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Effect of Coconut Fiber Ash on Strength Properties of Concrete

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Abstract: ***This research paper deals with the use of agriculture and industrial waste materials into concrete which enhance the property of concrete and make environment eco-friendly. With the increase in population the cost of cement used in construction is increasing day by day. The increase in demand of cement and need for infrastructural development there is urgent need to focus low cost alternating binding material which can be used solely or in partial replacement of cement. Agricultural waste material, in this case coconut fibre ash, which is an environmental pollutant. Coconut fibres are collected and the fibre are properly dried and burnt in the open air with a temperature range of 600□ to 700□. when the fibres turned into ash. The ash was collected and made to pass through 150-micron sieve. This work presents the results of laboratory test carried out using coconut fibre ash (CFA) as a partial replacement for cement in concrete production. Concrete cubes are cast and tested at curing aging 28 days using 0, 5, 10, 15, 20 percent replacement levels. The slump test results show that the workability of the concrete decreased as the CFA content increased & the compressive strength of CFA concrete decrease with increasing the percentage of coconut fibre ash. The percentage strength gained at 28 days for 5% is 18.66 %. The optimum compressive strength of 18.66 N/mm2 was obtained at 5% replacement at 28 days of ages.***

Keywords**:** ***coconut fibre ash, concrete, compressive strength, cement.***

I. INTRODUCTION

Concrete has been used in construction for over 2000 years, perhaps first by the Romans in their aqueducts and roadways. Concrete was a name applied to any number of compositions consisting of sand, gravel, crushed stone, or other coarse material, bound together with various kinds of cementitious materials. According to the type of binder used, there are many different kinds of concrete. For instance, Portland cement concrete, asphalt concrete, and epoxy concrete. In concrete construction the Portland cement concrete is utilized the most.

Thus, in our course, the term concrete usually refers to Portland cement concrete. Concrete is widely used in domestic, commercial, recreational, rural and educational construction. Communities around the world rely in concrete as a safe, strong and simple building material. It is used in all types of construction; from domestic work to multi-storey office blocks and shopping complexes. Besides that, concrete major used were for buildings, columns, beams, roofs, floor slabs, foundation walls, footings, staircases, sidewalks, paving, highways, bridges and other. Other than that, concrete was widely used all around the world because of its advantages which are fireproof, watertight, economical and easy to make.

Coconut fiber ash material as a cementitious material is currently a great deal of interest in developing the concrete mix in order to produce high strength concrete rather than use a large amount of cement that are costlier. Coconut fiber ash or also called as natural fiber exist in reasonably large quantities all over the world and mostly these type of natural fiber such as bamboo, cane and henequen are unused and not disposed properly. Rather than abundantly available, coconut fiber ash material are also claimed to offer environmental advantages such as reduced dependence on non-renewable energy, lower pollutant emissions, lower greenhouse gas emissions, enhanced energy recovery and end of life biodegradability of components.

This agriculture waste product obtained in the processing of coconut oil and available in the tropical regions of the world especially in Africa, Asia and America and this type of natural fiber is commonly used in construction industry. In countries where abundant agriculture wastes are discharged, these wastes can be used as a potential material or replacement material in construction industry. Due to the stiff surface of organic origin, they will not contaminate or leach to produce toxic substances once they bound in the concrete mix.2 Besides that, in this study, as a cementitious material, the coconut fiber ash will properly dry and burnt with a temperature 600 - 700 □ in open air and this temperature is fixed for all the cubes. Other than that, the percent of replacement for the coconut fiber are different for each concrete mix design which is 5%, 10%, 15% and 20%.

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II. LITERATURE REVIEW

A. Felix F. Udoeyo and Sanni A. Abubakar has studied the possibility of Maize – Cob ash filler in concrete. MCA in the range of 0-30% was used as a partial replacement for ordinary Portland cement in a concrete of mix ratio 1:2:4:0.6 (cement: sand:coarse aggregate: water-cement ratio). Fresh concrete properties, compressive, split tensile strengths, and modulus of rupture were measured for concrete mixtures with MCA within the investigated replacement levels The results showed that the setting times of MCA concrete increased with higher ash content, while the compressive, split tensile strengths and modulus of rupture showed a reverse trend. It was further observed that almost all of the studied specimens attained over 70% of their 28-day strength at seven-day curing.

B. Okere Chinenye Elizabeth did the experimental study on concrete by replacing cement with coconut fibre ash. The researcher replaced coconut fibre ash with cement as 0, 10, 15, 20, and 25%. The workability of the concrete decreased as the coconut fibre ash content increased. The compressive strength of coconut fibre ash concrete increased with curing age but decreased with increasing percentage of coconut fibre ash. The optimum strength found at 10% replacement.

