ASSESSMENT OF STEEL SLAG-SEA SHELL POWDER-BASED GEOPOLYMER CONCRETE ON MECHANICAL AND DURABILITY PROPERTIES

OKORO, WILSON CHUKWUNONYENIM
(20PCI02083)

AUGUST, 2022

ASSESSMENT OF STEEL SLAG-SEA SHELL POWDER-BASED GEOPOLYMER CONCRETE ON MECHANICAL AND DURABILITY PROPERTIES

BY

OKORO, WILSON CHUKWUNONYENIM
(20PCI02083)
B.Eng. Civil Engineering, Landmark University, Omu-aran, Kwara State

A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF ENGINEERING (M.Eng.) IN CIVIL ENGINEERING, COLLEGE OF ENGINEERING COVENANT UNIVERSITY, OTA, OGUN STATE, NIGERIA

AUGUST, 2022

ACCEPTANCE

This is to attest that this dissertation is accepted in partial fulfilment of the requirements for the award of the degree of Master of Engineering (M.Eng.) in Civil Engineering, College of Engineering, Covenant University.

Mr. Taiwo B. Erewunmi
(Secretary, School of Postgraduate Studies) **Signature and Date**

Prof. Akan B. Williams
(Dean, School of Postgraduate Studies) **Signature and Date**

DECLARATION

I, **OKORO, WILSON CHUKWUNONYENIM (20PCI02083),** declare that this research was done by me under the strict supervision of Dr. Solomon O. Oyebisi in the Department of Civil Engineering, Covenant University. To the best of my knowledge, no part of this report partially or wholly has been submitted here in Covenant University or elsewhere in a previous application for the award of a degree. All data have been duly acknowledged.

OKORO, WILSON CHUKWUNONYENIM

Signature and Date

CERTIFICATION

We certify that this dissertation **titled "ASSESSMENT OF STEEL SLAG-SEASHELL POWDER-BASED GEOPOLYMER CONCRETE ON MECHANICAL AND DURABILITY PROPERTIES"** is an original research work carried out by **OKORO, WILSON CHUKWUNONYENIM (20PCI02083)** in the Department of Civil Engineering, College of Engineering, Covenant University, Ota, Ogun State, Nigeria under the supervision of Dr Solomon O. Oyebisi. We have examined and found this work acceptable as part of the requirements for the award of Master of Engineering (M.Eng.) in Civil Engineering.

Dr. Solomon O. Oyebisi
(Supervisor) **Signature and Date**

Prof. Anthony N. Ede
(Head of Department) **Signature and Date**

Prof. Obanishola M. Sadiq
(External Examiner) **Signature and Date**

Prof. Akan B. Williams
(Dean, School of Postgraduate Studies) **Signature and Date**

DEDICATION

I dedicate this report to Almighty God, whose grace favoured me through my project duration, making it a success. To him alone be all the glory. Also, to my parents Mr & Mrs Okoro, for their admonition and encouragement.

ACKNOWLEDGEMENTS

My first gratitude is to the Almighty God, who has been with from inception till now and made my project a huge success. Also, my family most especially my parents Mr & Mrs Okoro for their consistent support throughout my master's programme.

I want to deeply appreciate the Chancellor, Covenant University, Dr. David O. Oyedepo, whose remarks have served as a continual inspiration of one's abilities and possibility mentality. Thank you, sir, and long live your legacy. Also, to the Vice-Chancellor, Prof. Humphrey Adebayo, Dean School of Postgraduate Studies, Prof. Akan B. Williams, Sub-dean, Dr Emmanuel O. Amoo, and the Dean of the College of Engineering, Professor David Olukanni. My deep appreciation to the Head of Department Civil Engineering, Prof, Anthony N. Ede for all their tenacious efforts to ensure that Covenant University becomes one of the top ten universities in the world by the year 2022.

I want to warmly appreciate my mentor and supervisor, Dr Solomon Oyebisi, for his effort towards the success of my project, especially his patience and longsuffering; God bless you sir.

My deep gratitude to the PG coordinator, Dr. Gideon Bamibgoye, Prof. David Omole, Engr. John Oluwafemi, Dr. Paul Awoyera, Dr. Ofuyatan Olatokunbo, Dr. Oluwarotimi Olofinnade, Dr. Mark, Engr. Abimbola Odetoyan, Engr. Jolayemi Joshua, Engr. Sanni, Mr Friday and the entire staff of Civil Engineering for their contribution to my project.

My warm appreciation to my siblings, friends, colleagues, and families in the Lord: Precious Okoro, Wilfred Okoro, Daniel Okoro, Ven. Prof. Oyedeji, Tomi Kayode, Adebanke Ogundipe, John Effiong, Daniel Ayoola, Victor Ajayi, Ogaga Odokuma, Promise Epelle, Prince Osilaechun, PraiseGod Aminu among others. I love you all.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF PLATES

LIST OF ABBREVIATION

$CaCO_3$	Calcium Carbonate
CaO	Calcium Oxide
$CaSO_4$	Calcium Sulfate
C-A-S-H	Calcium Alumina Silicate Hydrate
C-S-H	Calcium Silicate Hydrate
C_2S	Tri-calcium silicate
C_3S	Bi-calcium silicate
CO_2	Carbon dioxide
$Ca(OH)_2$	Calcium hydroxide
FA	Fly Ash
FAK	Fly Ash Kaolin
FASS	Fly Ash Silica fume furnace Slag
FTIR	Fourier Transform Infrared spectroscopy
GGBFS	Ground granulated blast furnace slag
GPC	Geopolymer Concrete
HNO_3	Nitric acid
H_2SO_4	Sulfuric acid
ID	Identifier
$MgSO_4$	Magnesium Sulfate
N-A-S-H	Sodium Alumina Silicate Hydrate
Na_2CO_3	Sodium carbonate
NaOH	Sodium hydroxide
Na_2SiO_3	Sodium silicate
OPC	Ordinary Portland Cement
pH	Potential of Hydrogen
PLC	Portland cement
PCC	Portland Cement Concrete
SEM	Scanning Electron Microscopy
S 1	Sample 1
S 2	Sample 2

S. Avg	Sample Average
Temp	Temperature
TGA	Thermogravimetric Analysis
K_2SiO_3	Potassium silicate
XRD	X-Ray Diffraction
XRF	X-Ray Fluorescence

ABSTRACT

Globally, a high carbon footprint has led to an unconducive and negative environmental impact on all living organisms. The production of cement is one of the sources which generates these footprints. To this effect, finding an alternative to cement to mitigate these footprints is imperative. One of these alternatives is the production of a geopolymer binder (GPB). This study deployed oyster seashell and steel slag as precursors combined with sodium silicate (Na_2SiO_3) as an activator in geopolymer concrete production. The concrete materials were prepared, cured, and tested. Workability, mechanical, durability and characterization test were conducted on the geopolymer concrete (GPC). The findings revealed an increase in slump value with an increment in a seashell. The optimum GPC compressive strength for 3, 7, 14, 28 and 56 days was obtained with 10% seashell, while seashell replacement exceeded 10 % declined in strength. Low thermal conductivity and less shrinkage were attained with seashell increment. Portland cement concrete achieved better mechanical strength when compared to steel slag geopolymer concrete. However, steel slag seashell powder-based geopolymer gained better thermal properties than Portland cement concrete (PCC) at 20% seashell replacement.

Keywords: Compressive strength, geopolymer concrete, sodium silicate, thermal conductivity, sustainable production, waste management.