International Journal of Architectural, Civil and Construction Sciences
ISSN: 2415-1734
Vol:8, No:2, 2014

Oil Palm Shell Ash - Cement Mortar Mixture and Modification of Mechanical Properties

Abdoullah Namdar, Fadzil Mat Yahaya

***Abstract*—**The waste agriculture materials cause environment pollution, recycle of these materials help sustainable development. This study focused on the impact of used oil palm shell ash on the compressive and flexural strengths of cement mortar. Two different cement mortar mixes have been designed to investigate the impact of oil palm shell ash on strengths of cement mortar. Quantity of 4% oil palm shell ash has been replaced in cement mortar. The main objective of this paper is, to modify mechanical properties of cement mortar by replacement of oil palm ash in it at early age of 7 days. The results have been revealed optimum quantity of oil palm ash for replacement in cement mortar. The deflection, load to failure, time to failure of compressive strength and flexural strength of all specimens have significantly been improved. The stress-strain behavior has been indicated ability of modified cement mortar in control stress path and strain. The micro property of cement paste has not been investigated.

***Keyword*—**Minerals, additive, flexural strength, compressive strength, modulus of elasticity.

I. Introduction

FACTORS effect on strengths of cement mortar are water/cement ratio, mix ratio, type of cement, aggregate grade, mixing method, placement, additive, room humidity, room temperature, curing method, change of temperature and humidity during curing, and the presence of chemical composition in water and aggregate. In this work effect of oil palm shell ash on strength of cement mortal has been investigated.

The cement mortar and concrete produce CO_2 gas emissions. The cement used in cement mortar and concrete in a chemical process significantly release of carbon dioxide [1]. The Kyoto Protocol indicates to reduce emissions of carbon dioxide. The reduction of carbon dioxide is an important issue for the construction industry and sustainable development [2]. Replace raw materials can improve the characteristics of cement and reduction of CO_2 emissions [3]. This replacement takes place during the mixing of cement mortar rather than during the manufacturing of cement. It has been observed [4], replacement of high percentages of some minerals to cement can result in a concrete with lower compressive strength. And superplasticizers in mix design result in economical concretes with enhanced durability and CO_2 emissions reductions.

The minerals replacement in cement has been applied for many purposes to improve cement function in concrete industry; the fly ash, marble powder and limestone powder were used as mineral and filler additives in self-compacting concrete [5], the results of a laboratory study were determined mineral admixtures including silica fumes (SF), metakaolin (MK), fly ash (FA) and Ground granulated blast slag (GGBS) improved the properties of the recycled aggregate concretes [6], In an experimental work with optimum mix design for concrete has been evaluated the suitability of quarry dust as a partial substitute for sand in high-strength concrete (HSC) containing rice husk ash (RHA) [7], the influence of silica fume, metakaolin, fly ash and ground granulated blast-furnace slag, on workability, compressive strength, elastic modulus, porosity and pore size distribution of high strength concrete (HSC) has been assessed [8], the bentonite and kaolin-bentonite mixture have been treated by heat, used for modification of mechanical properties of concrete [9], [10], the class F and class N fly ash, ultra-fine fly ash, silica fume, metakaolin, and ground granulated blast-furnace slag have been used for corrosion mitigation of mortar and concrete [11], the effect of silica fume and fly ash on compressive strength and modulus of elasticity of lightweight concrete [12]. It has been reported that the pozzolans increases the mechanical strength of concrete [13]. In this paper, to assess modification of flexural strength and compressive strength of cement mortar at early age of 7 days, the oil palm shell ash as a natural mineral has been replaced to cement mortar. And to precision analysis a comparative study with previous research work have been done.

Abdoullah Namdar and Fadzil Mat Yahaya are with the Department of Civil Engineering & Earth Resources, Universiti Malaysia Pahang, Malaysia (e-mail: ab_namdar@yahoo.com).

II. Experimental Setup

To avoid scattering in test results the cement mortar has been selected. Table I shows mixture design.

