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MECHANICAL AND MICROSTRUCTURAL ASSESSMENT OF AGRO-WASTE-BASED CEMENTITIOUS MATERIALS

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ABSTRACT

The utilization of agro-residues in concrete has attracted interest from both science and construction industries, because of the sustainable benefits offered by such residues and their cost-effective and environment-friendly nature compared with Portland cement. The aim of this study is to investigate the characteristics of agro-waste based cementitious/puzzolana material, the microstructural properties of agro-waste-based Cementitious material in comparison to OPC, and the rheology and mechanical properties of agro-waste cementitious material.

I. INTRODUCTION

Crop residue represents more than 50% of the global agricultural biomass [19]. The top ten CO2 emitting countries according to crop residues. Partial or full replacement of these raw materials of concrete by waste products may decrease cost, reduce energy consumption and decrease environmental pollution as well as protect the environment from industrial and agro wastes such as municipal waste, coal mine, lime sludge, ground nutshell ash, Quarry dust, iron tailing, marble dust, rice husk, limestone, Hazardous waste, zinc tailing, jute fiber, rice wheat straw, etc., Ground nut shell ash can be used as filler material and helps to reduce the voids content in concrete material.

Applications of Agro-Waste Materials in Concrete

The form of application of agro-wastes in concrete is roughly divided into two parts:

(1) Without chemical process, usually after physical treatment, such as chopping, cutting, and levigation. These materials are added into concrete in order to partially replace the cement, without variation or decreasing the performance of concrete, through applying agro-wastes.

(2) Through chemical combustion, where the burned agro-wastes constitute some of the conglutinant substances that could be exploited and partially displace the function of cement. So far, agro-waste admixtures have successfully been applied in Portland cement either with concretes, mortars, or pastes as supplementary cementitious materials.

II. LITERATURE REVIEW

1. Afonso R. G. de Azevedo, Mohamed Amin, Marijana Hadzima-Nyarko, Ibrahim Saad Agwa, Abdullah M. Zeyad, Bassam A. Tayeh, Adeyemi Adesina As for the application of ashes, they are more consolidated in the literature in the form of their incorporation and behavior that they play in the cementitious system. In general, the economic and environmental cost for the application of these wastes is still significant mainly because of the need for processing these fibers in the context of developing countries. In terms of the economic value, it is still necessary to conclude the proposition of classification of agro-industrial waste regarding its economic value into two classes. The first type has already consolidated economic potential with an adequate national and international consumer market. The second type is the new agro-industrial residues that present great scientific research potential in the coming years. As for the properties in the fresh state, it was concluded that the morphological, chemical, and cultivation characteristics of each of the agro-industrial products significantly influence these parameters, which may increase their costs and, in some cases, make the application of the cementitious material unfeasible. Finally, it was concluded that there is a feasibility of application of these agro-industrial wastes.

2. Menker Girma and Belachew Asteray The replacement percentage of biomedical waste incinerator ash and bagasse ash increases the slump, flowability, and compaction factor, and the density of fresh concrete decreases. At an early age of curing, the replacement percentage of BWIA and BA increases compressive strength, and split tensile strength decreases. At 28 days of curing, up to 10% replacement of the BA and BWIA can improve the mechanical properties of high-strength concrete. According to SEM images, a partial replacement of the cement mix ratio by bagasse ash and biomedical waste incinerator ash results in a denser C–S–H gel with fewer pores than the control mix. Furthermore, improved interlocking between aggregate and cement paste leads to improved mechanical properties in high-strength concrete. Partial replacement of the cement mix ratio by BA and BWIA results in a decrease in the pore proportion in the enlarged ITZ, reduced CH crystals, and a denser C–S–H gel when compared to control mix concrete. XRD could be used to identify the mineralogical components of the hydrated cement paste powder. e XRD data revealed the presence of hydration products like portlandite, ettringite, quartz, calcite, and okenite (hydrated C–S–H), as well as other mineral compounds that would hydrate over time. Lastly, biomedical waste incinerator ash and bagasse ash are waste product materials from medical waste incinerator centers and the sugarcane industry. eir use as a partial replacement for cement reduces the levels of CO2 emissions by the cement production process, and their use resolves the disposal problems associated with them in medical waste incinerator centers and sugarcane factories.

