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Experimental study on environment-friendly concrete production incorporating palm oil clinker and cockle shell powder as cement partial replacement

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A B S T R A C T

The demand for civil construction has increased recently; cement is now the most produced and consumed material globally. The carbon dioxide (CO_2) emissions are strongly influenced by the cement industry which make up 5 to 7% total global emissions, are ejaculating at a rate of one ton of CO_2 for every ton of cement produced. Consequently, additional cementitious substances like palm oil clinker powder (POCP), a by-product of palm oil mills and cockle shell powder (CSP), an agricultural and aquaculture byproduct derived from cockle shell combustion, can be employed as partially binding material to alleviate the ecological footprint of cement manufacturing. By substituting cement in different weight ratios ranging from 0 to 20%, this study examines the impacts of POCP and CSP on concrete. Concrete compressive strength, flexural strength and water absorption of varying POCP and CSP proportions for 7 and 28 days of curing are analyzed in the experimental investigation. This research demonstrated that samples with 10% cement substitution, comprising 5% POCP and 5% CSP, performed well in terms of mechanical aspects and water absorption. The study of concrete structures with POCP and CSP is a novel and important scientific topic, according to the research findings, and it should be emphasized.

1. Introduction

Due to the rapid growth of urbanization, developments in material science and global expansion of infrastructure, the worldwide demand for concrete has increased. A total of 25 billion tons of concrete are consumed annually throughout the world, making it the second most often utilized construction material today, behind water [1]. Currently, each person requires three tons of concrete [2,3] and more than 10 billion tonnes of concrete are used annually by the construction industry [4]. The need for concrete is anticipated to rise dramatically by 2050 owing to the expansion of the global demography, resulting in an annual demand for concrete of about 18 billion tonnes [5]. However, among all components, cement is the most expensive ingredient in concrete, which connects the aggregates and serves as a binding agent. By 2021, 4.42 billion tonnes of cement will be consumed worldwide, predicts the Global Cement Market [6]. Moreover, by 2050, this amount is expected to increase to 5 billion tonnes [7]. It is well known that globally cement is often produced by burning conventional raw materials such as stone and clay, as well as industrial waste residues such as fly ash and slag. Moreover, the procedure of manufacturing cementitious ingredients require raising the temperature to 1450 °C, that consumes a huge energy and eventually increases the cement production expenses [8]. Cement production is also a non-economic process, which uses around 1.6 MWh of energy per tonne. As per estimation, 1.7 tons of raw ingredients and 3 to 6 million Btu of power are needed to produce per ton of cement [9]. Additionally, cement manufacturing is harmful for both people and the environment. The production process is responsible for 10% of the world's CO_2 emissions, which contributes significantly to the greenhouse effect [10]. Ordinary Portland cement (OPC) production, for example, releases 1.5 billion tonnes of greenhouse gases annually [10]. Compared to 2012, 2013 had a 30% increase (467 million tonnes (Mt)) in CO_2 concentration in the air [11]. The greenhouse effect maintains the average surface temperature of the Earth between 15 and 18ºC by preventing solar radiation from being reflected back into the atmosphere [12]. Thus, the traditional concrete business has a great deal of adverse effects on the world and its conditions. Construction firms are

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