International Journal of Engineering Science Invention (IJESI)
ISSN (Online): 2319-6734, ISSN (Print): 2319-6726
www.ijesi.org ||Volume 9 Issue 1 Series. II || Jan.2020 || PP 47-53

Potential Of Coconut Shell Ash As Partial Replacement Of Ordinary Portland Cement In Concrete Production.

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Abstract
The cost implication of cement used in concrete construction works is accelerating and almost becoming unbearable, yet the need for sheltering and other infrastructure using this material keeps moving up. Thus the need to find alternative binding materials other than cement has become pressing issue in research and technology world. Agricultural waste material such as coconut shells were collected and pulverized in the furnace from 800^0 C to 1000^0 C for four hours to produce coconut shell ash (CSA), after XRF analysis was carried out to determine its pozzolanic property, which was used as partial replacement of cement in concrete production. Concrete cubes were produced using graded levels of 0, 10, 15, and 20 percent replacement of CSA for Ordinary Portland Cement. The concrete mix ratio of 1:2:4 with water cement ratio of 0.5 were used and total of 60 cubes were produced and cured in water for 7, 14, 21 and 28 days. Properties such as Workability, density, compressive strength and water absorption were determined in accordance to British Standards and pozzolanic property in accordance to American Standards. The results showed that the densities of concrete cubes for 5% replacement was above 2400Kg/m^3 while compressive strength were 25.17 N/mm^2, 24.72 N/mm^2, 23.08 N/mm^2 and 20.94N/mm^2 in step of 5% up to 20% at 28 days. It was observed that 10% replacement of CSA as has the lowest water absorption of 0.66%. XRF analysis showed that the CSA belongs to class F. Thus, replacement of OPC with CSA from 5% up to 15% is recommended for normal weight concrete production. (BS 8110:2, 1985)

Keywords*: Coconut Shell Ash, Compressive Strength, Pozzolanic, Water absorption Workability.*

Date of Submission: 20-01-2020 Date of Acceptance: 05-02-2020

I. Introduction

Concrete is widely used as construction material for various types of structures due to its durability [13]. For a long time, it was considered to be very durable material requiring a little or no maintenance. Many environmental phenomena are known significantly the durability of reinforced concrete structures. We build concrete structures in highly polluted urban and industrial areas, aggressive marine environment sand many other hostile conditions where other materials of construction are found to be nondurable. In the recent revision, one of the major points discussed is the durability aspects of concrete. So the use of concrete is unavoidable. The use and cost of cement in construction companies is rising everyday as it is one of the essential ingredients in concrete and very soon the source material (limestone) will soon get exhausted, because is the only source material used in the production of cement and much intense use is on it.Alternate material such as cocoa nut shell ash which is cheaply available in Nigeria has to be sourced for in replacement of cement and thereby reducing and minimizing the risk and hazard cocoa nut shell posed to health and environment. Utilization of industrial waste or secondary material has been encouraged in construction field for the production of cement and concrete because it contributes to reducing the consumption of natural resources. The composition of coconut production is fairly good, although the coconut palm is not indigenous to Nigeria, 15,000 hectare of land are estimated to be under coconut cultivation in the country, mostly in coaster area of Lagos state and the Delta area of River state. Portland cement is one of the important ingredients in concrete. The current cement production rate of the world is approximately 1.2 billion tons/year. The popularity of the concrete is due to the common ingredients, it is possible to change the properties of concrete to meet the demands of any particular situation. Among the various properties of concrete, its compressive strength is considered to be the most important and is taken as a measure of its overall quality. The strength of concrete is defined as resistance to its failure against a system of loading. The strength of concrete is measured in various ways depending on loading pattern such as compressive strength, flexure test, bond strength and resistance to abrasion. In this test only include compressive and porosity test. Compressive strengths are the resistance of the concrete to crushing. The compressive strength of cement concrete mainly depends on the type, quality and quantity of cement, the type, size, shape, strength and grading of aggregates, the water cement ratio, the degree of workability and compaction, the type ,quality and age of curing.

In this research, investigation on the use of cocoa nut shell as partial replacement of cement was fully discussed.

II. Background Of Study

According to[13] used coconut shell ash (CSA) as pozzolana in partial replacement of cement in concrete production and the results showed that the densities of concrete cubes for 10 -15% replacement was above 2400Kg/m 3 and the compressive strength increased from 12.45N/mm 2 at 7days to 31.78N/mm 2 at 28 days curing thus meeting the requirement for use in both heavy weight and light weight concreting. Thus, 10 - 15% replacement of OPC with CSA is recommended for both heavy weight and light weight concrete production. [13] observed that compressive strength of the ordinary Portland cement/coconut husk ash sandcrete blocks generally decreases as the percentage of coconut husk ash content increases.

III. Materials And Methods

Coconut shells were obtained locally in Arena market Oshodi, Lagos state. Ordinary Portland cement available locally in Nigeria was used. Portable water in the Department of Civil Engineering, Federal polytechnic Ilaro was used. The coconut shells were dried in the sun for forty eight hours. It was then ash in electrical furnace for three hours and allowed to cool. The burnt ash was collected and sieved through a BS sieve (75 microns).X-Ray Fluorescent test was carried on the cocoa shell ash and result is shown in table 1 below.

