ID 6013

Innovative Use of the Glass and Seashell waste Powders as Partial Cement Replacements in Eco-Flowable Sand Concrete

Bennabi Serine*, Boukhelkhal Djamila, Guendouz Mohamed, Melikchi Redouane, Hadjadj Moussa

[1] LME Laboratory, University of Medea, Medea, Algeria

* bennabi.serine@univ-medea.dz

ABSTRACT

This study aims to investigate the use of seashell waste powder (SWP) and glass waste powder (GWP) as partial cement substitutes in Flowable Sand Concrete (FSC), with substitution ratios ranging from 0 to 20%, focusing on their impact on slump flow, compressive, and tensile strengths. The findings suggest that incorporating these powders into the concrete improves its workability and yields favorable mechanical properties. Specifically, with a 10% substitution of cement with SWP and GWP, the mix showed an increase of 3.57% in slump flow, an enhancement in compressive strength by 9.22% at 7 days and 8.93% at 28 days, and an improvement in tensile strength by 9.84% at 7 days and 3.72% at 28 days, compared to the control mix. Using these waste materials reduces costs and CO_2 emissions, aiding sustainability.

Keywords: Flowable Sand Concrete, Glass waste powders, seashell waste powders, mechanical characteristics.

1. Introduction

With the depletion of cement raw materials, which are non-renewable resources, their availability is diminishing over time. The civil engineering sector now incorporates solid waste such fly ash, blast furnace slag, plastic fibers, and mining tailings in concrete production, as a substitute for traditional cement [[1], [2], [3]]. Seashell waste is utilized as a substitute for cement due to its elevated calcium content, which enhances concrete's mechanical and physical characteristics[4]. Bassam et al. [5] included seashell powder as a partial replacement for cement in the concrete mixture. They observed that introducing more seashells to the mixtures improves the concrete's workability. Glass powder is also a waste material, and it has been employed in certain studies as a replacement for aggregate or cement, using waste glass as an alternative. However, waste glass contains amorphous SiO_2 and also includes alkali metal oxides (Na_2O, CaO), which possess the capability to induce the alkali-silica reaction phenomenon. Nonetheless, there is limited research available on the replacement of high-dose cement with microparticulate waste glass. In addition, the incorporation of stabilizers, such as calcium oxide (CaO) and magnesium oxide (MgO), into concrete has been shown to effectively decrease the occurrence of alkali-silica reaction (ASR) phenomena[[6], [7], [2]]. This study aims to investigate the use of seashell waste powder (SWP), rich in CaO and $CaCO_3$, as well as glass waste powder (GWP), as partial substitutes for cement in the production of Flowable Sand Concrete (FSC). The substitution ratios evaluated for these materials are 0, 5, 10, 15, and 20%. The primary objective of this research is to assess the impact of these additions on two key FSC parameters: slump flow and compressive strength. The findings suggest that incorporating these powders into the concrete improves its workability and yields favorable mechanical properties. This study also ensures that the reuse of these types of waste in the FSC gives a positive approach to reduce the cost of materials and solve certain environmental problems (emissions of CO_2).

DOI: 10.21467/abstracts.170 ISBN: 978-81-970666-1-0 (eBook)

2. Experimental

A meticulous procedure was followed to prepare the flowable sand concrete samples used in this study. The seashells and glass were carefully washed, dried, and ground into a fine powder. This powder was then incorporated into the concrete formulation.

The concrete composition was developed based on the SABLOCRETE 1994 theoretical method. The concrete was formulated with sand from Oued-Souf, an artificial Portland cement CPJ-CEM II/A (Mâtine) with a minimum compressive strength of 42.5 MPa at 28 days.

3. Results and Discussion

In this study, the use of seashell powder and glass powder as partial substitutes for cement was analyzed to determine their effect on concrete properties. It was observed that the utilization of these powders improves the slump of the concrete in its fresh state, indicating a potential enhancement in the mixability of the blend. However, a decrease in compressive strength was noted in samples containing seashell and glass powder compared to the control sample.

4. Conclusions

- The incorporation of seashell powder and glass powder improves workability of fresh concrete.
- However, SWP and GWP slightly decrease the compressive strength of hardened concrete.

References

[1] M. Guendouz, D. Boukhelkhal, A. Mechantel, et T. Boukerma, « VALORIZATION OF COFFEE WASTE AS BIO-AGGREGATES IN CRUSHED SAND CONCRETE PRODUCTION. | Environmental Engineering & Management Journal (EEMJ) | EBSCOhost ». Consulté le: 30 janvier 2024.

[2] X. Yuan, M. Dai, Y. Gao, Y. Zhou, et F. Liu, « Effect on mechanical properties and microstructure of high-strength eco-friendly concrete with waste glass powder-eggshell particles », Journal of Building Engineering, vol. 79, p. 107871, nov. 2023, doi: 10.1016/j.jobe.2023.107871.

[3] F. Soltanzadeh, M. Emam-Jomeh, A. Edalat-Behbahani, et Z. Soltan-Zadeh, « Development and characterization of blended cements containing seashell powder », Construction and Building Materials, vol. 161, p. 292-304, févr. 2018, doi: 10.1016/j.conbuildmat.2017.11.111.

[4] K. H. Mo, U. J. Alengaram, M. Z. Jumaat, S. C. Lee, W. I. Goh, et C. W. Yuen, « Recycling of seashell waste in concrete: A review », Construction and Building Materials, vol. 162, p. 751-764, févr. 2018, doi: 10.1016/j.conbuildmat.2017.12.009.

[5] B. A. Tayeh et al., « Durability and mechanical properties of seashell partially-replaced cement », Journal of Building Engineering, vol. 31, p. 101328, sept. 2020, doi: 10.1016/j.jobe.2020.101328.

[6] D. A. Muhedin et R. K. Ibrahim, « Effect of waste glass powder as partial replacement of cement & sand in concrete », Case Studies in Construction Materials, vol. 19, p. e02512, déc. 2023, doi: 10.1016/j.cscm.2023.e02512.

[7] M. Chandra Sekhar, M. H. Kumar, S. Lova Raju, et I. Saikrishnamacharyulu, « Influence of Metakaolin and glass powder on mechanical behaviour of concrete », Materials Today: Proceedings, avr. 2023, doi: 10.1016/j.matpr.2023.03.713.

ISBN: 978-81-970666-1-0

Series: AIJR Abstracts

DOI: 10.21467/abstracts.170