Chapter in Book

Compressive Strength of Palm Boiler Ash as Sand Replacement in Lightweight Foamed Concrete

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Abstract: *The distinct properties of industrial by-products derived from agricultural wastes make it viable as substitute material in construction material applications. The present study investigates the workability and the compressive strength performance of lightweight foamed concrete using palm boiler ash produced from palm oil boilers as partial sand replacement material. The palm boiler ash with different percentage mass replacement; 4%, 8% and 12% were used to replace the sand in the foamed concrete. The inclusion of palm boiler ash as sand replacement in the foamed concrete matrix has been found to increase the compressive strength of the concrete blends. The integration of palm boiler ash also aids in the formation of pores, resulting in a lightweight product with higher compressive strength.*

Keywords: palm boiler ash; compressive strength; foamed concrete.

1. INTRODUCTION

Integrating natural fibres and industrial by-products into environmentally friendly and sustainable concrete has paved its way in structural application. The utilization of these industrial by-products in foamed concrete offers great potential in reducing the weight with acceptable strength (Rashad, 2016; Mannan & Ganaphaty, 2004; Awang et al. 2014; Mohamed Yusof et al. 2022). This study aims to evaluate the ideal composition and the compressive strength performance of palm oil boiler ash (POBA) as partial sand replacement in foamed concrete.

2. METHOD & MATERIAL

The foamed concrete consists of original Portland cement, foaming agent, POBA, free water, and fine aggregate. POBA used to replace the sand in this study was sieved through a 2 mm sieve, with different percentage mass replacement; 4%, 8% and 12%. The details of the mix proportions sample are shown in Table 1.

Table 1. Details of mix proportions foamed concrete sample.

Mixture sample	Mix proportion [kg.m^{-3}]				Foaming agent [l m^{-3}]
	Cement	Fine aggregate	POBA	Water	
Control	538	538	-	323	301.55
4% POBA	538	517	21	323	301.55
8% POBA	538	495	43	323	301.55
12% POBA	538	473	65	323	301.55

The foamed concrete with various percentages of POBA were evaluated under 3 tests: water absorption test, density determination and uniaxial compressive test. Foamed concrete with a density of 1,400 kg.m^{-3} was prepared in this study. The mixture of foamed concrete was poured into a mould and weighed to get the wet density of the mixture. The foamed concrete was then left to dry after the curing process and weighed again to determine the density of the dry foamed concrete. The compressive strength test was conducted using three samples of foamed concrete for each POBA mix proportion at the ages of 7, 28, 60 and 90 days, following standard practice.

3. FINDINGS

Figure 1 shows the density of foamed concrete with 4%, 8% and 12% of POBA replacement at 7, 28, 60 and 90 days. The foamed concrete with 12% POBA recorded the highest density of other replacement levels. The density result indicates that longer curing days have led to greater foamed concrete density. Foamed concrete with the highest proportion of POBA recorded the highest water absorption. This result indicates that increasing POBA in the foamed concrete will increase the water absorption value as observed in Figure 2. Replacing sand with POBA greatly increases the strength of foamed concrete, as the 12% POBA recorded the highest compressive strength as shown in Figure 3.

