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OSUN CHAPTER

EFFECTS OF SUGARCANE FIBRE ASH AS PARTIAL REPLACEMENT FOR CEMENT ON THE COMPRESSIVE STRENGTH OF CONCRETE

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ABSTRACT

This project investigated the use of sugarcane fiber ASH (SCFA) as a partial replacement for Ordinary Portland cement (OPC) concrete production, 60 concrete cubes with 0 % to 25 % SCFA (as partial replacement for cement) were cast using 1:2:4 mix and water-cement ratio of 0.65. . The cubes were tested at curing age of 7days, 14days, 21days and 28 days. The chemical composition of the SCFA revealed that the ash contains $Al_2 O_3$, SiO_2 and Fe_2O_3 is 75.00%. It was observed that compacting factor value and slump value decreases as the SCFA content increase. The compacting value reduces from 0.98 to 0.88, and water absorptivity increases from 5.53% to 9.09% as percentage of SCFA increase from 0 to 25%,. As the percentage of SCFA increases from 0%, 10%, 15%, 20%, and 25% the compressive value are 23.50N/mm^2, 18.50N/mm^2, 17.50N/mm^2, 15.50N/mm^2 and 13.50N/mm^2 respectively within 28 days curing period, this shows that the higher the content of SCFA in the concrete the lower the compressive value within a specified period. It was concluded that SCFA is a good pozzolan which can be used at 10% for heavy and light weight concrete.

1. INTRODUCTION

Concrete is one of the fundamental structural materials widely used in the development of infrastructure throughout the World (Frías et. al, 2007).The importance of concrete in construction industry is increasing day by day since it was innovated (Govindarajan and Jayalakshmi, 2011).

It is most abundantly available, inexpensive and durable material that can be converted into different forms and finishes. Concrete is man-made material prepared with ordinary Portland cement commonly used on earth. In this regard, the production of concrete is worldwide despite, having an impact on environment. Global warming is one the alarming problem created during the manufacture of cement due to release of CO_2 in the atmosphere (Srivastava et al, 2013).

Concrete is made up of three main ingredients which is cement, aggregates and water. However, there were also other materials put into the concrete mix which are known as additive to increase the strength of the concrete. However, concrete has low tensile strength and easily can be crack due its brittleness characteristics (Ologunagba, Daramola, and Aliu, 2015).

Cement is a fundamental unit of concrete which does not only create environmental hazards but it's expensive too (Uche, 2008). Subsequently, cement industries are looking for alternatives instead of using cement in construction in order to avoid environmental problems. A number of researchers have worked on partial cement replacement with industrial as well as agriculture waste product like rice husk ash, millet husk (Bheel et al, 2018), tile powder (Bheel et al, 2018), fly ash, maize cob ash (Bheel et al, 2019) and many more in order to increase the reinforced concrete structures and decrease the requirement of ordinary Portland cement (Shaikh et.al, 2018). These fillers with pozzolanic properties impart nominal merits along with large content of cement replacement to be accomplished. The proper usages of these environmental degrading materials will enhance the air quality; reduce the generation of solid waste and the sustainability of the cement and concrete industry.

Also, increasing demands of concrete in the industries, researchers and scientist are developing alternate binders that are eco-friendly and contribute towards waste management especially for agricultural waste such as sugarcane.

Sugarcanes (*Saccharumofficinarum*) belong to the family of sweet grasses and grow in tropic and subtropical climate zones. The plants are 3 to 5 meters tall and their stem has a diameter of 2 – 4.5 centimeters. Sugarcane is a tree-free renewable resource and one of the most important agricultural plants that are grown in hot regions. Sugarcane is "carbon neutral" (i.e.

emissions are equal to energy generated) and is the product of choice in the manufacture of bio-fuels due to its high energy conversion rate.

