REUSE THE CERAMIC GLAZED TILE WASTE FOR THE DEVELOPMENT OF MARINE CONCRETE MODULAR

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Degree of Master of Science

Department of Civil Engineering

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Thesis 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 does not incorporate without acknowledgment 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 acknowledgment is made in the text.

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Signature: Date: 10/03/2025

The above candidate has carried out research for the master's under my supervision.

Name of the Supervisor: Prof. R.U. Halwatura

Signature of the supervisor: Date: 10/03/2025

Name of the Supervisor: Prof. Terney Pradeep kumara

Signature of the supervisor: Date: 10/03/2025

ABSTRACT

Coral reefs are critical to marine ecosystems, offering essential services such as coastal protection, food security, and habitats for diverse marine life. Despite their importance, these ecosystems are rapidly degrading due to environmental stressors and human activities. This study addresses coral reef degradation by developing an eco-friendly, sustainable solution using ceramic tile waste in concrete modular designs to support coral regrowth. The primary objectives were to study Sri Lanka's coastal marine environment, assess the feasibility of reusing ceramic tile waste, and develop an optimized concrete mix for marine conservation structures.

The methodology included an extensive literature review on coral transplantation, the role of concrete structures in marine conservation, and ceramic tile waste as an alternative material. Laboratory experiments explored the use of ceramic tile waste as a partial replacement for fine aggregates at proportions of 25%, 50%, 75%, and 100%. Key tests—such as sieve analysis, slump tests, compressive strength tests, and X-ray diffraction (XRD)—validated the safety and suitability of ceramic waste for marine environments. Field deployment of two modular designs, Coral Hab and Marine Condo, at Polhena Beach, Sri Lanka, monitored coral growth and marine biodiversity. Results indicated that the optimal mix was achieved with a 25% replacement of fine aggregates using ceramic tile waste, providing structural integrity, environmental compatibility, and the required strength of 25 MPa. Incorporating foam concrete emerged as the most effective method, with 26% foam content identified as the optimal composition for cost efficiency, weight reduction, and improved surface quality.

XRD tests confirmed the absence of harmful substances in the ceramic waste. Following this, additional efforts focused on reducing weight, improving porosity, and lowering costs. Field results demonstrated that the concrete modules supported coral colonization and enhanced marine biodiversity. These findings confirm ceramic tile wastes and foam concrete's viability as sustainable materials for coral reef restoration. The study contributes to both marine conservation and sustainable waste management by repurposing ceramic tile waste into innovative reef restoration solutions. Further research is recommended to expand the application of these materials and assess long-term impacts on coral regrowth and marine ecosystems.

Keywords — Ceramic Tile Waste, Corals, Mix Designs, Marine Conservation, Foam Concrete, Waste Management.

DEDICATION

This Dissertation is dedicated to

My loving parents, my wife, my siblings, and my friends.

For their endless love, support, and encouragement given during this journey.

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Many people helped me out with this project. Professors Prof. R.U. Halwatura and Prof. P.B. Terney Pradeep Kumara gave me vital comments on my analysis and framing, replying to my emails at odd hours of the night and early in the morning. As I mentioned several other professors also, provided insightful comments.

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Furthermore, I want to acknowledge the invaluable contributions of several colleagues who played a significant role in facilitating and supporting this study. Their assistance was important, and their collective efforts were crucial to the successful completion of this study.

Finally, I will always be grateful to my family for everything they have done for me. I devote everything to my loving family.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

Abbreviations	**Description**
CGTW	Ceramic Glazed Tile Waste
NFC	Natural Fiber Composites
CC	Climate Change
MCM	Marine Concrete Modular
GB	Green Building
GBCSL	Green Building Council of Sri Lanka
LCC	Life Cycle Cost
PCA	Principal Components Analysis
MPA	Marine Protected Area
MPW	Marine plastic waste
NARRDA	National Aquatic Resources Research and Development Agency
SDG	Sustainable Development Goal
WMA	Waste Management Authority
XRD	X-ray diffraction
MB	Marine Biological
MGE	Marine Geological environment