ENERGY EFFICIENCY OF WASTE-BASED MASONRY MATERIALS

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Master of Science - Major Component by Research

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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 PhD/MPhil/Masters thesis/dissertation under my supervision. I confirm that the declaration made above by the student is true and correct.

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Signature of the Supervisor: Date:

31/12/2025

31/12/2025

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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