Sugarcane fibre is the residual product that remains after squeezing sugarcanes during sugar production. Usually, they consist of 40 – 60% cellulose, 20 – 30% hemicelluloses, and about 20% lignin. The use of Fiber is primarily found in countries that produce high amount of sugar like Brazil, Vietnam, China or Thailand. Today, Fiber is being used as a bio-fuel in factory ovens. There is increase in the usage of sugarcane fiber due to needs for material re-cycling. Nowadays, Sugarcane fiber is being used for the production of building materials, packaging materials, and disposable tableware. Also, paper industries have started replacing wood fibers with sugarcane fibers to produce napkins, toilet paper and cardboards. (Ghazali, 2010).
Recently Sugarcane fibers has been studied for its feasibility as a cement replacing material in some parts of the world and has been found to improve some of the properties of mortar and concrete. The performance of mortar and concrete is assessed by different tests on both the fresh and hardened concrete. These include workability and compressive strength (Okagbue, 2012).
The aim of this work is to compare the effect of sugarcane fibre ash as partial replacement of cement on the compressive strength of concrete.

2. MATERIALS AND METHODS

2.1 *Materials*
The materials used are Sugar Cane fibre, Cement, Gravel, sand and water.

2.2 *Methods*

Sample Preparation
Sugar cane used for this research work was collected from Aregbesola park before Ajifolokun Junction, Ijebu-Jesa Osun State. Ordinary Portland cement (OPC) cement was bought in Esa-Oke, Osun State. Coarse Aggregate (Gravel) and Fine Aggregate (Sharp Sand) that are clean, strong, sharp, free from clay, loam, dirt or organic matters conforming to the requirement of BS EN 12620 (2008) were also collected in Esa Oke. Physical examination of the water used shows that it is clean, free from impurities and fit for drinking as recommended by the standard. BS EN 1008 (2002)

Preparation of SCFA
Sugarcane collected was squeezed using Hydraulic Juice Extractor so as to get the fibre having few moisture content. The collected fibre was oven-dried and burnt into ashes by open burning in a metal container as shown in Plate 1. Burning process continued until the sugar cane fibre turned to ash and allowed to cool for 3 days. The ash was sieved using 75μm sieve, fine enough to react perfectly with ordinary Portland cement. Physical analysis was carried out to determine the physical composition of sugarcane fibre ash (SCFA).

Plate 1: Burning of Sugarcane Fibre Ash in a Local Oven

Production of Sugarcane Fibre Ash Cement Concrete
The production of the sugar cane fibre ash cement concrete was carried out at Civil Engineering Workshop, Osun State College of Technology Esa-Oke. The production process comprises of batching, then casting of specimen cubes.

Batching of Sugarcane Fibre Ash Concrete
A weighing balance was used along with head pan, shovel, concrete cube mould and tamping rod. The sugar cane fibre ash cement concrete consists of the mixture of sugar cane fibre ash, ordinary Portland cement, sand, granite and water. Batching of materials was done by weighing in kilogram. The mixing involved the replacement of 0, 10, 15, 20, and 25 percent by the weight of ordinary Portland cement with sugar cane fibre ash during the mixing process. The cement and SCFA were mixed first before pouring fine and coarse aggregate together.

Preparation of Concrete and Casting of Specimens
The mixed ratio 1:2:4 was used with water cement ratio of 0.60 to achieve the desirable concrete strength. Cubic samples with size 100 X 100 X 100 mm^3 were cast for determination of compressive strength. Sixty (60) cubes were cast given a total of cubes for all batches. The concrete was mixed, placed, and compacted in three layers. In placing the mixed concrete in the

mould, a scoop was moved around the edges of the mould to ensure uniform distribution of concrete. Each layer was tamped with 25 blows using a tamping rod. The surface area was dressed with trowel. The sample was left in the cube mould for 24 hours, after which the cube mould was removed and the concrete was cured in water for proper hydration for 7, 14, 21 and 28 days.

