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Comparative study on open air burnt low- and high-carbon rice husk ash as partial cement replacement in cement block production

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ABSTRACT

This study analyzes the feasibility of using high-carbon content rice husk ash waste generated from open air burning of rice husk, as secondary raw materials in the manufacture of cement blocks. Solid masonry blocks having the size of 215 mm × 105 mm × 65 mm, were cast with the mix proportion of 1:5 cement and sand. Blocks were manufactured with two types of rice husk ash (RHA); low-carbon content RHA and high-carbon content RHA. Cement blocks, at four different RHA replacement levels of 5%, 10%, 15% and 20% were prepared for low and high-carbon RHA as partial cement replacement. Testing was included for workability (water/binder ratio and setting time), strength (compressive, flexural bending and splitting tensile) and durability (water absorption, sorption, acid attack resistance and alkaline attack resistance). Results from this test results indicate that the workability, mechanical and durability characteristics of low-carbon RHA cement blocks slightly better than that of high-carbon RHA cement blocks. However, both RHA replacement cement blocks satisfy the limit recommended by standards. Even, high-carbon RHA replacement cement block does not vastly improve the strength or durability properties, the economic and environmental benefits encourage to use high-carbon RHA in cement block production.

1. Introduction

Cement is the fundamental material in the construction industry. The demands of cement are growing rapidly due to the rapid development and construction worldwide. Increasing demand for the building materials had come into the concern of related industries [1]. The issue is not only the chronic shortage of building materials, manufacturing cement leads to severe environmental issue due to CO_2 emissions [2]. Government and cement industry has developed several strategies to overcome this issue [3].

Another environmental problem, pollution is increased with respect to disposal of waste. Open dumping of waste is becoming a major issue due to it destroys the aesthetic appearance of nature and harmful to public health. Considering the environmental issue due to waste and scarcity of cement; many attempts have been made to incorporate the waste material in the production of concrete and cement block. As examples rice husk ash, fly ash, sugar cane bagasse ash and sawdust ash can be used as a partial cement replacement in masonry block production. Using these waste materials into construction material is a sustainable solution for waste management issue. Also, this reduces the use of cement in the production of masonry blocks [4–6].

Rice husk is one of the agricultural waste and by-products of rice, which constitute about one-fifth of 751.9 million tonnes of rice produced annually in the world [7]. It is the outer covering of rice and poor in nutrients. Although rice husk is used as biomass fuel in power plants, still a large amount of rice husk is disposed to overcome large accumulation. Rice husk waste generally dumps on land or burn in the open air, creating land dereliction problems and water contamination. Therefore, incorporating rice husk in cement blocks will reduce the problems due to the disposal of rice husk waste [8].

Rice husk ash (RHA) is obtained from burning of Rice Husk, which is the by-product of rice milling. During the burning of the rice husk, about 20% of the mass remains as rice husk ash [9]. If all rice husks had been burned, it would annually produce about 30 millions of tons of RHA worldwide. Burning of rice husk at high temperature induces in more than 70–80% weight loss and convert the silica material into unreactive crystalline silica. During this process, the color of RHA has been changed from to gray or white and in ash, silica content is high and carbon content is approximately below 2.7% [10]. On the other hand, burning of rice at low temperature for shorter time periods induces in less than 30% weight loss and gives a mixture of a carbonaceous material and amorphous silica. During this process, ash has around 50–70% of amorphous silica and 30–50% of carbon content or loss of ignition [11].

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