Compressive Strength and Water Absorption of Concrete Containing Ground Coal Bottom Ash as Partial Cement Replacement

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Abstract

Growing coal consumption at power plants due to the rising demand for energy results in coal bottom ash waste generation. The disposal of this ash at landfills is consume space and poses a risk of pollution to the environment. Channelling this waste to produce blended cement would reduce the consumption of raw materials from nature and decrease greenhouse gas releases. This research aims to investigate the effect of ground coal bottom ash (GCBA) as partial cement replacement on compressive strength and water absorption of concrete. The proportion of coal bottom ash integrated ranges from 0%, 10%, 20%, 30%, and 40% (by weight of binder). All specimens were water-cured until the testing day. Integration of 10% coal bottom ash produces concrete with enhanced compressive strength. The presence of silica has enabled the occurrence of pozzolanic reactions that contribute to the well-packed internal structure of concrete with enhanced compressive strength and lower water absorption. Success in utilizing coal bottom ash for cement production would reduce the harvesting of limestone from the environment and waste disposed of at landfills.

1 Introduction

Concrete is extensively used in many constructions project all over the world owing to its strength and ease of production. Worldwide, the consumption rate of concrete is approaching 25 gigatonnes/year [1]. The demand for this building material continues to rise resulting in growing cement production which is the sole binder of concrete. It is anticipated that the demand for this material would escalate in the future [2]. Despite its vital role in binding the aggregates in the concrete mixture to form a hardened matrix, the process of manufacturing this material poses an undesirable impact on the surrounding. Despite this, concrete is regarded as one of the most essential building materials in terms of durability, cost-efficiency, and other benefits when compared to other building materials. Nonetheless, its manufacturing method has negative environmental implications and requires a lot of energy [3, 4]. The process of harvesting the limestones and other raw material destroy the natural green landscape as well as an increase the pollution issue. Generally, 1 tonne of ordinary Portland cement manufactured releases a similar quantity of carbon dioxide into the environment [5]. In addition, the raw materials are reduced over the year as they are non-renewable resources. The limited availability of natural resources is realized by the building industry [6]. The building industry may face problems owing to exhaustion and shortage of resources as well as a rise in production expenses [7]. Nowadays, it is critical to identify alternative concrete solutions that meet the criteria of sustainable building while also being ecologically friendly [8]. According to the EPA, four areas are listed in the agency's strategic plan for producing sustainable results: energy efficiency, green infrastructure, sustainable materials management, and sustainable buying and goods [9]. Thus, in view of a sustainable environment and construction, alternative material needs to be discovered to reduce the dependency on natural materials reaped from the environment.

At the same time, expanding population that creates development in many sectors causes rising demand for energy. Globally, the demand for electricity has enlarged by 66% from 2007 to 2017 [10]. In Malaysia, the coal consumption for energy generation has also risen in the last 2 decades [10]. The combustion of coal at the plant causes the formation of dark-colored coal bottom ash waste. It is not used for any purpose and is stored in an ash dump in the vicinity of the plant [11]. However, the practice of dumping this waste have appeared to be the main challenge due to inadequate disposal area [12]. Other than that, the ash tends to pollute the water and air [13] which would harm certain living things. The continuous energy-generating activity at the thermal plant contributes to the increase in the quantity of waste disposed of at the dumpsite. Thus, new lands would need to be explored for disposal of this waste in the future along with the allocation of extra expenditure for the waste management process. Recycling and reusing industrial wastes is seen as an excellent

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