III. MATERIALS

The materials used for this study include coconut fibre ash, ordinary Portland Cement, fine and coarse aggregated and water.

A. Coconut Fibre Ash (CFA)

The coconut fibre was properly dried and burnt at a temperature range of 600°C - 700°C in open air until the fibres turned into ash (after about 1 hour forty minutes). The ash was allowed to cool and collected and the sieved using 150-micron sieve. Coconut fiber were collect from local temples.

B. Ordinary Portland Cement

In this research Ordinary Portland(OPC) cement was used as binding material. The cement used was fresh, without any lump. OPC is commonly available in local market. OPC is the most widely used cement which is suitable for all general construction. The chemical composition of cement is given in table 1. OPC of of 43 grade (ultratech cement) was used the chemical composition of cement is given in table 2.

C. Coarse Aggregates

Coarse aggregate is the crushed stone is used for making concrete. The maximum size of coarse aggregate used for this investigation is 20mm.

D. Fine Aggregates

The fine aggregate was washed, dried and sieved through 4.75 mm to remove the finer particles or dust particles and organic matter and graded.

E. Water

Clean water was used which was free from suspended particles and chemical substances was used for both mixing and curing of concrete. The water: cement ratio was 0.50. Water conforming to the requirements of IS:456-2000 is found to be suitable for making concrete. It is generally stated that water fit for drinking is fit for making concrete. The water used for making concrete should be free from undesirable salts that may react with cement and admixture and reduce their efficiency. Silts and suspended particles and undesirable as they interfere with setting, hardening and bond characteristics. Algae in mixing water may cause a marked reduction in strength of concrete either by combining with cement to reduce the bond or by causing large amount of air entrainment in concrete.

Compound	% Mass
Sio_2	17-25%
Al_20_3	4-8%
Fe_2o_3	0.5-0.6%
cao	61-63%
mgo	0.1-4%
So_3	1.3-3%
Na_2	0.4-3%

Table 1: Chemical composition of OPC

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IV. MIX PROPORTION AND CURING

Total 15 cubes were cast. The casting schedule is shown in table 2. The dimension of cubes were 150X 150X 150 mm. The mix ratio used was 1:1.5:3 in regular weight basis of each ingredient and an water binding ratio os 0.50 is chosen. All batches contain the same fine aggregate and coarse aggregate mix ratio where only amount of CFA and cement varies. Among the 15 cubes 3 cubes were control cubes(0% replacement) and other remain their identities as 5%, 10%, 15%, 20% partial replacement with CFA. After casting the cubes are demoulded within 24 hours to maintain a curing period of 28 days.

A. Calculation of Mix Proportion

For M20 grade concrete.
M20 grade proportion is = 1:1.5:3
Total volume = 1+1.5+3 = 5.5
1 mould capacity = 0.003375 m3
15 mould capacity = 15x 0.003375 = 0.050625 m3
Shrinkage or safety factor = 1.54
Dry volume of concrete = 0.050625x1.54 = 0.0779625 m3
Dry volume of aggregate required = (3/5.50) x 0.0779625 = 0.04252 m3
Dry volume of sand required = (1.5/5.5) x 0.0779625 = 0.0212625 m3
Dry volume of cement required = (1/5.5) x 0.0779625 = 0.014175 m3 = 0.014175x1440 = 20.412 kg
For kg of M20 (1:1.5:3)
Aggregate = 0.04252 x 1500 = 63.78 kg
Sand = 0.0212625 x 1450 = 30.83 kg
Cement = 20.41

Description	For Conventional	5% Replacement	10 % Replacement	15% Replacement	20% Replacement
cement	4.08	3.876	3.672	3.468	3.264
CFA	.....	0.204	0.408	0.612	0.816
Coarse aggregate	12.75	12.75	12.75	12.75	12.75
Fine aggregates	6.165	6.165	6.165	6.165	6.165
water	2.05	2.05	2.05	2.05	2.05
W/C ratio	0.5	0.5	0.5	0.5	0.5

Table 2: Materials Quantity

% composition	Conventional(0%)	5%	10%	15%	20%
No. of cubes	3	3	3	3	3

Table 3: No. Of Cubes for Various Types of CFA %.

V. METHODS

Following test were conducted on concrete:

A. Slump Test

Test on fresh concrete were carried out to determine the workability of conventional concrete. Slump test is the most common test to evaluate the workability of a fresh concrete in worldwide. The apparatus of slump test is simple, portable and suitable for laboratory and on-site testing. These apparatuses include mould, tamping rod, scoop, Base plate and Ruler.

