exhibits a distinct crack development mechanism compared to conventional bonded masonry wall. Initial cracks were observed at stress concentration zones, gradually extending along mortarless joints and block interfaces. Confinement significantly enhanced resistance to lateral deformations and delayed the onset of major cracking, improving the overall load-carrying capacity. The experimental outcomes highlight the potential of interlocking block masonry as a sustainable and structurally reliable alternative for construction, while emphasizing the importance of understanding crack patterns for performance assessment and design applications.

Interlocking Block Masonry, Experimental Study, Crack pattern

1. Introduction:

Masonry construction has been one of the oldest and most widely adopted building techniques due to its availability, durability, and structural reliability. In recent decades, interlocking block masonry has gained significant attention as an innovative construction system that reduces reliance on mortar, lowers construction costs, and enables faster assembly. The interlocking mechanism enhances stability, provides ease of alignment, and ensures better structural performance compared to conventional masonry wall (Baneshi et al., 2023; Joyklad et al., 2021). Such systems are increasingly being utilized in both low-cost housing projects and disaster-prone regions, where efficient construction methods with adequate strength and stability are essential (Fundi et al., 2018).

Despite its practical advantages, the structural behavior of interlocking block masonry under different loading conditions remains a subject of active research. In particular, the crack initiation and propagation patterns in full-scale wall play a critical role in determining their overall load-bearing capacity and failure mechanisms. Understanding the damage evolution is vital for evaluating seismic performance, assessing safety, and improving design guidelines (Ahmed et al., 2022). Previous studies have highlighted that the crack distribution in interlocking block wall differs significantly from that of traditional bonded masonry due to block geometry, interfacial contact behavior, and absence of mortar (Casapulla et al., 2021; Akbar et al., 2023). However, comprehensive experimental investigations focusing specifically on crack patterns in full-scale confined interlocking block masonry wall are still limited (Joyklad et al., 2018; Koudje & Adjovi, 2025).

This study aims to address this research gap by experimentally investigating the performance of full-scale interlocking block masonry wall, with particular emphasis on crack initiation, propagation, and failure modes under applied loads. The outcomes of this research are expected to provide valuable insights into the structural response of interlocking block systems and contribute to the development of reliable design recommendations for their safe and efficient use in construction.

1.1 Importance of Dry Stacked Masonry

The importance of dry stacked masonry lies in its cost-effectiveness, ease of assembly, and sustainability. By eliminating mortar, construction waste is reduced, and the need for skilled labor is minimized, making it an ideal solution for low-cost housing and emergency shelters. Additionally, interlocking dry stacked masonry provides improved seismic performance due to its ability to allow controlled movement and energy dissipation during an earthquake.

This technique is widely used in various applications, including residential buildings, retaining wall, and infrastructure projects. Its modularity and speed of construction make it a viable alternative to conventional masonry techniques, particularly in regions where rapid, cost-effective, and durable construction solutions are required.

2. Experimental Setup

The experimental program was designed to evaluate the structural behavior and crack development of full-scale interlocking block masonry wall under applied loading conditions. The setup involved constructing wall specimens using Hydraform-type interlocking concrete blocks, which were prepared to standard dimensions with uniform geometry to ensure consistency in the interlocking mechanism. The blocks were stacked in a dry configuration without mortar, while vertical reinforcement and confinement were provided in selected specimens to replicate practical construction conditions.

Each wall specimen was constructed on a rigid reinforced concrete base to ensure proper load transfer and to avoid boundary-induced failures. The wall was confined using reinforced concrete tie columns at the edges and a horizontal tie beam at the top to simulate realistic boundary conditions commonly adopted in practice. Prior to testing, the wall was cured and visually inspected to eliminate any pre-existing cracks or defects in the blocks.

3. Loading Protocol

The loading protocol shown in Figure 01 was designed to simulate both gravity and lateral actions typically experienced by masonry wall. A constant vertical compressive load was first applied at the top of the wall to replicate the effect of gravity loading from superimposed structural components. Once the vertical load was stabilized, monotonic in-plane lateral loading was introduced through a hydraulic actuator mounted against a strong reaction frame.

The lateral load was applied in displacement-controlled increments to capture the progressive response of the wall. At each increment, the corresponding lateral force and displacement were recorded, allowing for detailed tracking of stiffness degradation and ultimate strength. Linear Variable Differential Transducers (LVDTs) were positioned at critical locations, such as the wall mid-height and near the supports, to measure in-plane deformations.

Throughout the loading sequence, crack initiation and propagation were closely observed. A predefined grid was marked on the wall surfaces to facilitate systematic crack mapping. Digital photography and visual inspection were employed at each load stage to document damage progression, enabling correlation between applied load levels and observed crack patterns. The test continued until the specimen reached its failure state, characterized by loss of load-carrying capacity or excessive displacement.