A w/c of about 0.38 is necessary to obtain full hydration as the hydration reaction is expansive and the C–S–H absorbs (gel) water as it grows [14]-[16]. The w/c has been selected based on previous research reports. The quantity of consumed cement has been reduced for 4% by replacement of oil palm shell ash.

TABLE I
Mix Designs of the Solidified Wastes

OPC	Sand	Oil palm shell ash	W/C ratio
(50%)	(50%)	(0%)	0.4
(46%)	(50%)	(4%)	0.4

The cubical molds of (10cm × 10cm × 10cm) and beam molds of (10cm × 10cm × 50cm) have been designed and materials have been made according to Table I. After 7 days of hydration, the compressive strength and flexural strength have been measured.

III. Result and Discussion

The natural additive with environment friendly is desirable for sustainable development. This paper, the oil palm shell ash has been selected for modification of cement mortar mechanical properties. Force versus time to failure for cubic specimen has been shown in Figs. 1, 2, 4% of oil palm shell ash improved compressive strength and time to failure of specimens. Figs. 3, 4 are depict level of enhancement of deflection in cubic specimens in replacement of 4% of oil palm shell ash in cement mortar. The graphs of stress versus strain for cubic specimen show, the static compressive modulus elasticity has not considerably been changed (Figs. 5, 6). The small cement mortar beam have subjected to the flexural load, Figs. 7-10 indicate behavior flexural strength, time to failure and deflection of small cement mortar beam. It has been observed that the replacement of 4% oil palm shell ash to cement mortar results in enhancement flexural strength enhanced, and time to failure and deflection have been decreased. Is has been understood that the deflection governs time to failure of beam. In comparative results of compressive strength and flexural strength concluded that the deflection and time to failure of cubic specimens and small cement mortar beam are not same. From this point, it is expected the flexural modulus elasticity and compressive modulus elasticity have different behavior.

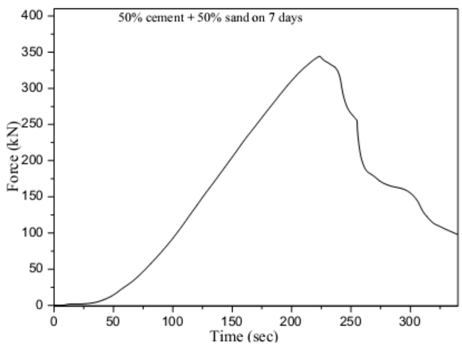

Fig. 1 Force Vs time to failure for cubic specimen [17]

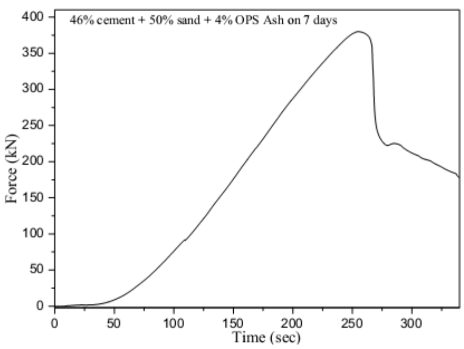

Fig. 2 Force Vs time to failure for cubic specimen

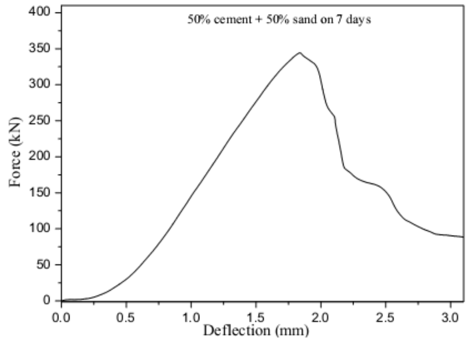

Fig. 3 Force Vs deflection for cubic specimen [17]