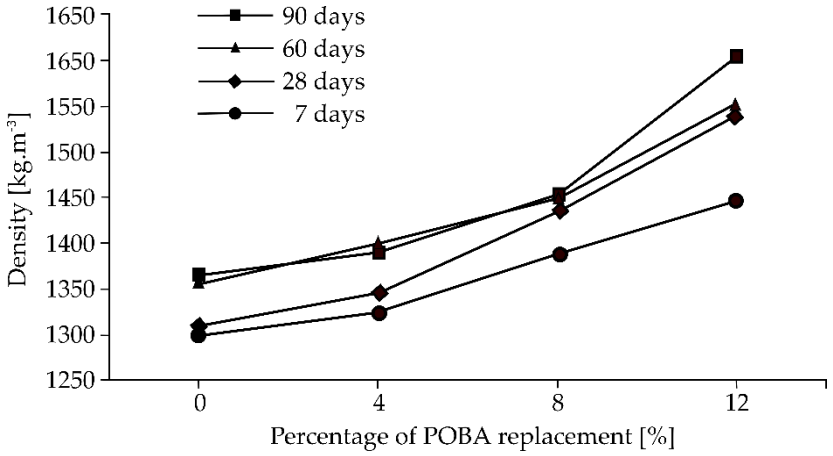

Figure 1. Density of the foamed concrete with 4, 8 and 12% POBA replacement at curing age of 7, 28, 60 and 90 days.

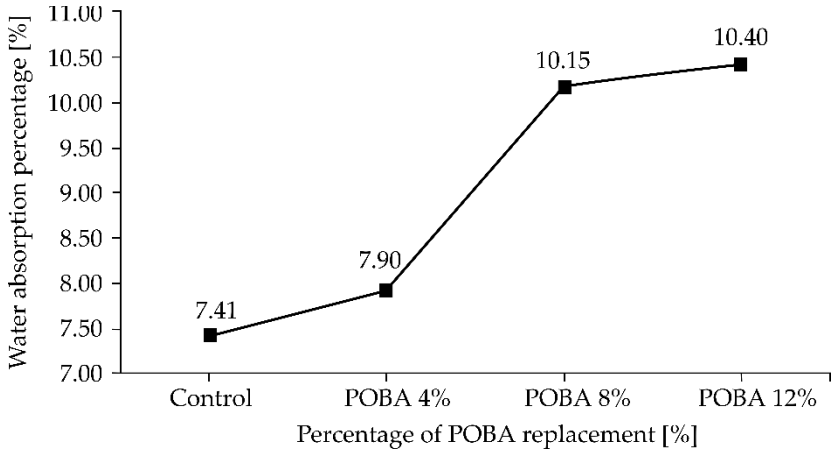

Figure 2. Relationship between the percentage of POBA replacement and water absorption percentage.

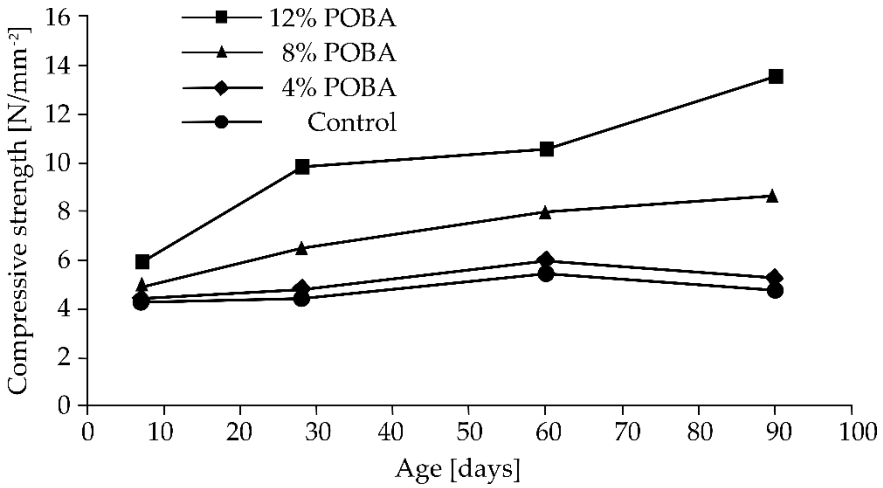

Figure 3. Compressive strength of foamed concrete with different percentage of sand replacement.

5. CONCLUSION

The present study on utilizing palm boiler ash (POBA) as sand replacement in foam concrete shows a promising result in concrete manufacturing. The presence of POBA in foam concrete significantly enhanced the pore amount in their matrix structure, resulting in the invention of lightweight concrete but with higher compressive strength. The result from this study indicated that the POBA was feasible to be utilized as the supplementary cementing material in the concrete mixture.

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