B. Compressive Strength Test

Most common test on hardened concrete is compressive strength test. It is because the test is easy to perform. Concrete cubes of size, 150mm x 150mm x 150mm were produced by replacing the cement content partially with the coconut fibre ash. The percentage replacements used were 0%, 5%, 10%, 15%, 20% A total of 15 specimens were cast and cured in the curing tank for periods of 28 days. Three specimens were crushed using the universal testing machine at the end of each curing regime and the average strength was recorded.

VI. RESULT AND DISCUSSION

A. Slump Test Result

Table 2 shows the slump test result & it can be observed that the slump value decrease with increasing the percentage of coconut fibre ash. This indicates that the concrete became less workable (stiff) as the CFA content increased.

Replacement (%)	Slump value
0	18
5	20
10	23
15	24
20	25.5

Table 4: Slump test result of coconut fibre ash concrete.

B. Compressive Strength Test Result

The compressive strength test is performed at 28 days in a total of 15 cubes. Average of 3 specimen gives the crushing strength of concrete. The compressive strength of concrete is determined by dividing maximum load to area of cube. The area of cube is 22500 mm^2.

Table 3 Shows the compressive strength of concrete decreased with increasing percentage of coconut fibre ash. The optimum compressive strength of 18.66 N/MM^2 was obtained at 5% replacement at 28 days of curing ages.

% Replacement	Compressive strength
0	19.75
5	18.66
10	15.33
15	12.36
20	8.23

Table 5: Compressive Strength Test Result

VII. GRAPHS

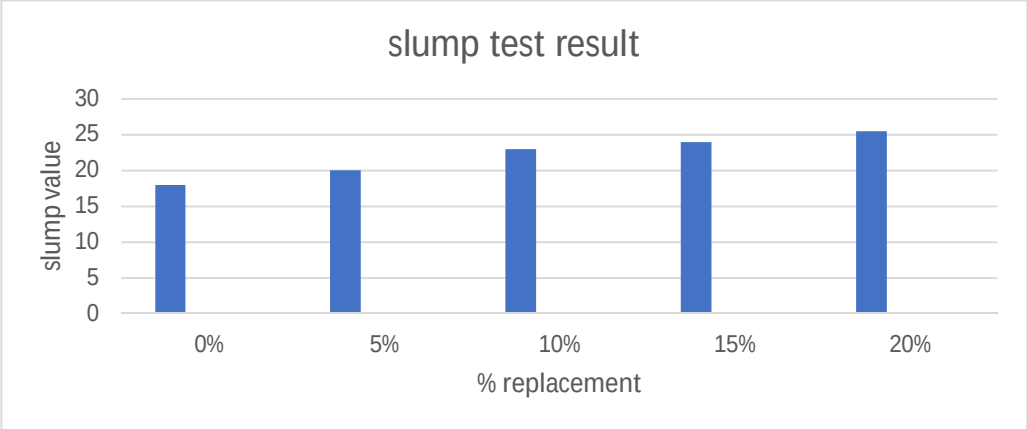

Figure 1: slump test graph

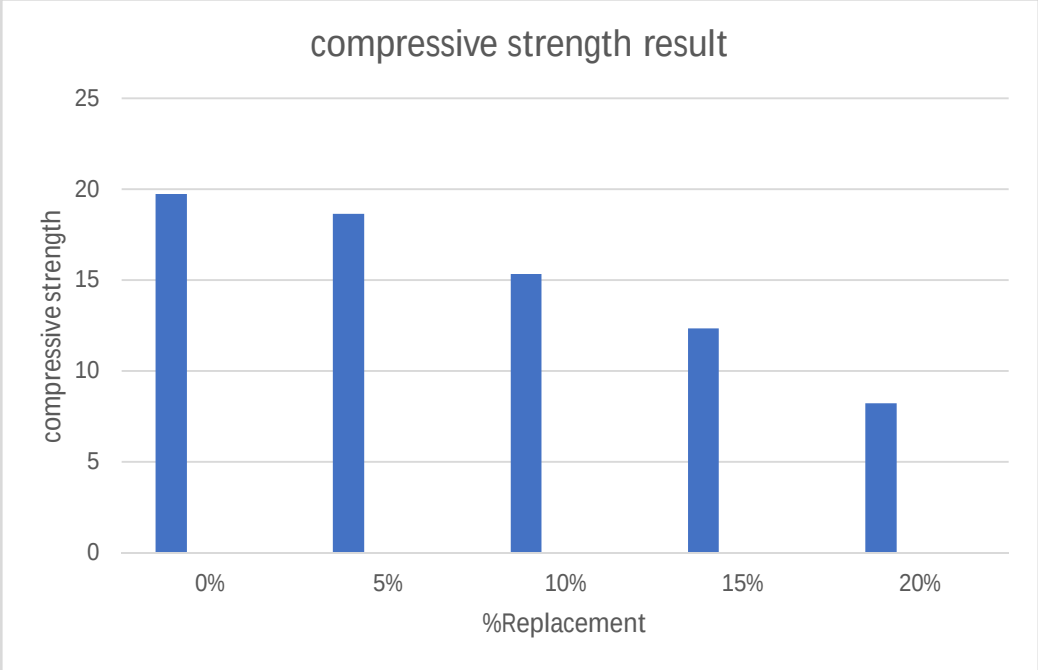

Figure 2: compressive strength graph

VIII. CONCLUSION

1.The workability of fresh CPA concrete measured by the slump test reduces as the CPA content increases. Therefore, CPA makes concrete to be less workable which in turn helps to control bleeding of concrete to avoid segregation of the ingredients of the concrete mix.

