DESIGNING AND DEVELOPING A PROTOTYPE OF SMART AND HYBRID PAVING SYSTEM

Nipun Rochana Kumarage

(218070M)

Degree of Master of Science

Department of Civil Engineering

University of Moratuwa

Sri Lanka

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Thesis submitted in partial fulfilment 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 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.

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The above candidate has carried out research for the Master thesis under my supervision.

Name of Supervisor : Prof. (Mrs.) C. Jayasinghe

Signature of Supervisor : UOM Verified Signature Date : 18/12/2022

Name of Supervisor : Dr K.P.H. Perera

Signature of Supervisor : UOM Verified Signature Date : 18/12/2022

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Abstract

Landfilling has now become a prime concern all around the world, not only because it squanders usable land, it causes major environmental issues such as contamination of soil, water, and air, as well as an impact on human health. Glass is one of these waste products which is often dumped when mixed with impurities. A similar landfill was found in a Sri Lankan glass factory dumping its waste for over 20 years. Moreover, one of the major drawbacks of Permeable Interlocking Concrete Paving (PICP) is its unsatisfying appearance. Although many researchers created better aesthetic appearances for PICP, none were cost-effective. Hence, a study was implemented to solve these two issues by developing sustainable paving blocks with smart top-layer customizations utilizing this glass waste. Initially, finite element modelling was used to determine the optimal paving block dimensions, and 200x100x80 mm^3 was discovered to be the ideal paving block dimension for cobble-type paving blocks. Following that, tests were performed on glass waste to determine its suitability for use as fine aggregate. In all tests, glass waste exhibited favourable results. As a result, a mix design was developed using this glass waste, and it was discovered that it could replace 100% of the fine aggregate while maintaining structural strength. Three alternatives were proposed to meet the customers' aesthetic satisfaction and were tested in accordance with the SLS 1425 standard, in which all three alternatives resulted satisfactorily. Finally, a Life Cycle Costing Assessment (LCCA) was performed to determine the economic feasibility of the proposed products. LCCA indicated that when only mortar is considered, the proposed mix has a 37% cost reduction, and after smart top layer customizations, two alternatives had 6% and 5% cost reductions, while the final alternative had a 17% cost increment compared to existing paving blocks.

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List of Abbreviations

Abbreviation	Description
AADTT	Average Annual Daily Truck Traffic
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASTM	American Society for Testing and Materials
BS/ BS EN	British Standards
FEM	Finite Element Modelling
ICE	Inventory of Carbon and Energy
ICPI	Interlocking Concrete Pavement Institute
IRC	Indian Roads Congress
IS	Indian Standards
LCCA	Life Cycle Costing Assessment
LKR	Sri Lankan Rupee
Mn	Millions
NPV	Net Present Value
PAP	Porous Asphalt Paving
PCP	Permeable Concrete Paving
PGP	Plastic Grid Paving
PICP	Permeable Interlocking Concrete Paving
SLS	Sri Lankan Standards
SSD	Saturated Surface Dry