Concrete Containing Palm Oil Fuel Ash (POFA) and Oil Palm Shell (OPS) Subjected to Elevated Temperatures

L.Y. Jong and D. C. L. Teo
Department of Civil Engineering, Faculty of Engineering, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia
Date Received: 4 November 2014
Date Published: 30 January 2015

Abstract - Nowadays, waste products such as Palm Oil Fuel Ash (POFA) and Oil Palm Shell (OPS) are produced in large quantities from the agriculture industry on a daily basis. Improper disposal of the agriculture wastes at landfills contributes to environmental pollution. The cost of construction material increases when the demand is high. Therefore, reutilization of these waste products not only reduces the cost of construction material but also minimizes waste disposal problem. In this research, waste POFA and OPS as cement and aggregate replacement respectively are used to produce a 'greener' concrete. This paper presents the effects of elevated temperatures on POFA OPS concrete. A concrete made from OPS aggregates (0% POFA) was also produced as a comparison. From the results obtained, it was observed that the formation of hair-line cracks on the surface of POFA OPS concrete specimen was less visible than OPS concrete specimen. All concrete specimens experience mass loss after being subjected to elevated temperatures. In terms of compressive strength, both OPS concrete and POFA OPS concrete specimen experienced a decrease in strength after being subjected to elevated temperatures. However, the POFA OPS concrete specimen showed better strength performance as compared to OPS concrete specimen at elevated temperatures of 200˚C to 500 ˚C.

***Keywords*:** POFA OPS, Elevated temperatures, Crack development, Mass loss, Compressive strength

I. INTRODUCTION

CONCRETE is used in buildings, bridges, dams tunnels, sewerage systems pavements, runways and even roads. However, the production of concrete consumes large amount of natural resources. Due to the increasing cost of raw materials and continuous depletion of natural resources, the use of waste materials is a potential alternative in the construction industry. The reuse of waste materials helps to save and sustain natural resources that cannot be replenished, decreases pollution to the environment and also helps to save and recycle energy production processes [1].

In Malaysia, palm oil industry is one of the largest agricultural industries. The accumulation of leftover agrowaste will cause land and air pollution in the vicinity of palm oil factories. Researchers have taken the initiative to utilize the palm oil wastes to develop sustainable construction materials [2-3]. Palm Oil Fuel Ash (POFA) contains high amount of silica that can react with calcium hydroxide ($Ca(OH)_2$) through hydration process and the pozzolanic reactions produce a lot of calcium silicate hydrate (C-S-H) gel compound in order to reduce the amount of calcium hydroxide [4]. Hence, POFA can contribute to make stronger, denser and more durable concrete in concrete production. Concrete using OPS as coarse aggregate has been found very useful as structural lightweight concrete [5]. OPS is much lighter and has low bulk density compared to conventional stone aggregate. Consequently, the resulting OPS concrete becomes a lightweight concrete [5]. However, the study of concrete incorporating POFA and OPS as partial cement and coarse aggregate replacement respectively is still relatively new and only limited information is available. By integrating the POFA in OPS concrete, it would be an added benefit to construction industry as well as palm oil industry in terms of economic and environmental aspects.

Fire is one of the most destructive powers which can expose concrete to elevated temperatures and it is one of the major risks faced by building structures. The chemical composition and physical structure of concrete will be affected when concrete is subjected to elevated temperature. During elevated temperatures, the strength of Ordinary Portland Cement (OPC) concrete decreases due to chemical and physical changes [6]. In addition, spalling of concrete during fire will cause a rapid layer-by-layer loss of concrete cover and finally leading to the exposure of the main reinforcements within the concrete

Jong, L. Y is with the Department of Civil Engineering, Faculty of Engineering, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia (e-mail: xnykira90@gmail.com).
Teo, D. C. L is with the Department of Civil Engineering, Faculty of Engineering, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia (corresponding author, phone: 082-58 3273; e-mail: tdelsye@feng.unimas.my).