UTILIZATION OF DEMOLISHED CONCRETE WASTE FOR ROLLER COMPACTED CONCRETE PAVEMENT(RCCP) APPLICATIONS

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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/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).

Signature: Date: 30/11/2024

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

Name of Supervisor: Prof. W.K. Mampearachchi

Signature of the Supervisor: Date: 30/11/2024

DEDICATION

To my family and everyone who patiently endured long discussions when I insisted that, yes, concrete can indeed be rolled and laid—your support (and raised eyebrows) kept me going.

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Lastly, I am eternally grateful to my family for their boundless love and support. Without their encouragement, none of this would have been possible.

ABSTRACT

Roller Compacted Concrete (RCC) has gained popularity in concrete pavement applications owing to its strength, durability, and cost-effectiveness. However, due to the growing scarcity of natural aggregates, sustainable alternatives for natural aggregates are in demand. This study explores the use of Recycled Concrete Aggregates (RCA) obtained from demolished concrete waste in RCC pavement applications, aiming to assess its mechanical performance. The research explores the most suitable compaction method for optimum moisture content (OMC) determination for RCC, the influence of RCA quality improvements on RCC properties and the impact of using clay tile aggregates (CTA) for internal curing.

Various compaction methods, such as the Standard Proctor Test (SPT), Modified Proctor Test (MPT), Vibratory Hammer Test (VHT) and Modified Vebe Test (MVT), were analysed to determine the most suitable OMC for RCC mix design with RCA (RCC_RCA) and virgin crushed aggregates (RCC_VCA). VHT and MVT emerged as suitable methods for OMC determination of RCC.

The study also compared the performance of RCA treated through various methods: surface coating with fly ash (FA), surface coating with sugarcane bagasse ash (SCBA), and ball milling. Results revealed that ball milling RCA significantly improved aggregate quality by reducing water absorption and porosity. RCC with 100% ball-milled RCA and cement showed increased strength, nearly matching the performance of RCC made with VCA.

The incorporation of waste CTA in RCC mixes enhanced early-age (3-day) compressive strength by 13-18% compared to externally cured RCC, owing to the benefits of internal curing. However, it showed a reduction in long-term compressive strength in comparison to externally cured conventional RCC. Tensile and flexural strength also slightly declined with the inclusion of CTA. Uncured RCC specimens with CTA performed better than uncured RCC specimens without CTA in terms of all mechanical properties. These findings indicate that RCA can be successfully utilised in RCC pavements, and internal curing using CTA as fine aggregates at a replacement percentage of 5% will provide significant benefits for the early hydration of RCC.

The study contributes to the scientific knowledge of sustainable construction practices and provides practical recommendations for incorporating RCA in RCC and alternative curing techniques for RCC pavements.

Keywords: Roller Compacted Concrete (RCC), Recycled Concrete Aggregate (RCA), Internal Curing, Clay Tile Aggregate (CTA), Concrete Pavements

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LIST OF ABBREVIATIONS

Abbreviation	Description
ACV	Aggregate Crushing Value
ADT	Average Daily Traffic
AIV	Aggregate Impact Value
C&D	Construction and Demolition
CDW	Construction and Demolition Waste
COWAM	Construction Waste Management
CTA	Clay Tile Aggregates
CTW	Clay Tile Waste
FA	Fly Ash
GMC	Galle Municipal Council
HPC	High-Performance Concrete
IC	Internal Curing
ICA	Internal Curing Aggregates
ITZ	Interfacial Transition Zone
LAAV	Los Angeles Abrasion Value
LWA	Light Weight Aggregate
MCDM	Multi-Criteria Decision Making
MDD	Maximum Dry Density
MPT	Modified Proctor Test
MVT	Modified Vebe Test
NAC	Natural Aggregate Concrete
OD	Oven Dry
OMC	Optimum Moisture Content
PCA	Portland Cement Association
PCC	Portland Cement Concrete
PCCP	Portland Cement Concrete Pavement
RCA	Recycled Concrete Aggregates

RCC	Roller Compacted Concrete
RCCP	Roller Compacted Concrete Pavement
SCA/5	Standard Specifications for Construction and Maintenance of Roads and Bridges
SCBA	Sugarcane Bagasse Ash
SEM	Scanning Electron Microscope
SPT	Standard Proctor Test
SSD	Saturate Surface Dry
VCA	Virgin Crushed Aggregates
VHT	Vibratory Hammer Test
XRD	X-Rad Diffraction
W/C	Water: Cement
SWG	Solid Waste Generation
EU	European Union
MRA	Mixed Concrete and Masonry Recycled Aggregates
RMA	Recycled Masonry Aggregates
NMAS	Nominal Maximum Aggregate Size
OCC	Optimum Cement Content
ACI	American Concrete Institute
ASTM	American Society for Testing Materials
SGC	Superpave Gyratory Compactor

LIST OF APPENDICES