Scientia Africana, Vol. 23 (No. 3), August, 2024. Pp 127-132
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THE EFFECT OF USING COCONUT SHELL ASH AS A PARTIAL REPLACEMENT OF CEMENT IN CONCRETE

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Received: 24-04-2024
Accepted: 11-06-2024

https://dx.doi.org/10.4314/sa.v23i3.12

Journal Homepage: http://www.scientia-african.uniportjournal.info
Publisher: *Faculty of Science, University of Port Harcourt.*

ABSTRACT

The cost of cement, which is used in concrete works, is rising and becoming unaffordable, but as the population grows, so does the need for homes and other structures that require this material. Because Portland cement is produced using a lot of CO_2, it has a major environmental impact. Because it helps to reduce the use of natural raw materials as resources, the use of secondary materials or industrial waste in the production of cement and concrete has been promoted in the building industry. The world's waste output has grown over time as a result of socioeconomic progress, population growth, and socioeconomic activity. Looking at the prospect of waste minimization and reuse is one of the most appealing ways to manage such waste. In this instance, agricultural waste material, coconut shells, which are environmentally polluting, are gathered and burned without oxygen (pyrolysis). The resulting ash from the burning process is then used as pozzolana, partially replacing 0%, 5%, 10%, 15%, and 20% of ordinary Portland cement with ash from coconut shells. Concrete grade M20 having a mix ratio of 1:1.5:3 was used in the course of this project and a water cement ratio of 0.55 was maintained. This experiment indicates that the addition of Coconut Shell Ash (CSA)into cement composite does increase the compressive strength but the strength only increases up to certain CSA content. Specimen with 10% CSA gave the highest compressive strength of 28.3 N/mm² and this optimum strength dropped when the CSA content is further increased from 10%-20%. At 7 and 14days, the experiment shows a low compressive strength of specimens compare to the result at 28 days which gave the highest compressive strength.

Keywords: Coconut shells, Pozzolana, Workability, Compressive strength

INTRODUCTION

Research into the creation of a new green concrete material has begun due to the expanding demand from the construction industry and the issue of environmental problems brought on by agricultural wastes Heba et al (2024). Research on using industrial or agricultural wastes as a source of raw materials for the industry is now being conducted all over the world. Utilizing these wastes would not only be cost-effective but also result in foreign exchange earnings and pollution reduction. Coconut shell is a type of agricultural waste that is widely available in tropical nations all over the world. Additionally, coconut is evolving into a significant agricultural crop for tropical nations worldwide as a new biofuel source of energy, Adeala et al (2020). Methane and CO_2

emissions were significantly enhanced in the past when solid waste was disposed of by burning coconut shells (Madakson et. al, 2012). However, the perception of coconut shell as waste has begun to change as the costs of electricity, natural gas, and fuel oil have increased and grown more volatile. Right now, the Nigerian coconut shell is used as a fuel source for the boilers, and any extra shell is thrown away as gravel to maintain the plantation roads.

The utilization, storage, and disposal of coconuts should be the focus of global initiatives based on economic and environmental related issues. Although, there are several ways to use coconut shells, none of them have yet shown themselves to be financially or commercially feasible. Therefore, the goal of this work is to characterize coconut shell so as to investigate whether itcanbe utilizedin concrete as a partial replacement for Portland cement. The pollution caused by this trash while it rots can have a detrimental impact on the healthy lifestyle of those who choose to let this agricultural waste material biodegrade on its own because it takes longer and produces more pollution. Therefore, initiatives to incorporate this agricultural waste as a mixing element in concrete manufacturing have been made in order to prioritize protecting the environment for the benefit of future generations. The goal of this research is to determine whether this material, Coconut Shell Ash (CSA)has the ability to replace Portland cement in the production of concrete to some extent Oyedepo, et al (2015). It is hoped that creating concrete that incorporates crushed coconut shell ash to partially replace Portland cement will give concrete producers another option to utilize this waste material in their manufacturing processes instead of heavily relying on Portland cement. The use of this waste as a mixing ingredient or component in the manufacturing of concrete would increase its usefulness and decrease the amount of coconut shell that ends up in landfills. The performance of several concrete mixes in terms of density and compressive strengths is covered in the current study. Many of the waste materials that don't degrade will stay in the environment for hundreds or even thousands of years. Non-decaying waste items lead to a disposal crisis and exacerbate environmental issues.