Slump Test

Slump test was carried out using the slump cone 300mm high. The cone was placed on a smooth horizontal surface with the smaller opening at the top. The concrete was poured in three layers; each layer was tapped 25 times with standard steel rod of 16mm diameter. Immediately after filling, the cone was lifted and the decrease in the height of the slump was measured and recorded.

Compacting Factor Test

Compacting factor test was carried out by using the compacting factor apparatus. The upper hopper was filled with concrete in such a way that no compaction occurred, the bottom clamp was released so that concrete will fall to lower hopper. The bottom door of the lower hopper was then released so that concrete falls to the cylinder; excess concrete was cut off. Compacting factor was achieved by dividing weight of concrete in the cylinder to the weight of fully compacted concrete.

$$C.F = \frac{Weight\ of\ partially\ compacted\ concrete}{Weight\ of\ fully\ compacted\ concrete}$$

Water Absorptivity Test

This was done by removing the concrete from cube and weighing the concrete on weighing balance and recorded as Initial reading. After this the concrete was immersed in curing tank for 7, 14, 21,and 28 days. The cured concrete cubes with various percentage replacement from 0 - 25% (at 5% interval) was removed in the curing tank after these days and allowed to air dried for 48 hours (2 days) and the concrete was placed on weighing balance and record taken as well, in order to determine the rate of absorption of water capillary suction of the concrete cubes that is in contact with water.

Compressive Strength Test

The concrete cube was removed from curing tank, then air-dried for 45 minutes before subjecting it to compression test.

3. RESULTS AND DISCUSSION

Table 1 below shows the mixed proportion of the concrete samples which indicate the Percentage of Sugarcane fibre ash, Cement weight, Sand weight, Granite weight, Pozzolan weight and weight of cement added to each samples.

Table 1: Proportion of Materials for Concrete Production

SCA	CONCRETE MIX	WEIGHT OF CEMENT (kg)	WEIGHT OF SAND (kg)	WEIGHT OF GRANITE (kg)	WEIGHT OF POZZOLAN (kg)	WEIGHT OF CEMENT ADDED (kg)	TOTAL WEIGHT OF MIXED RATIO (kg)
0%	1:2:4	4.31	8.43	16.66	0	4.31	2.5
10%	1:2:4	4.31	8.43	16.66	0.43	3.9	2.34
15%	1:2:4	4.31	8.43	16.66	0.65	3.66	2.20
20%	1:2:4	4.31	8.43	16.66	0.86	3.45	2.07
25%	1:2:4	4.31	8.43	16.66	1.08	3.02	1.81

Figure 1 below shows the result of compacting factor result:

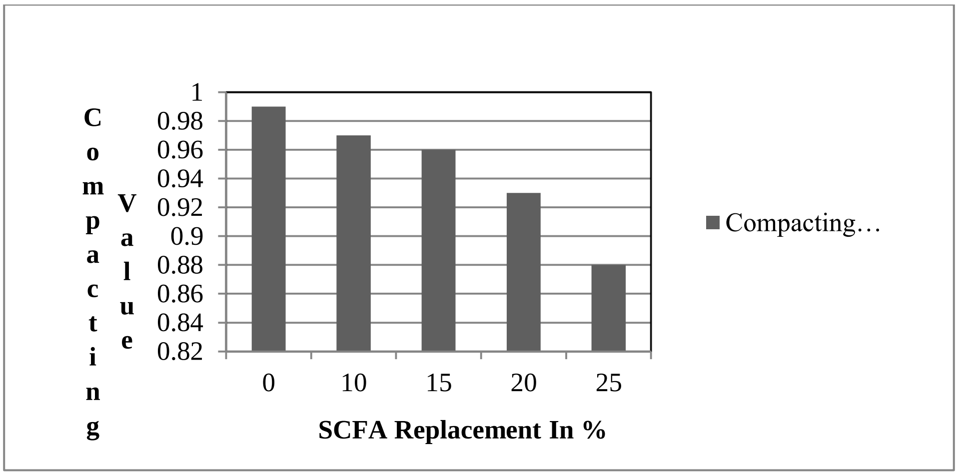

Figure 1: Compacting Factor Result

Figure 1 above shows that the compacting factor values decreases as the percentage of SCFA content increases. The compacting values are 099, 0.97, 0.96, 0.93 and 0.88 as 0%, 10%, 15%, 20% and 25% of sugarcane fibre ash is used to replace cement in the specimen

Slump Test Result

Figure 2 below shows the slump values at various percentage of replacement in the slump test carried out.