2. The compressive strength of concrete decreased with increasing percentage of coconut fibre ash. The maximum compressive strength of 18.66 N/mm2 was obtained at 5% replacement at 28 days of age.

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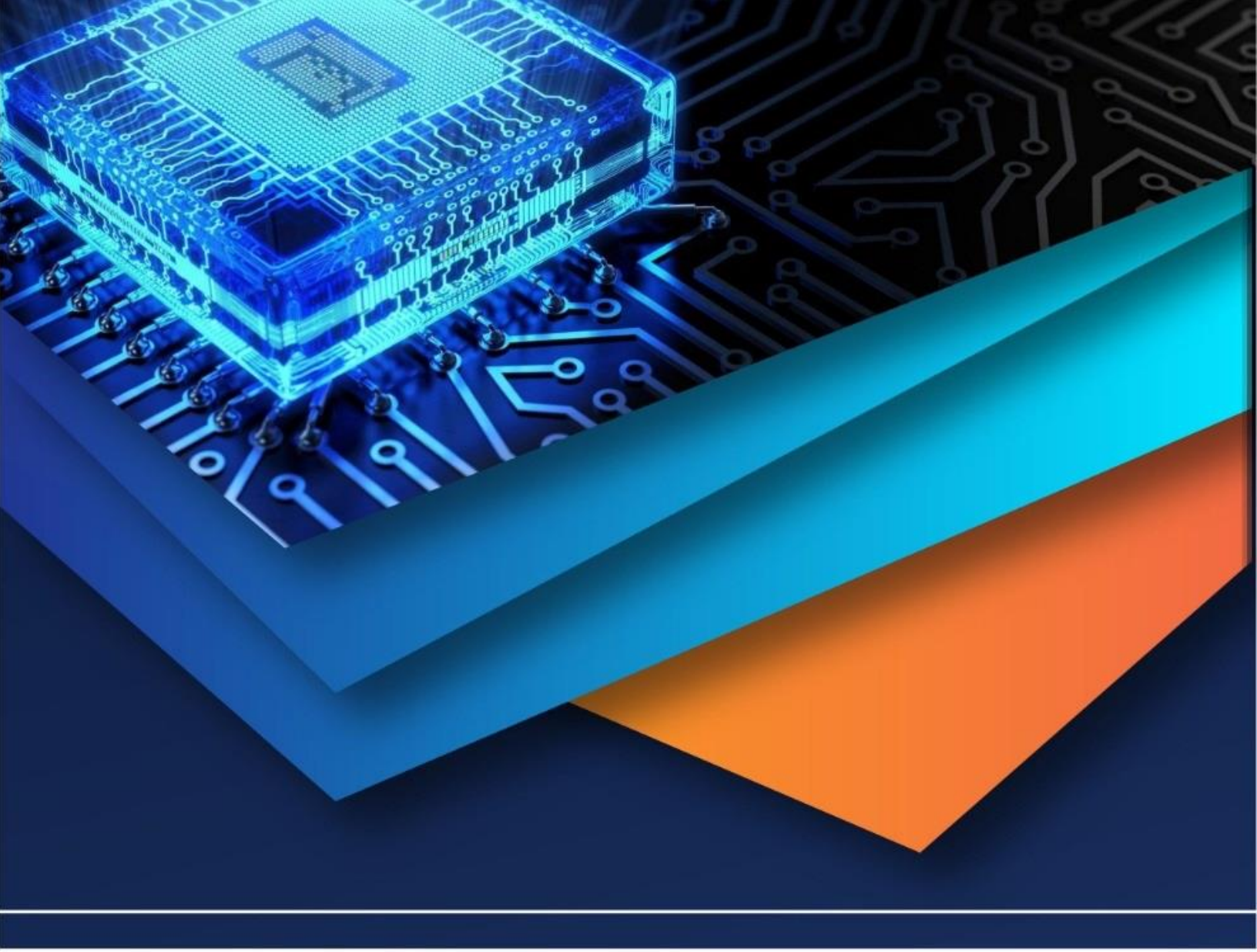

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