Globally, concrete is the most widely used building material. It is utilized in a wide variety of structures, including bridges, dams, paving, and building frames. Additionally, compared to other materials, it is utilized the most widely in the world.

The construction industry's strong demand for traditional building materials like concrete, bricks, hollow and solid blocks, pavement blocks, and tiles has caused a sharp decline in natural resources like gravel, granite, and river sand, which has led to an ecological imbalance (Olufemi et al, 2002). The cost of construction has increased as a result of the high cost of building supplies like cement and reinforcement bars. This, together with the pollution caused by cement production, has made it necessary to look for an alternative binder that may completely or partially replace cement in the creation of concrete. To make matters worse for the environment, it has become difficult to dispose of agricultural waste materials including rice husk, groundnut husk, corn cob, and coconut shell. As a result, it is necessary to turn these waste products into valuable commodities. According to research, most materials that contain a lot of amorphous silica can be utilized to partially replace cement. Additionally, it has been demonstrated that amorphous silica, which is present in several pozzolanic materials, reacts with lime more quickly than crystalline silica. By using such pozzolans, compressive and flexural strengths may be improved. Due to the increased demand for human requirements like coconut oil, coconut as a food source, and its fluid being utilized in the manufacture of delicacies in many restaurants, the need for coconuts has continued to rise in Nigeria. This shell has been thrown out and piled up in a landfill, which creates storage issues near the factories that use it to make coconut oil and

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that utilize the coconut fluid to make coconut rice and fruit vendors, which results in daily waste creation. Therefore, the ecology is harmed by these wastes. Additionally, the building costs for constructions are quite costly because ofthe constituent materials used, the global economic downturn, and market inflationary trends. Utilizing leftover coconut shells in the manufacture of concrete would not only help the environment but also lower the price of green concrete.

MATERIALS AND METHOD

Sample Collection

Some chemical constituents in the CSA, such as lime (CaO), silica (SiO_2), alumina (Al_2O_3), and iron oxide (Fe_2O_3), are the same as the chemical constituents in cement suggesting that CSA can provide cementitious properties if used as a Supplementary Cementitious Material (SCM) in concrete.

CSA has been the additional cementitious material used in this study. It was created through the operations of grinding, burning, and sieving.

Coconut shell(Figure 1)was sourced from Badagry, Lagos, Nigeria (6.4183° N,

2.8901° E). The fibrous outer parts of the coconut shell were thoroughly removed. After collection, the shells were sundried to remove moisture and later burnt(Figure 2)in a gas-powered furnace at the Civil Engineering Department Workshop in Federal University of Agriculture, Abeokuta (FUNAAB) for three hours at a temperature of 800°C. 34kg of the coconut shell was burnt and 7.4kg was gotten after been subjected to burning. Then it was grinded and air dried(Figure 3). The burnt ash was collected and sieved thoroughly using 75 µm sieve.

Figure 1: coconut shell

Figure 2: Burnt coconut shell

Figure 3: Coconut shell ash

Data Collection

Workability of fresh concrete was determined using slump test which is an empirical test. The compressive test was conducted using a compressive machine at the Concrete laboratory of Civil Engineering of College of Engineering and Environmental Studies, Ibogun, Ogun State, Nigeria.

RESULT AND DISCUSSION

The purpose of the current study is to examine coconut shell ash's (CSA) workability and compressive strength when used in concrete as a partial replacement for regular Portland cement. After the 30 specimens were cured, data were gathered every 7, 14, and 28 days. Two specimens were crushed each day, and the average of the two values was calculated. Throughout the trial, a water-to-cement ratio of 0.55 was maintained in the concrete mix ratio of 1:1.5:3.

Workability Test Results

Figure 4 shows the average slump test VS% of CSA. As the percentage of CSA increases, workability decreases. As the CSA proportion in the mixes increases, the slump of the concrete reduces. 0% and 5% CSA gave 45 mm and 140 mm respectively.

