Australian Journal of Civil Engineering Volume 20, 2022 - Issue 1
Research Article

Slag-based geopolymer concrete incorporating ash: effects on thermal performance

Solomon Oyebisi
, Anthony Ede
, Festus Olutoge
, Hilary Owamah
& Tobit Igba

Pages 208-221 | Received 25 Mar 2020, Accepted 17 Jun 2021, Published online: 19 Jul 2021

- Read this article
-
- Share

- Back to Top

ABSTRACT

The thermal performance (TP) of concrete structures is vital to the evaluation of the fire response. Thus, this study examined the thermal properties slag-based geopolymer concrete (GPC) incorporating corncob ash (CCA). Corncob was valorised and partially used as a substitution for slag under the ambient curing conditions. Sodium hydroxide (SH) solution and sodium silicate (SS) gel were used as alkaline activators at 12, 14, and 16 M concentrations. The TP of GPC was compared with that of Portland cement concrete (PCC). Thermal predictions were developed based on the thermal properties. Based on the findings, GPC exhibited lower thermal conductivity (TC) and thermal diffusivity (TD) with increasing specific heat capacity (SHC), indicating good thermal insulation properties (TIP) compared with PCC. The TIP increased with increasing CCA content in the mixture at all levels of alkaline activators. Thus, CCA improves the insulating capacity of the GPC. In addition, a good correlation exists between the GPC produced and thermal properties. These findings can be beneficial in the hot climate regions and utilised for structural insulating construction concrete. Finally, the proposed models can be used in the assessment of GPC structures incorporating supplementary cementitious materials (SCMs) to enhance the TIP of construction materials.

KEYWORDS:

- Corncob ash
- geopolymer concrete
- ground granulated blast furnace slag
- thermal conductivity
- thermal diffusivity
- specific heat capacity

Acknowledgments

The authors appreciate the Covenant University Centre for Research, Innovation, and Discovery (CUCRID) for the provision of the funding and conducive environment in the course of this study.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Data Availability Statement

The authors confirm that some data supporting the findings of this study are available within the article. Besides, other data that support the findings of this study are available on request from the corresponding author [S.O]. These data are not publicly available due to restrictions, e.g. they contain information that could compromise the privacy of research participants.

Additional information

Funding

This work was supported by the Covenant University Centre for Research, Innovation and Discovery.

Notes on contributors

Solomon Oyebisi

Solomon Oyebisi holds a BTech in Civil Engineering, MSc in Structural and Materials Engineering, and PhD in Civil Engineering. He is a corporate member of the Nigerian Society of Engineers, International Association of Engineers, and Nigerian Institution of Civil Engineers. He is a registered member of the Council for the Regulation of Engineering in Nigeria. Currently, he is a Lecturer I at the Civil Engineering Department of Covenant University, Ota, Nigeria. His area of research interests includes concrete technology, sustainable materials, construction management and project quality control. He has published over fifty (60) papers in Peer-reviewed Journals and International conferences.

Anthony Ede

Anthony Ede has a Laurea (combined BSc and MSC) in Civil Engineering. He received his PhD in Composite Materials for Civil Structures. He is a corporate member of the Nigerian Society of Engineers and Nigerian Institution of Civil Engineers. He is a registered member of the Council for the Regulation of Engineering in Nigeria. At present, he is a Professor of Structures and Sustainable Construction Materials and a Head of Civil Engineering Department, Covenant University, Nigeria. His current research focus includes the use of natural fiber in structural strengthening, behavior of natural fiber, and fiber reinforced polymer composites for structural applications. He has published over 90 articles in reputable Journals and Conferences.

Festus Olutoge

Festus Olutoge holds a BEng in Civil Engineering, MSc in Structural and Materials Engineering, and PhD in Civil Engineering. He is a corporate member of the Nigerian Society of Engineers, and a registered member of the Council for the Regulation of Engineering in Nigeria. Currently, he is working as a Professor at the Civil Engineering Department of the University of Ibadan, Nigeria; and at the Civil and Environmental Engineering, University of the West Indies, Trinidad and Tobago. His area of research interests includes concrete technology, sustainable materials, and materials science and engineering. He has published over fifty (50) papers in Peer-reviewed Journals and International conferences.

Hilary Owamah

Hilary Owamah holds a BEng in Soil and Water Engineering, MEng in Environmental Engineering, and PhD in Civil Engineering. He is a corporate member of the Nigerian Society of Engineers; Fellow, Nigerian Institution of Civil Engineers and Nigerian Institution of Environmental Engineering. He is a registered member of the Council for the Regulation of Engineering in Nigeria. Currently, he is an Associate Professor at the Civil and Environmental Engineering Department of Delta State University, Abraka, Nigeria. His area of research interests includes solid waste management and renewable energy. He has published over thirty (30) papers in Peer-reviewed Journals and Conferences.

Tobit Igba

Tobit Igba has a BEng in Civil Engineering and MSc in Structural Engineering and Mechanics. His PhD Programme is at advanced stage. Currently, he is a Lecturer II at the Civil Engineering Department of the Federal University of Agriculture, Abeokuta, Nigeria. He has published over twenty (20) papers in reputable Journals and Conferences.

Previous article**View** issue table of contents**Next** article

Related Research

5 Howick Place | London | SW1P 1WG