

LB/TH/08/2026
TH6135

ENERGY EFFICIENCY OF WASTE-BASED MASONRY MATERIALS

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Master of Science - Major Component by Research

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University of Moratuwa
Sri Lanka

December 2025

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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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ACKNOWLEDGEMENT

I extend my sincere appreciation to Prof. (Mrs.) Chintha Jayasinghe of the Department of Civil Engineering, University of Moratuwa, for her exemplary supervision and mentorship throughout this research endeavour. Her profound expertise, guidance, and unwavering support played a pivotal role in shaping the direction of this study. The insightful feedback and constructive criticism received greatly enriched the research process, making this journey both rewarding and enlightening.

I would also like to express my heartfelt gratitude to Dr. Indunil Erandi, also from the Department of Civil Engineering at the University of Moratuwa, for her invaluable assistance and guidance. Dr. Erandi's willingness to share her expertise, clarify uncertainties, and offer continuous encouragement played a significant role in navigating the complexities of this work and enhancing its overall quality.

I am deeply thankful to the officials and staff of International Construction Consortium (Pvt) Ltd, including Mr. Ravindra; LankaAAC (Pvt) Ltd, including Mr. Supun; and Ekala Prestressed Concrete Industries (Pvt) Ltd, including Mr. Niranjan Fernando and Mr. Chamod Fernando, for their continuous support during the work studies and their assistance with sample preparation for testing. Their cooperation and contribution made a significant impact on the successful completion of the experimental component of this research.

Special thanks are extended to Ms. Niluka Athukorala and Prof. M. T. R. Jayasinghe for their invaluable guidance and support throughout the thermal properties testing process. Their expertise and assistance are greatly appreciated.

I would also like to convey my sincere appreciation to the Head of the Department, along with all academic and non-academic staff members of the Department of Civil Engineering, University of Moratuwa. Their guidance, administrative support, and the facilities provided throughout the study greatly contributed to the successful completion of this work.

Finally, I am deeply grateful to my family and friends for their unwavering support, encouragement, and understanding throughout this endeavour. Their patience and belief in me have been a constant source of motivation and strength, for which I am truly thankful.

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ABSTRACT

The construction industry has been recognised as a major contributor to several environmental challenges, mainly due to rapid urbanisation and economic growth that have driven a substantial increase in housing demand. This demand has heavily relied on energy-intensive masonry materials, including cement sand blocks, and fired clay bricks, typically manufactured using depleting natural resources. Consequently, industrial growth often accompanies economic development, resulting in vast quantities of waste, much of which is disposed of in landfills, further exacerbating environmental concerns. In this context, applying circular economy principles to industrial waste by repurposing it into building materials can optimise the use of scarce natural resources and reduce the embodied energy involved in manufacturing processes. To address this, the energy efficiency of two waste-based masonry products, including autoclaved aerated concrete (AAC) blocks and expanded polystyrene (EPS) blocks, in comparison with conventional cement sand blocks, has been evaluated, which are readily available in Sri Lanka. Embodied energy was systematically quantified through a process-based analysis including raw material extraction, transportation, and manufacturing. Operational energy was compared using thermal simulations of a single-storey residential building, utilising empirically measured thermal properties of the materials. Although the waste-based masonry materials exhibited a comparable embodied energy to the conventional reference, the operational energy reductions observed throughout the lifespan of the buildings built using these materials demonstrated clear potential for net savings of energy. Therefore, waste-based masonry units emerged as viable solutions to reduce the total energy consumption in tropical climates and promote circular economic principles.

Keywords: Embodied Energy, Masonry, Operational Energy, Thermal Simulations, Waste Materials

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LIST OF ABBREVIATIONS

Abbreviation	Description
GHG	Greenhouse Gas
EE	Embodied Energy
OE	Operational Energy
SDG	Sustainable Development Goal
AAC	Autoclaved Aerated Concrete
EPS	Expanded Polystyrene
HFM	Heat Flow Meter