A Short Review on Oil Palm Shell (OPS) as Pozzolan Material in Concrete

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ABSTRACT: This paper provides a short review on the agricultural waste such as Oil Palm Shell (OPS) as pozzolan material in concrete. Climate change due to global warming and environmental protection has become significant due to CO_2 emissions from Portland cement production. The quantity of waste generated from agricultural waste also increases every year, including Malaysia. The agricultural waste which is OPS is highlighted to be use as pozzolan material in concrete due to its relatively low amorphous silica content after incineration process (< 50% silica), apart for other used. Therefore, an alternative approach was studied form the previous researcher to extract high proportion of amorphous silica from OPS ash that fulfils the minimum requirement of pozzolanic standard.

Keywords: *Concrete; Pozzolan; Oil Palm Shell*

1. INTRODUCTION

Climate change due to global warming and environmental protection has become significant due to CO_2 emissions from Portland cement production. (Nwankwo *et al*., 2020). The concrete industry then needs to find alternative binding agents for concrete production that reduce emissions of CO_2 and utilize waste materials such as agricultural waste.

Moreover, the amount of waste generated worldwide has risen over the years (Nagarajan *et al.,* 2017). Furthermore, by utilizing the waste materials, the production cost of building materials can be reduced (Munir *et al.,* 2015). Recently, researchers have shown an increased interest in producing the cement replacement material (partial replacement) using various waste products, especially agricultural-based due to abundant availability and reactive silica produced. Therefore, it is essential to use local pozzolanic materials as a partial cement replacement because they are economical in comparison with Portland cement and environmentally friendly without sacrificing concrete strength (Abdul Ghayoor *et al.,* 2017).

Palm oil industry which is the major agro-industry in this country has been generating large amount of waste which becomes one of the main contributors to the nation's pollution problem (Teo *et al.,* 2006). So far, OPS has been successfully incorporated as coarse aggregate replacement in lightweight concrete (Shafigh *et al.,* 2012). Besides that, the use of OPS in reinforced concrete structural members demonstrated promising results (Mo *et al.,* 2014a). The innovative use of OPS in concrete could improve the sustainability of the environment since it reduces the dependency of non-renewable gravel and at the same time encourages the re-use of waste OPS.

2. POZZOLAN AND CEMENTITIOUS MATERIAL

The cementitious materials of today were one of the leading cementitious components of concretes created many centuries ago. These materials are generally called pozzolans and may form a durable binder. In accordance with ASTM C125-11b, the Pozzolan is an aluminum and silica material that does not have any cementitious or zero characteristics; however, it comes to contact with humidity begins chemical reactions with $Ca(OH)_2$ and appears to have cementitious material characteristics. There are two types of cement replacement material sources; agricultural waste and industrial waste.

2.1 Agricultural Waste

Many agricultural waste materials are already used in concrete as replacement alternatives for cement and other applications. Several types of agricultural waste usually used as replacement material in concrete like Bagasse ash, Groundnut shell, Oyster shell, Giant reed ash, Giant reed fibre and Tobacco waste (Prusty *et al.*, 2016).

2.2 Industrial Waste

There are several industrial wastes used as full or partial replacement of coarse aggregate or fine aggregate. Dash *et al.,* 2016 carry out a thorough assessment of industrial waste substances, which can be adequately utilized in concrete as a fine aggregate substitution. They reviewed some of these industrial wastes like waste foundry sand, steel slag, copper slag, imperial smelting furnace slag (ISF slag), blast furnace slag, coal bottom ash, ferrochrome slag and palm oil clinker.

2.3 Silica Extraction Method and Incineration Process

There are a number of previous researches that have conducted the silica extraction method and incineration process to increase its pozzolanic reactivity and fulfill the minimum requirement of the pozzolanic standard. G.S.V.

Hariharan (2013) intended to study the synthesized nanosilica from sugarcane bagasse ash with no pretreatment applied. Throughout the study, the incineration process was conducted by burning sugarcane calcined through a heating rate of 300 °C/h, 650 °C/2h and constant burning temperature at 500 °C and 650°C.

By controlled-burning the sugarcane bagasse ash at 650 °C/2h, the researcher obtained 72 % of silica content with some metallic impurities.

Andri *et al.* (2018) carried out the extraction method by cleaning and drying the sugarcane bagasse ash for 24 hours before conducting the pretreatment process with low-concentration HCl at various concentrations of 0.1 M, 0.5 M, and 1.0 M to remove alkali metals from the bagasse. The incineration process for the treated sugarcane bagasse ash was conducted in various temperatures at 600, 700, and 800 °C) and burning periods (1, 2, and 3 h). The researcher developed highly pozzolanic sugarcane-bagasse ash, which would improve the use of SCBA as cement substitution material, through experimental work.

Faizul *et al.* (2013), conducted the only pretreatment without incineration process to extract silica from Palm Ashvia by using Citric Acid leaching treatment method. The purpose of the strong acid leaching treatment is to remove metallic impurities and organics in rice husk with optimum extracting conditions at 700 °C of solution temperature, 60 minutes of reaction time, and concentration of citric acid of more than 2 %. The purity of silica extracted is more than 90 %.

3. ENGINEERING PROPERTIES

Engineering characteristics, considered in general, are observable, measurable, and affecting the conduct. They are essential for the analysis and design of engineering and performance components, systems, or processes. In this study, compressive strength and water permeability properties from previous studies were compared in order to observe cement mortar performance with the partial cement replacement.

3.1 Compressive Strength

One of the most essential and valuable properties is the compressive strength of concrete. Concrete is used as a building material to withstand compressive stress. Although the compressive strength is of significant importance in areas with tensile strength or shear strength, it is used to estimate the desired property.

Polat et al. (2017) conducted a compressive test on high-performance cement paste and mortar. Their research found that at the age of seven days, the concrete's compressive strength decreased when nano-MgO was used, but with the rise in nano-MgO dosage, the strength was marginally increased (Ye et al., 2015). The addition of nano-MgO is generally said to increase the compressive strength for 28 days (Ye et al., 2015; Hou et al., 2017).

Hou et al. (2017) also report that the compressive strength of the w / b = 0.60 mortars increased to up to 28 days with rising concentrations of ultrafine MgO but decreased at 90 and 180 days due to seed and coating effect on cement particle's surfaces. The high level of activity and seed effects could increase the mortar compressive strength containing ultrafine MgO at an early age (Hou et al., 2017).

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