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PALM OIL CLINKER: A POTENTIAL PARTIAL SAND REPLACEMENT IN BRICK PRODUCTION

K. Muthusamy[1, 2*], M. F. S. Ali[1], M. N. A. A. Zawawi[1], N. Nordin[1], S. M. S. Mohsin[1], N. F. Ariffin[1]

[1] Faculty of Civil Engineering and& Earth Resources, Universiti Malaysia Pahang, Malaysia
[2] Centre of Resources and Research Management Centre, Universiti Malaysia Pahang, Malaysia

A R T I C L E I N F O

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A B S T R A C T

The present research stems out from the environmental problem posed by dumping of palm oil clinker, a by-product of palm oil industry and excessive sand mining issues. Thus, experimental work has been conducted to investigate the effect of palm oil clinker content as partial sand replacement on the properties of brick. A total of five mixes containing various percentage of palm oil clinker, which are 0%, 10%, 20% 30% and 40% have been prepared. All specimens were water cured until the testing date. The compressive strength test, flexural strength test and water absorption test was conducted at 7 and 28 days. The findings show that incorporation of 10% palm oil clinker contributes towards densification of the mix which enhances both compressive strength and flexural strength performance of the brick. The water absorption of the brick increases slightly when palm oil clinker is integrated as partial sand replacement. On overall, the brick produced using palm oil clinker as partial sand replacement can be used for non load bearing application.

1. Introduction

Sand is one of the main ingredients used to produce a sand brick. Usually, the natural sand produce from the mining activity has been used in sand brick since years before. The raw sand and gravel produced in Malaysia is increasing from year 2014 which is about 34,341,300 tonnes to 29,862,000 tonnes on 2015 respectively (Malaysianminerals.com, 2016). This increment shows that the demand of sand is quite high as well as the mining activities also increasing. Even though the mining activity gives a positive impact especially in term of economy growth in Malaysia, however, it also contributes to the serious environmental issues problem. The stream mining resulted in channel degradation and erosion, head cutting, increased turbidity, stream bank erosion and sedimentation of riffle areas (Kondolf, 1993). Moreover, the mining activity pollutes the river which is the main source of the fresh water and also effect the aquatic life. Sand mining activity not only effecting river's ecosystem but it also can cause deforestation for the purpose of road construction to mining area. This problem can be reduced by minimizing the use of natural sand in construction industry, which in the present work is sand brick.

Malaysia is one of the world largest palm oil producer which generates a large amount of by products that disposed as wastes. Malaysia generates about 3.13 million tonnes of oil palm shell as waste, which estimated to grow due to the ongoing global consumption demand for palm oil (Basri et al., 1999). Palm oil clinker is one of the palms oil waste by product which normally discarded as profitless waste. Palm oil clinker is produced from the incineration process of oil palm shells and fibers. This by product is dump at the landfill without any utilization and estimated around 2.6 million tons of solid waste was produced annually by the palm oil industry which

*Corresponding author. Tel: +609-5492947 Fax: +609-5492998
*Email address: khairunisa@ump.edu.my

mostly composed of palm oil clinker and palm oil shell (Basri et al., 1999). Many research has been conducted by utilizing the palm oil by product to produce a new construction material that can be used to replace or partially replace the natural resources. Palm oil clinker can be classified as an artificial aggregate due to its properties which are similar to the natural aggregates.

Thus, the aim of this study is to develop an environmental friendly cement sand brick containing palm oil clinker. In this research, the effects of using different percentage of palm oil clinker as partial sand replacement in cement sand brick were investigated. Furthermore, the properties of this newly developed palm oil clinker cement sand brick was determined.

2. Experimental Setup

The experimental work was conducted at the concrete laboratory in Faculty of Civil Engineering and Earth Resources, Universiti Malaysia Pahang. The overall work comprised of three stages that is material preparation, casting of specimens and testing.

2.1 Materials

Ordinary Portland cement, river sand, tap water and palm oil clinker are among the materials that were used in specimen preparation. River sand was obtained from the nearby local supplier. Clean tap water was used for cement sand brick mixing and curing process. No admixture was added in the mixture. The palm oil clinker wastes were supplied by palm oil mill located in Gambang, Pahang.

Palm oil clinker wastes which have been disposed at the dumping sites were packed in gunny sacks before transported to concrete laboratory for further processing. Figure 1 illustrates the palm oil clinker collection process. At the laboratory, the clinkers were prepared before ready to be used for brick production. The clinkers were cleaned to ensure that it was free from debris. Then, it pulverized into small particles using crushing machine as shown in Figure 2. Figure 3 shows appearance of palm oil clinker waste before. Figure 4 shows it appearance after ground be fine.

Figure 1: Palm oil clinker collection process

Figure 2: Palm oil clinker pulverizing process

Figure 3: Palm oil clinker chunks before grinding

Figure 4: Fine palm oil clinker after grinding

2.2 Brick Preparation

Five types of mixes were used to prepare specimens in form of brick with 210 x 100 x 65 mm dimensions. Plain cement sand brick produced using 100% river sand was used as control specimen. The rest of the mixes contain various percentage of crushed palm oil clinker (POC) from 10% up to 40% as partial fine aggregate replacement.

The mixing process was carried out using electric mixer machine to ensure all materials were mixed properly. Then, the mixes were placed in timber brick mould as shown in Figure 5. All the specimens were covered with wet gunny sack and left overnight. The next day, it was demoulded and immersed in water tank (see Figure 6) until the testing age.