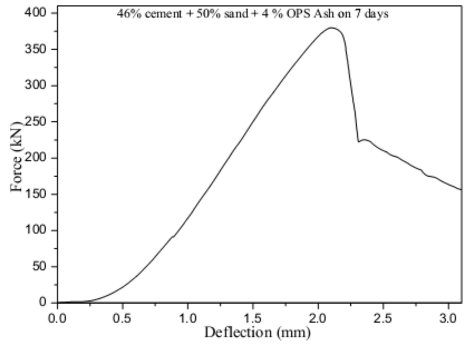

Fig. 4 Force Vs deflection for cubic specimen

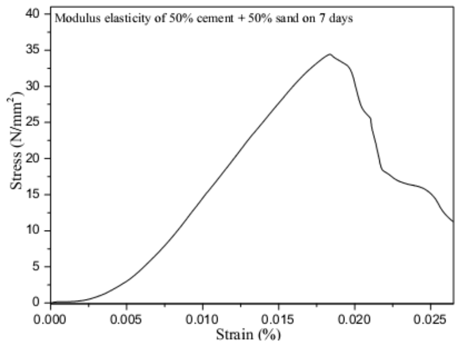

Fig. 5 Stress Vs strain for cubic specimen [17]

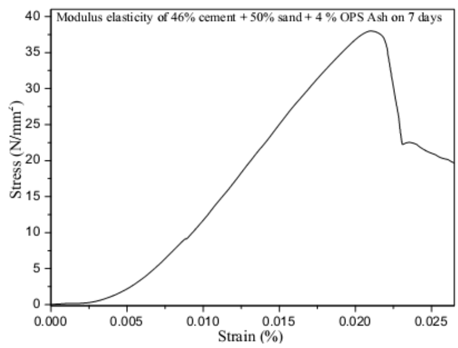

Fig. 6 Stress Vs strain for cubic specimen

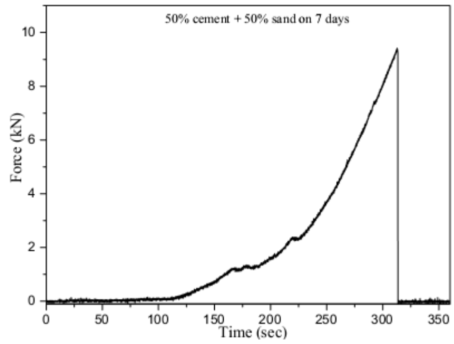

Fig. 7 Force Vs time for beam [17]

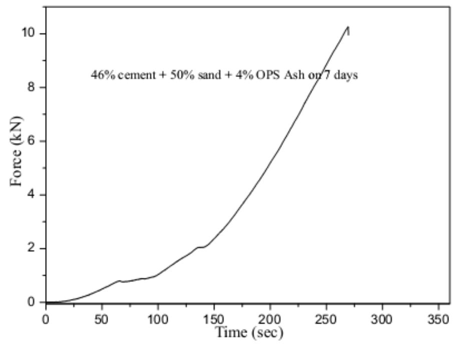

Fig. 8 Force Vs time for beam

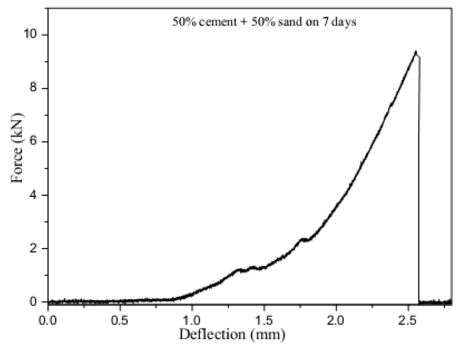

Fig. 9 Force Vs deflection for beam [17]

