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Performance evaluation of palm oil clinker sand as replacement for conventional sand in geopolymer mortar

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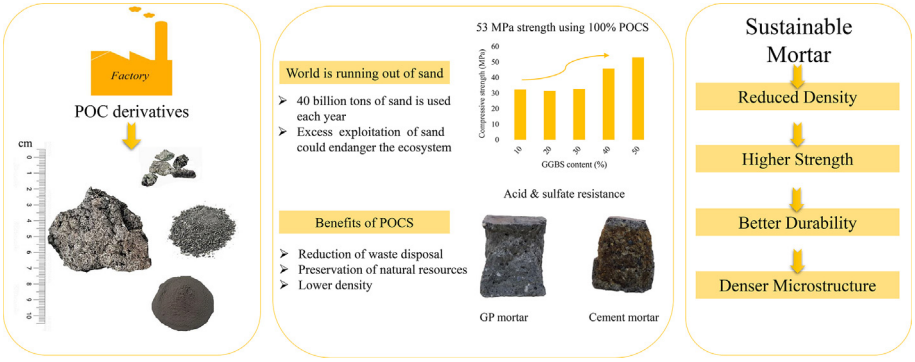
HIGHLIGHTS

- Palm oil clinker is a potential by-product for replacement of sand in geopolymer.
- Comparable mechanical properties were achieved with POC sand geopolymer mortar.
- POC geopolymer mortar showed a great resistance to HCl and $MgSO_4$ solutions.
- Density reduction of about 17% was achieved using POC as sand in geopolymer mortar.
- The strength development of mixes was increased with higher GGBS content.

GRAPHICAL ABSTRACT



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ABSTRACT

As a result of excessive exploitation and the growing need for conventional sand, a potential replacement for sand has never been this vital to preserve the environmental ecology. This paper investigated the performance of palm oil clinker sand (POCS), a local industrial by-product and waste as a whole sand replacement in geopolymer mortar; a total number of 16 mixes were cast by varying the molarity of NaOH and binder. Mechanical properties, durability, and microstructural characteristics were investigated. The novelty of this research lies on the use of sustainable POCS as sand replacement for conventional mining sand; the mix design was carried out using a volume-based approach by employing the specific gravity of the fine aggregates. In addition, with partial replacement of the fly ash (FA) with ground granulated blast furnace slag (GGBS) as the binder, the need for oven-curing was avoided. Based on the test results, the 28-day compressive strength of 53 MPa was achieved for ambient-cured mix with FA-GGBS (50:50) as binder and replacement of conventional sand with POCS. Geopolymer mortars showed higher resistance to the HCl and magnesium sulfate compared to cement mortar. XRD and EDX analyses showed enhanced formations of Si-O-Si and C-A-S-H bonds in GGBS incorporated mixes, and the presence of calcite mostly in the ambient-cured mixes resulted in stronger mechanical properties.

1. Introduction

The explosive growth of the world population from around 1 billion in the year 1800 to an increase of 7-fold [1] since then

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