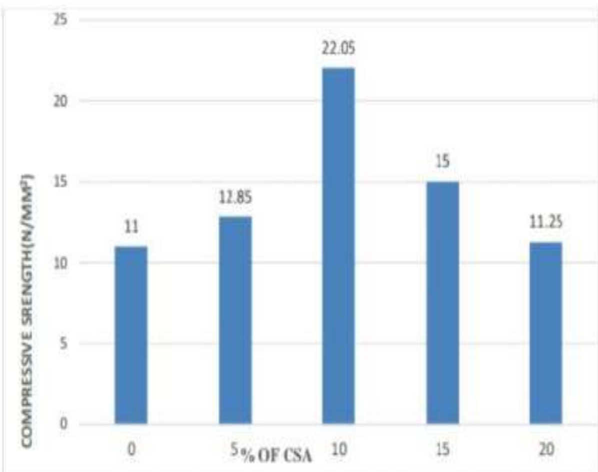

Figure 4: Slump Height VS % of CSA

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Compressive Results

The addition of CSA into cement composite does increase the compressive strength but the strength only increases up to certain CSA content. Figures 5 to 7 shows variability of strength for 7, 14 and 28 days curing time. Specimen with 10% CSA gave the highest compressive strength of 28.3 N/mm² and this optimum strength dropped when the CSA content is further increased from 10% -20%.

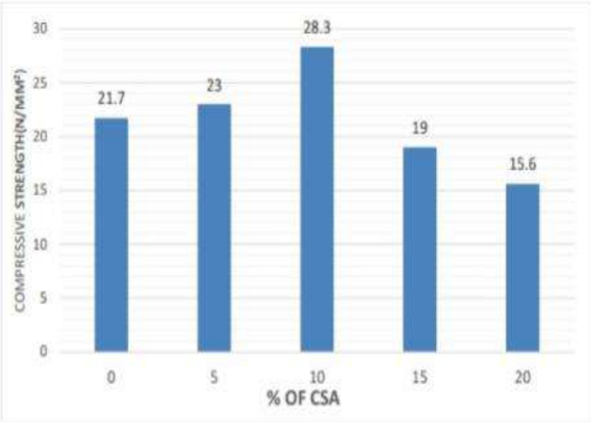

Figure 5: Average Compressive Strength VS % of CSA for 7 days

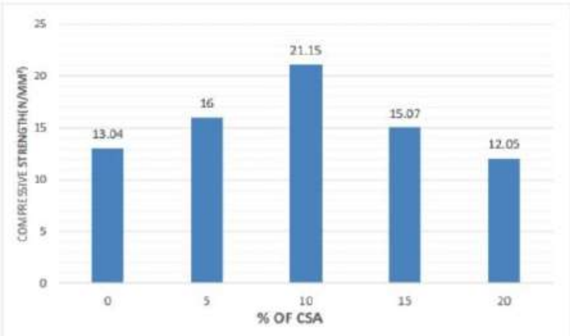

Figure 6: Average Compressive Strength VS % of CSA for 14 days

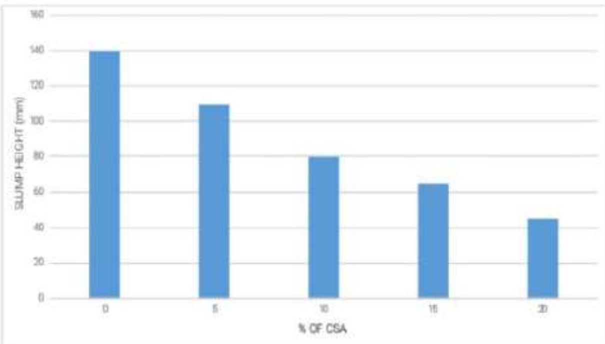

Figure 7: Average Compressive Strength VS % of CSA for 28 days

CONCLUSION

Concrete's performance was compared to regular concrete to see how well coconut shell ash (CSA) improved it. Every form of concrete, including ash and regular/plain concrete, was designed using the same size and type of materials in a constant ratio of 1:1.5:3. The CSA content, which was achieved by adding 5 -20% of the weight of regular Portland cement to the concrete mixture, is the only changeable parameter. The impact of partially replacing Portland cement with CSA on the workability (slump test) and compression test results were the test's findings.

As the ash level of the concrete mix increases, the workability of coconut shell ash-concrete declines. This resulted in low slump during the slump test and is related to the CSA's water absorption properties during the mixing process. The studies also reveal that a high ash level made the combination stiffer, which decreased the mixture's consistency. Workability is a prerequisite for consistency.

The research on CSA-Portland cement substituted concrete cubes under compression test demonstrates that adding CSA to the concrete mix in place of 10% Portland cement boosts the composite's strength with a value of 28.3 N/mm^2 as against the control (0% replacement) which gave a value of 21.7 N/mm^2 at 28 days. .

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