# FIRE PERFORMANCE OF MASONRY WALLS: EXPERIMENTAL INVESTIGATION OF WALL BONDING PATTERNS

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Thesis/Dissertation submitted in partial fulfillment of the requirements for the degree

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## DECLARATION

I declare that this is my own work and this thesis/dissertation does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other University or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text. I retain the right to use this content in whole or part in future works (such as articles or books).

Signature: Date: 2026.02.27

The above candidate has carried out research for the ~~PhD/MPhil~~/Masters thesis/~~dissertation~~ under my supervision. I confirm that the declaration made above by the student is true and correct.

Name of Supervisor: Dr. T.G.P.L.Weerasinghe

Signature of the Supervisor: Date: 2026.02.27

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# ABSTRACT

Masonry walls are widely used as load bearing and compartmentation elements due to their inherent fire resistance; however, their structural performance under fire exposure is governed by complex thermo-mechanical interactions that depend on masonry unit geometry, mortar configuration, and bonding arrangement. Despite extensive international research, experimental data on the fire performance of masonry constructed using locally available materials remain limited, particularly for Sri Lankan construction context. This study experimentally investigates the fire performance of load-bearing masonry walls using medium-scale wallette testing. Eight masonry wallettes (including the trial specimen) were constructed using three commonly used masonry unit types—smart bricks, polished bricks, and standard solid clay bricks—incorporating different mortar joint thicknesses and bond patterns. Specimens were exposed to one-sided heating following a time–temperature curve based on ISO 834 using a medium-scale laboratory furnace for a duration of 60 minutes. The experimental program evaluated thermal response, vertical and lateral deformation behavior, visual damage characteristics, and residual compressive strength after cooling. The results showed that all masonry wallettes maintained unexposed surface temperatures below commonly referenced insulation limits under the applied heating conditions. A consistent trend was observed indicating that increased mortar joint thickness was associated with higher internal temperatures and greater vertical and lateral displacements. Bond pattern exhibited a secondary influence, with Flemish bond demonstrating comparatively improved deformation control relative to stretcher and English bonds. Smart brick masonry showed comparatively greater strength degradation after fire exposure, while polished and standard brick masonry retained higher residual compressive capacity, reflecting the influence of unit geometry and brick–mortar interaction. Overall, the findings indicate that masonry fire performance is governed by the combined effects of unit type, mortar configuration, and bonding arrangement. The study provides experimental evidence relevant to locally available masonry systems and demonstrates the suitability of medium-scale testing for comparative performance-based fire evaluation.

**Keywords**: Fire performance, Medium-scale testing, Thermal behavior, Masonry walls, Post-fire residual strength

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# LIST OF ABBREVIATIONS

| Abbreviation | Description |
|---|---|
| LVDT | Linear Variable Differential Transformers |
| AAC | Aerated Autoclaved Concrete |
| LWC | Lightweight Concrete |
| HMC | Hot Mechanical Characterization |
| BB | Burnt Masonry Bricks |

# LIST OF APPENDICES