

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

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AUGUST, 2022

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PROPERTIES**

BY

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**A DISSERTATION SUBMITTED TO THE SCHOOL OF
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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.

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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.

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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.

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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.

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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 ₂ S	Tri-calcium silicate
C ₃ S	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 ₂ SO ₄	Sulfuric acid
ID	Identifier
MgSO ₄	Magnesium Sulfate
N-A-S-H	Sodium Alumina Silicate Hydrate
Na ₂ CO ₃	Sodium carbonate
NaOH	Sodium hydroxide
Na ₂ SiO 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 ₂ SiO 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.