3. Jawad Ahmad, Ali Majdi, Mohamed Moafak Arbili, Ahmed Farouk Deifalla and Muhammad Tayyab Naqash Physical properties of Metakaolin (MTK) show rough surface texture which adversely affects the slump flow of concrete. The chemical composition of MTK indicates that MTK has the potential to be employed as a cementitious material. Increased the workability of concrete with the incorporation of MTK. The heat of hydration declined as the percentage of MTK increased. This is owing to the fact that the pozzolanic response is slow. The pozzolanic activity of MTK shows an increase in CSH concentrations which improved the binding properties of concrete. Mechanical performance such as compressive, flexural, and tensile capacity improved significantly with the replacement of MTK. The highest compressive capacity was obtained at a 10% substation of MTK which is 25% more than the control sample (28 days). However, the optimum amount is important. Based on the review, the optimum dose differs from 10 to 20% changing on the basis of MTK. It can be also noted that the enhancement in the initial age mechanical performance of concrete with MTK was not significant. However, at a later age (91 days) considerable improvement in strength was observed. An increase in the durability performance of concrete with MTK was observed up to some extent but less information is available. SEM results confirm the micro filling creditability MTK which gives more dense concrete.

4. Selvadurai Sebastin, Arun Kumar Priya, Alagar Karthick, Ravishankar Sathyamurthy, and Aritra Ghosh The compressive strength of the specimen (both cubical and cylindrical) rises to a maximum when the cement has been partially removed at a percentage of 17.5 after it decreases linearly. The split tensile test shows that the math heating effect does not affect split tensile power. This is primarily because the SCBA's micro loading capacity only affects the tensile power. The flexural strength findings show that the mathematical heating effect does not always impact the variance in flexural strength. Whenever the specimens are exposed to heat at a temperature of 400 ◦C, the math intense heat does not affect the stress–strain characteristics. Hardness increases due to the movement of SCBA's crystalline materials and, during mathematical temperature increase, into aqueous dispersion. Math heating at a temperature of 800 ◦C would offer higher mechanical output when SCBA has been partially replaced with cement at a ratio of 17.5%. An improved proportion of silica is provided by mathematical heating down to a temperature of 400 ◦C; however, the amount of carbon is not eliminated. In comparison with both the specimens heated under 400 ◦C, math heating to higher than 400 ◦C delivers the best performance. The elasticity modulus determined from the stress–strain curve is greater than the values of the IS code, so it cannot be used for RPC.

5. Jing He, Satoru Kawasaki, and Varenyam Achal Agro-wastes can serve as alternative eco-efficient and sustainable pozzolans for future concrete industries. The incorporation of these residues into cementitious materials has proven that the addition of wastes is not only advantageous to the environment but also brings about a great performance of concrete properties. At present, rice husk ash is recognized as the most appropriate alternative material for volcanic ash, while other agricultural wastes are also being studied at a large scale. Generally, they have similar characteristics to ordinary Portland cement and can be effectively used in construction. Up until now, only a few studies have conducted cost analyses on the application of ago-waste, mainly RHA in cement, and a complete economic analysis with most agro-wastes is not reported, which is necessary for their future application in construction. To some extent, although the application of agro-wastes with a partial replacement of cement was recognized by the public, the existence of their limitations, such as the addition of a high level of agro-waste ash becoming more susceptible to scaling, is still not completed. Future studies should pay more focus on aspects including the modification of agro-cement with a superplasticizer, large-scale actual application and life cycle assessment of agro-cement, and appropriate schemes for various agricultural residues with cement. This is expected to greatly amplify the scope of recycled agriculture, while rational disposal and optimal applications of agricultural waste can be achieved.

6. Gaurav Chand The excessive demand for ordinary portland cement for construction purposes has led to soaring emissions of carbon from cement production units. In order to curb these emissions, substituents of cement are the need of the hour. Meanwhile, it has to be ensured that the strength of concrete should not be compromised with the use of supplementary cementitious materials. In this process, the development of sustainable cement is the most outstanding achievement by the researchers because it not only substitutes the demand for cement but also produces concrete/mortar with improved engineering properties.

III. CONCLUSION

A paradigm shift is observed in the production of ordinary Portland cement (OPC) due to its high carbon emission worldwide and the need for adopting sustainability in construction industry. For the same, newer practices have been proposed, which includes the production of sustainable cement whose escalating demand is associated with utilization of different supplementary cementitious materials (SCMs). These SCMs, act as a key component in sustainable construction by emitting lesser carbon. Cement and concrete are among the major contributors to CO2 emissions in modern society. Researchers have been investigating the possibility of replacing cement with industrial waste in concrete production to reduce its environmental impact.

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