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Mechanical, durability and microstructure properties of lightweight concrete using aggregate made from lime-treated sewage sludge and palm oil fuel ash

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HIGHLIGHTS

- The novel Posslite LWAC produced from LWA made from lime-treated SS and POFA.
- Dense shell and rough surface of Posslite LWA enhanced the strength of LWAC.
- Presence of crystals prevents Posslite LWA from decay in concrete.
- Workability of Posslite LWAC is comparable with NWAC and yet it is 15% lighter than NWAC.
- The mechanical and durability performance of Posslite LWAC is comparable to NWAC.

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ABSTRACT

This paper reports the investigation on toxicity characteristics, microstructure, physical and mechanical properties of artificial Posslite lightweight aggregate (LWA) made from lime-treated sewage sludge (SS) and palm oil fuel ash (POFA). The presence of crystals and a dense shell of Posslite LWA enhanced its strength and the rounded shape of LWA enhanced the workability of fresh lightweight aggregate concrete (LWAC). Results showed that mechanical and durability properties of Posslite LWAC were comparable to normal weight aggregate concrete (NWAC). Posslite LWAC possesses compressive strength, VPV, sorptivity, chloride diffusion of 50.4 MPa, 8.7%, 0.0151 mm/s$^{0.5}$ and 2.12×10^{-11} m^2/s, respectively.

1. Introduction

Concrete is the most widely used construction material and its high production has led to the depletion of natural resources such as conventional normal weight aggregate (NWA) and cement. For instance, the quarrying of coarse aggregates in Kuwait had been completely stopped and is entirely dependent on imported aggregates from the neighbouring countries [1]. Several other countries such as Taiwan and Argentina also face the shortage of good quality natural aggregates to support the needs in the local construction activities [2–3]. In order to alleviate this problem, researchers have been developing a more sustainable approach in the construction industry. One such approach is the reuse of different solid waste streams to produce artificial lightweight aggregate (LWA) [4–7].

LWA can be categorised into two major types – natural LWA and artificial LWA. The primary source of natural LWA is from

Abbreviations: LWAC, Lightweight aggregate concrete; NWAC, Normal weight aggregate concrete; VPV, Volume of permeable voids; RCPT, Rapid chloride penetration test; SEM, Scanning electron microscopy; XRD, X-ray diffraction; EDX, Energy dispersive spectroscopy; SS, Sewage sludge; POFA, Palm oil fuel ash.

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