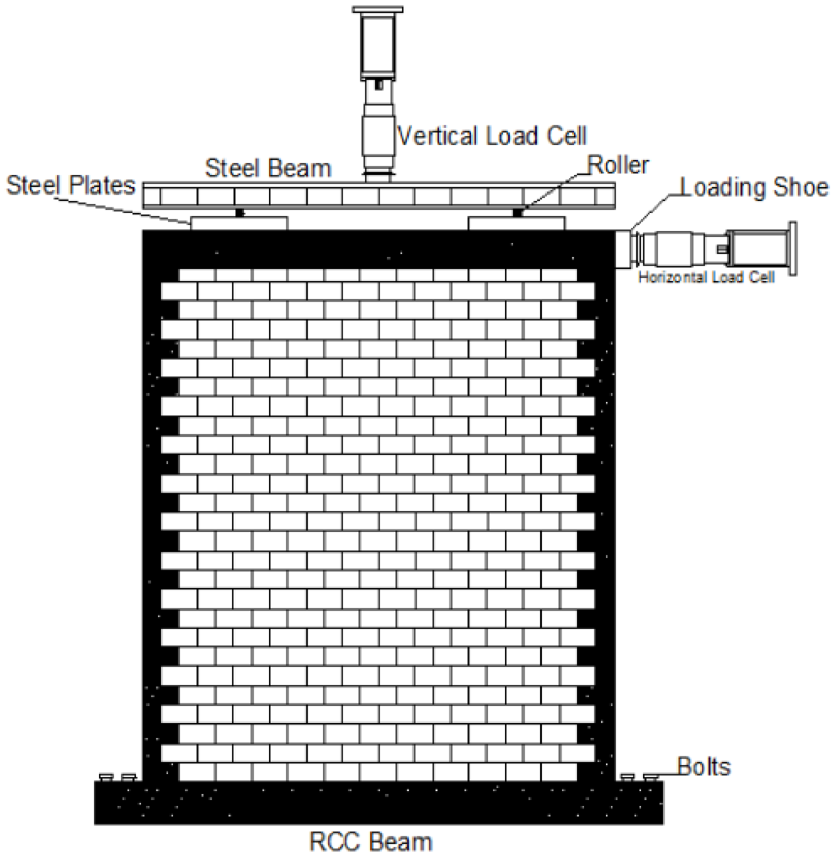

Figure 3.1 Preparation and Testing Setup of DSBM Wall

4. Results and Discussion:

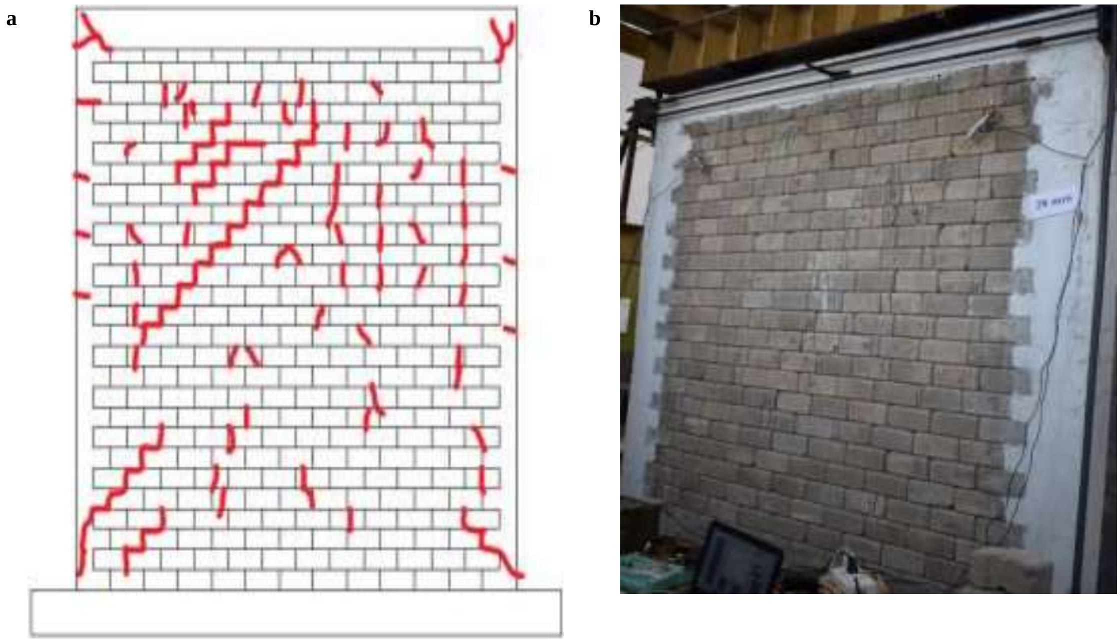

Fig 4.1: (a) Damages and Crack Development in the DSBM Wall (b) Real Time Picture showing crack pattern

5. Conclusion

- Dry-stacked block masonry (DSBM) wall demonstrated good initial stiffness and stability under cyclic lateral loading when confined vertically.
- No visible cracks appeared until a drift ratio of ~0.15%, indicating adequate elastic response in the early stages.
- Hairline cracks near the pier marked the onset of damage, followed by diagonal joint openings at ~0.30% drift due to block sliding.
- Progressive widening of joints and minor cracks in piers and beam–column joints indicated a shift to combined shear and rocking behavior.
- At higher drift levels, block crushing and the development of V-shaped diagonal cracks became dominant failure mechanisms.
- The ultimate drift capacity of the tested wall was ~0.55%, at which point more than a 20% strength reduction was observed, meeting the ASCE/SEI 41-13 failure criterion.
- Overall, DSBM wall exhibit promising performance under lateral loads but are vulnerable to progressive sliding and crushing, which must be addressed through adequate confinement and design improvements.

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