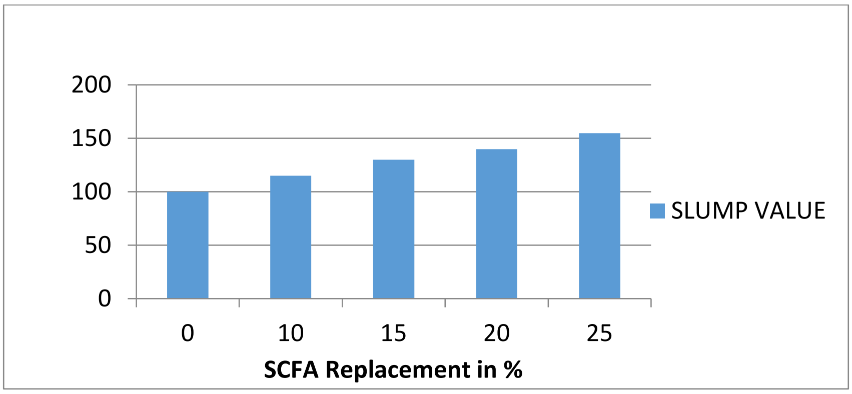

Figure 2: Slump Test Result

The result of the slump test which indicate workability of the concrete is shown in Figure .2, the slump value increases from 100 to 155(mm) as the percentage of SCFA increases from 0 to 25%. Similarly; These indicate that concrete becomes less workable as the percentage of SCFA increases meaning that more water is required to make the mix more workable.

Water Absorption

Figure 3 below shows the water absorption test values carried out on the concrete cube:

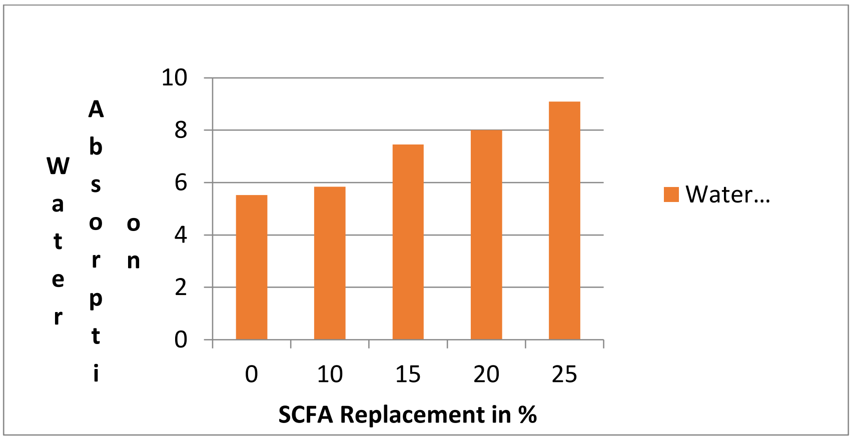

Figure 3: Water Absorption Test Result

The Concrete cube samples at each percentage were weighed in a dry condition and was placed under a wet condition and later reweighed in the wet condition. The result above shows the variation in the rate of water absorption at each percentage from 0%-25%. The result above shows the increase in the rate of water absorption from 5-53%-9.09% as the SCFA addition increases. The increase was due to the replacing agent SCFA bond in the concrete.

Compressive Strength Test

Figure 4 below shows the compressive strength value of the concrete cube.