Figure 5: Casting of brick specimen

Figure 6: Specimen subjected to water curing

2.3 Testing Procedure

Both compressive strength and flexural strength test were conducted at 7 and 28 days. Water absorption test were conducted at 28 days. All tests were conducted in accordance to ASTM C55 (2014). Figure 7 shows the machine used for compressive strength test of brick.

Figure 7: Compressive strength test in progress

3. Result and Analysis

3.1 Mechanical Properties

Both compressive strength and flexural strength of POC cement brick specimens containing various percentage of crushed palm oil clinker is presented in Figure 8 and Figure 9. Based on both figures, the strength recorded at 10% replacement of palm oil clinker (POC) shows the highest result of compressive strength and flexural strength. The strength of the specimen increases due to the ability of POC to fill the void inside the specimen to make the brick denser and stronger. Similar observation has been highlighted by Shettima *et al*. (2016) when solid waste known as iron ore tailing were integrated as partial fine aggregate replacement in concrete.

However, the replacement percentage has a limit, and in this case, it was at 20%. Starting from 20% replacement, it can be seen that the strength of the brick decrease with increase in percentage of POC. The value drop due to increase in porosity of the specimen. Porosity of the specimen increases due to porous structure of POC particle. Porous structure of POC will make the structure to become less rigid and less dense. This will lead to a lower strength of the specimen with increased number of POC inside the specimen. Although the strength of specimen contain 20% of POC lower than specimen contain 10% POC, its strength can still be accepted because the specimen still has higher strength compare to control specimen.

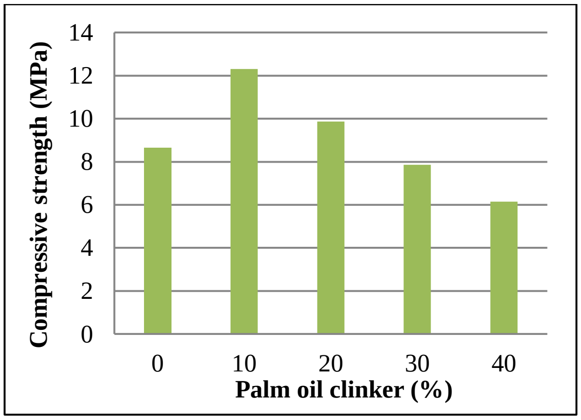

Figure 8: Compressive strength result up to 28days

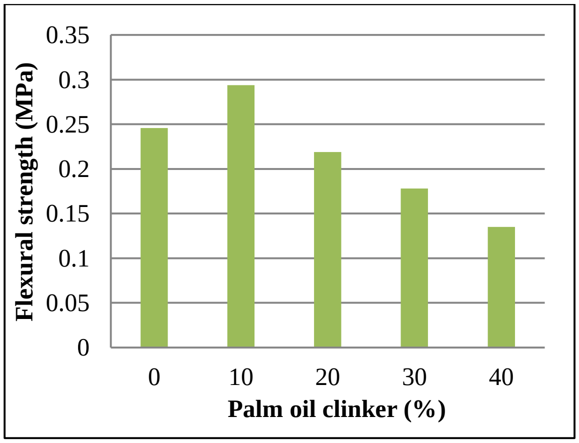

Figure 9: Flexural strength result up to 28days

3.2 Water Absorption

Water absorption test was conducted to determine the ability of specimen to absorb water. Figure 10 shows in detail the percentage of water absorption for each mixes. The water absorption pattern increase as more POC was added as partial sand replacement. This is owing to the porous structures of the POC particles. Porous structure of POC particle will act as a storage place for water. At the same time, increase percentage of POC replacement will cause increase percentage of specimen porosity. Increase in specimen porosity will lead to more water to be absorbed by the specimen and increase the percentage of water absorption.

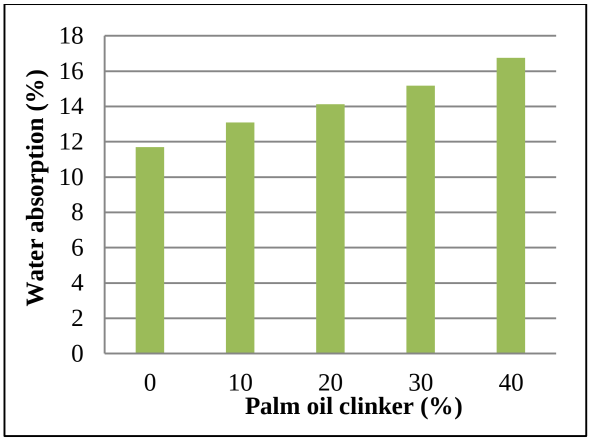

Figure 10: Water absorption result at 28days

4. Conclusion

From the test results presented, it can be concluded that 10% of pulverized palm oil clinker replacement produces a good POC cement sand brick exhibiting higher compressive strength and flexural strength owing to the filler effect of the fine palm oil clinker which filled the void inside the brick. Thus, it shows that palm oil clinker is suitable to be used as a partial sand replacement in POC cement sand brick. This finding encourages the use of palm oil clinker as partial sand replacement in POC cement sand brick production. Most importantly, pollution issue related to disposal of palm oil clinker at dumping site can be reduced and consequently the sand mining problem can be reduced. In conclusion, another locally made environmental friendly cement sand brick containing lesser natural river sand is possible to be produced for the use in construction industry.

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