EVALUATING THE RESIDUAL PROPERTIES OF MASONRY UNITS AND MORTAR AT ELEVATED TEMPERATURE CONDITIONS AND ITS COMPLIANCE WITH SRI LANKAN BUILDING FIRE SAFETY GUIDELINES

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Master of Science (Major Component of Research)

Department of Civil Engineering
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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).

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

Name of Supervisor: Dr. (Ms) Ariyaratne K.P.I.E.

Signature of the Supervisor: Date: 19/02/2026

DEDICATION

This thesis is dedicated to all those whose steadfast support, encouragement, and kindness have guided me throughout my academic journey. It is more than just a piece of research; it stands as a reflection of endurance, commitment, and the strength drawn from the people who stood by me during one of the most challenging yet defining phases of my life.

I dedicate this work to my dearest family, whose endless motivation and faith in me have been my greatest source of strength. My deepest gratitude goes to my mentors and supervisors, especially Senior Lecturer I. E. Ariyaratne, whose insightful guidance, expertise, and genuine humanity shaped this study and helped me grow both academically and personally.

To my dear friends and research colleagues, I dedicate this in appreciation of your encouragement, optimism, and friendship, which brought energy and positivity throughout this journey.

Lastly, this thesis is dedicated to all aspiring researchers who dare to explore, to those who pursue knowledge with courage and perseverance, and to everyone who has helped me become a more independent, confident, and resilient individual.

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ABSTRACT

Masonry structures are valued for their strength and durability, and the properties of masonry materials under ambient conditions have been studied widely. The behaviour of masonry materials under fire conditions has also been investigated; however, studies on their residual performance after fire exposure remain limited. As the post-fire capacity of masonry walls is uncertain, studying their residual behaviour is important for improved fire safety. Therefore, this study evaluates the residual properties of masonry units commonly used in Sri Lanka, including clay bricks and cement–sand blocks as conventional units, and compressed stabilized earth blocks (CSEBs), foam concrete blocks, and autoclaved aerated concrete blocks as alternative units. Three specimens of each unit type, along with mortar samples, were heated to 200 °C, 400 °C, 600 °C, 800 °C, and 1000 °C, and then assessed for mass loss, crack propagation, and compressive strength, with ambient-condition specimens serving as references. Wall strengths were calculated using the experimental results. The results showed a unique behaviour in solid clay bricks, which recorded a 29% increase in compressive strength at 200 °C before reducing at higher temperatures. All other masonry units and mortar exhibited a continuous decrease in strength, with reductions ranging from 1% to complete loss depending on temperature. Solid cement–sand blocks and their corresponding walls performed best among the tested units, satisfying load-bearing and non-load-bearing strength requirements up to 800 °C. CSEBs were unsuitable at elevated temperatures and lost all capacity by 800 °C, showing weaker residual performance. Mass loss varied between 0% and 20% across units. Cracks were observed only in solid clay bricks and CSEBs, with CSEB cracks exceeding 3 mm after 800 °C, resulting in a complete loss of strength. Based on the findings, the study highlights the importance of incorporating material-specific fire-performance data into building design regulations to improve fire safety.

Keywords: Masonry, Mortar, Elevated Temperature, Residual Strength, Mass Loss

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LIST OF ABBREVIATIONS

Abbreviation	**Description**
CSEB	Compressed Stabilized Earth Blocks
AAC	Autoclaved Aerated Concrete

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