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Performance evaluation of masonry grout containing high volume of palm oil industry by-products

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ABSTRACT

The rapid depletion of natural resources has led to the need to develop sustainable practices and material in various applications. One such sustainable practice is to divert the waste generated in the palm oil industry into production of building materials. In this study, palm oil clinker (POC) is used to replace cement and coarse aggregate. The POC chunks are crushed to be used as coarse aggregate and further ground to produce POC powder (POCP) to be used as a binder. The physical properties, chemical composition and scanning electronic microscopic studies were conducted to check the feasibility of substitution of up to 50% POCP as binder and up to 100% POC as coarse aggregate. Density, ultrsonic pulse velocity(UPV), compressive strength for air & water curing, flexural, tensile strength, modulus of elasticity in water cured regimes and structural efficiency were evaluated for the samples. Carbon footprint, cost effieciency and energy savings were also evaluated to understand the contribution of POC to sustainability. The results revealed that the ideal mixture of GPP (30% POCP & 50% POC) masonry grout achieved 79% of compressive strength, a 83% of flexural strength, 85% of tensile strength and about 85.5% of modulus elasticity, as compared to control masonry grout. Carbon emissions of GPP was reduced by 21% and 14.60% cost reduction was established, in addition, appreciable energy savings was notified. The study showed that that utilisation of POC as eco-friendly material in masonry grout is highly recommended based on performance and can provide a route to sustanable practices in the building industry.

1. Introduction

Rapid growth in urbanisation has led to higher demand for housing in Malaysia. Masonry buildings have become common choices for the hard-pressed community due to rise in costs of building materials. However, masonry elements must have high load resistance, especially when used in the construction of walls and columns. This has given rise to considerable demand for masonry grout. There are two types of grout, fine and coarse grout used in the construction of masonry structures. Fine grout uses the fine aggregate, therefore, it flows between tight spaces when reinforcement bars are close to each other; whereas coarse grout uses the fine and coarse aggregates combination and therefore coarse grout is more suitable when there are larger spaces between bars and masonry. The higher demand for masonry grout has, in turn, led to higher consumption of building materials such as cement and aggregates. The over exploitation of natural resources as raw material for masonry and building materials has resulted in serious environmental problems in recent years. There has therefore been a worldwide drive towards the use of industrial waste and renewable resources for the manufactured of many engineering products used in the construction industry.

Malaysia is the largest exporter and second largest producer of palm oil in the world. The demand for biofuel worldwide offers avenues for the expansion of the palm oil market for the country (Basri et al., 1999). The production of palm oil is associated with environmental problems such as tropical deforestation, biodiversity loss, and more importantly, climate change associated with inappropriate landfilling of the large amounts of wastes produced from oil palm mills. Environmental deterioration can be reduced by

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