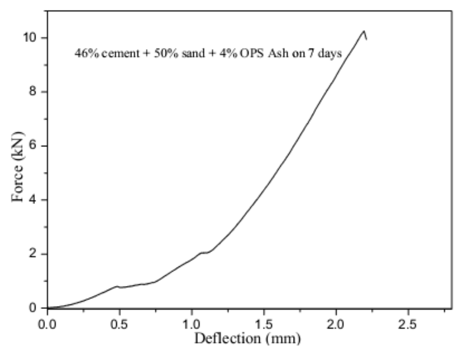

Fig. 10 Force Vs deflection for beam

IV. Conclusions

The Portland cement has been replaced by oil palm shell ash. The results of this research indicate effect of the Portland cement - oil palm shell ash mixture on compressive and flexural strengths. The mineral presents in Oil palm shell ash operates in modifying mechanical properties of beam and cubic specimens, according to cementitious paste interactions with the fine sand. Addition of Oil palm shell ash has not been effect on static compressive modulus elasticity of cement mortar. It is expected the flexural modulus elasticity and compressive modulus elasticity have different behavior. The finding of this research is applicable for replacement of oil palm shell ash to sand to improve compressive and flexural strengths of cement mortar and concrete. The micro property of cement paste has not been investigated.

References

[1] M.I.A. Khokhar, E. Roziere, P. Turcry, F. Grondin, A. Loukili. Mix design of concrete with high content of mineral additions: Optimisation to improve early age strength. Cement & Concrete Composites 32 (2010) 377-385.
[2] P.K. Mehta, M Walter. Roadmap to a sustainable concrete construction industry. Construct Specifier 61(1) (2008)48-57.
[3] Roskovic R, Bjegovic D. Role of mineral additions in reducing CO2emissions. Cem Concr Res 35(2005) 974-8.
[4] Malhotra VM. Reducing CO2 emissions-the role of fly ash and other supplementary cementitious materials. Concr Int 2000 (September) 42-5.
[5] Uysal M, Tanyildizi H. Predicting the core compressive strength of self-compacting concrete (SCC) mixtures with mineral additives using artificial neural network. Construction and Building Materials 25 (2011) 4105-4111.
[6] Kou SC, Poon CS, Agrela F. Comparisons of natural and recycled aggregate concretes prepared with the addition of different mineral admixtures. Cement & Concrete Composites 33 (2011) 788-795.
[7] Raman SN, Ngo T, Mendis P, Mahmud HB. High-strength rice husk ash concrete incorporating quarry dust as a partial substitute for sand. Construction and Building Materials 25 (2011) 3123-3130.
[8] Megat Joharia MA, Brooks JJ, Kabir S, Rivard P. Influence of supplementary cementitious materials on engineering properties of high strength concrete. Construction and Building Materials 25 (2011) 2639-2648.
[9] A. Namdar. Thermally Modifying Bentonite for Construction Industry. Int. J. of GEOMATE, 1 (2011) 95-98.
[10] A. Namdar. Natural minerals mixture for enhancing concrete compressive strength. Frattura ed Integrità Strutturale, 22 (2012) 26-30; DOI: 10.3221/IGF-ESIS.22.04.
[11] Shi X, Yang Z, Liu Y, Cross D. Strength and corrosion properties of Portland cement mortar and concrete with mineral admixtures. Construction and Building Materials 25 (2011) 3245-3256.
[12] Shannag MJ. Characteristics of lightweight concrete containing mineral admixtures. Construction and Building Materials 25 (2011) 658-662.
[13] G.C. Isaia, A.L.G. Gastaldini, R. Moraes. Physical and pozzolanic action of mineral additions on the mechanical strength of high-performance concrete. Cement & Concrete Composites 25 (2003) 69-76.
[14] Powers TC, Brownyard TL. Studies of the physical properties of hardened Portland cement paste. Bulletin, 22. Research Laboratories of the Portland Cement Association, Chicago; 1948.
[15] Taylor HFW. Cement chemistry. New York: Academic Press; 1990.
[16] Neville AM. Properties of concrete. New York: Wiley; 1996.
[17] Namdar A, Yahaya FM, Jie KJ, Ping LY. An Investigation on Effect of Oil Palm Shell Ash on Flexural Strength and Compressive Strength of Cement Mortar. 2014 The 4nd International Conference on Advanced Materials Research (ICAMR 2014). Macau, China, Jaunary 22-23, 2014.