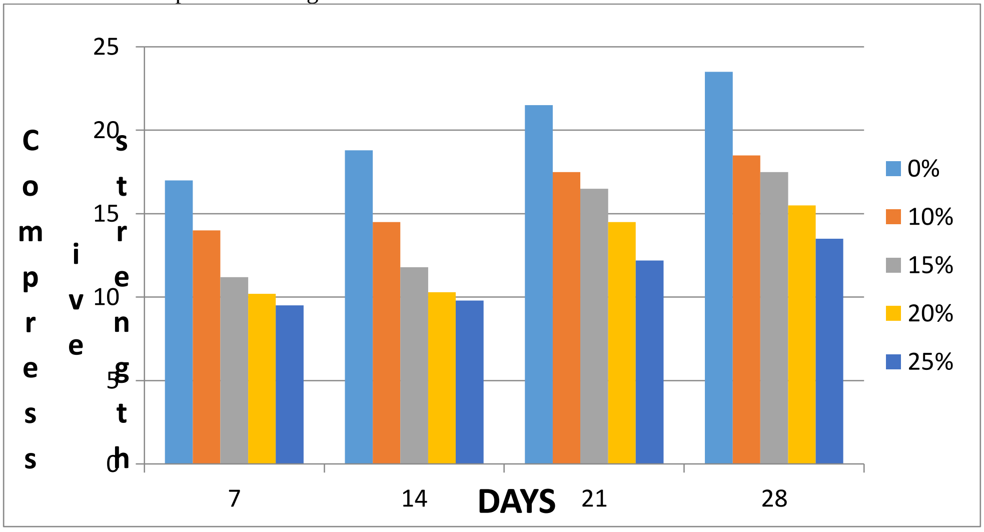

Figure 4: Compressive Strength Test Result

The result of the compressive strength of concrete cubes shows that the compressive strength decreases as the percentage of SCFA is partially replaced with OPC. However, the compressive strengths increase as the curing period increases for each percentage of SCFA. The compressive strength for the control concrete cube, the increases from 17.00 to 23.50N/mm^2 at curing period of 7days to 28days.The strength at 28days was in line with the specified value of 25N/mm^2 for grade 20 concrete (BS 8110,1997). The strength of 10% replacement of sugarcane fiber ash with cement in concrete cube production showed an increase in compressive strength from 14.00 to 18.50N/mm^2 at 7- 28 curing days. At 15% of sugarcane fiber ash the compressive strength increases from 11.80-17.50N/mm^2 at age 7 to 28days curing period respectively. The compressive strength of 20% replacement of sugarcane fiber ash with cement in concrete cube production increases from 10.20-15.50N/mm^2 at age 7-28days curing period. At 25% of sugarcane fiber ash the compressive strength increases from 9.50-13.50 N/mm^2 at age 7 to 28 days curing period respectively. Therefore, the compressive strength decreases as the percentage of SCFA increases from 0%-25%.

4. CONCLUSION AND RECOMMENDATIONS

Conclusion

(a) The 10% SCFA concrete cube at twenty-eight (28) days curing met the compressive strength recommendations of the Nigerian Building and Road Research Institute and Nigerian Industrial Standard for its suitability in construction. The 10% SCFA concrete cube at 28days has a closer compressive strength to the control concrete cube at 28days.

(b) SCFA is a good replacing agent because of its effect in the water absorption rate of the concrete cube in which water absorption rate increases with increase in the replacing agent (SCFA), this therefore makes the brick to become stronger with higher compressive strength but cannot be used for construction in a water logged area or swampy area due to the rate at which water moves through the pores.

Recommendations

In Nigeria, though construction industry is booming these days, much effort is still needed on cement replacement. The awareness on different materials that can replace cement and their advantages is negligible. Therefore, Sugarcane fibre ash which is investigated in this research work is hereby recommended as cement replacing material due to its economic and environmental benefits.

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