Fig.1: Coconut shell

Fig.2: crushed coconut shell

Fig.3: Coconut shell ash

Table 1: Chemical Composition of oxides in CSA and Cement (%)

Sample	CSA	Cement
SiO_2	45.02	19.99
$Al2O_3$	15.08	4.78
Fe_O3	12.38	3.57
MnO	0.22	
CaO	0.55	63.74
P_2O_5	0.01	0.10
K_2O_5	0.52	
TiO_2	0.01	
MgO	16.19	1.90
Na_2O	0.45	0.21
SO_3		2.70
LOL	9.57	2.41

From table 1 above it was observed that coconut shell ash belongs to Class F pozzolan because it consists of SiO 2 ,Al 2 O 3 and Fe 2 O 3 of 72.48% and greater than 70% minimum oxides silicon, alumilium and iron for class F pozzolan[1].

Table 2: Batch Weight of materials (kg) for each mix

	Mix I (0%)	Mix II (5%)	Mix III (10%)	Mix IV (15%)	Mix V (20%)
Cement	14.3	13.58	12.87	2.15	11.44
F.A	28.60	28.60	28.60	28.60	28.60
C.A	57.20	57.20	57.20	57.20	57.20
C.S.A	0	0.72	1.43	2.13	3.00
Water	7.15	6.79	6.44	6.08	5.72

Concrete cubes were cured and compressive were carried out on cured cubes at 7, 14, 21 and 28 days. Also 28 days water absorption tests were carried on concrete cube. Cube (150mmx150mmx150mm were tested for compression using power testing machine in accordance with [8], workability was carried out in accordance to [6] Density was carried in accordance to [7] and Water absorption in compliance with [10]

IV. Results And Discussions

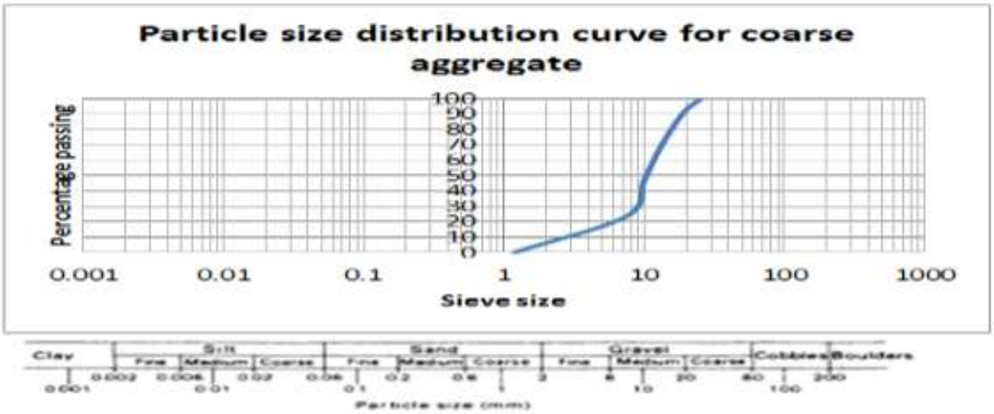

Fig.4: Particle size distribution curve for coarse aggregate (granite).

From the fig.4 above it was observed that
Coefficient of uniformity C u = 4.3 >3 (non-uniform)
Coefficient of gradation (curvature) C c = 2.08 (well graded)
Interpretation: Coarse aggregate was non-uniformly and well graded because C u and Cc lied within the accepted range in accordance to BS 1377: Part2: 1990.

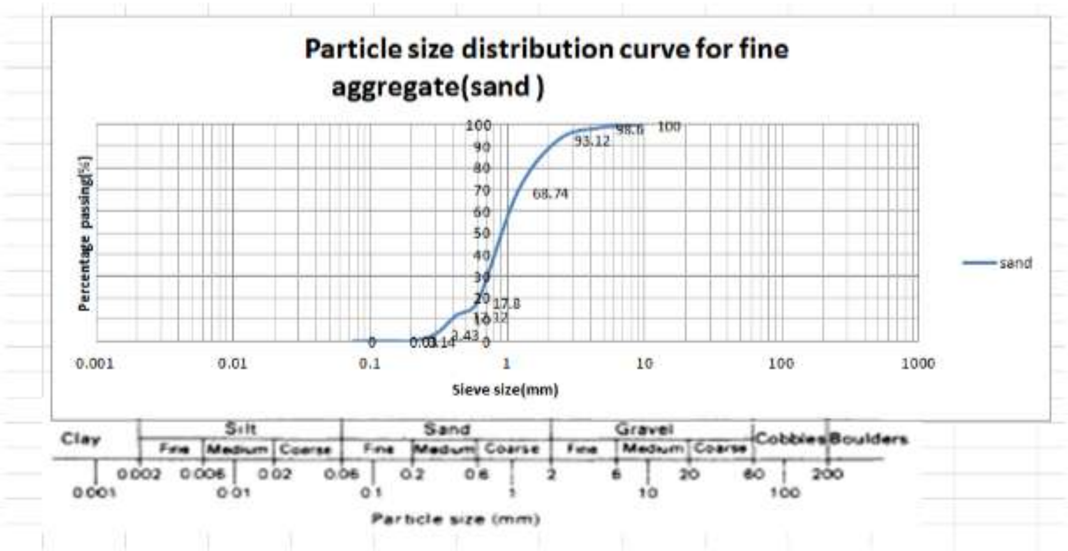

Fig.5: Particle size distribution curve for fine aggregate (sand).

C u = 1.0/0.4 = 2.50< 3 (uniform)
Coefficient of gradation (curvature) Cc = (D 30) 2 /D 60 *D
10 C c = 0.7 2 /1.0*0.4
= 1.23 lies between 0.5 and 2 (well graded)
Interpretation: Fine aggregate (sand) was uniformly and well graded because C u and Cc lied within the accepted range in accordance to BS 1377: Part2: 1990.

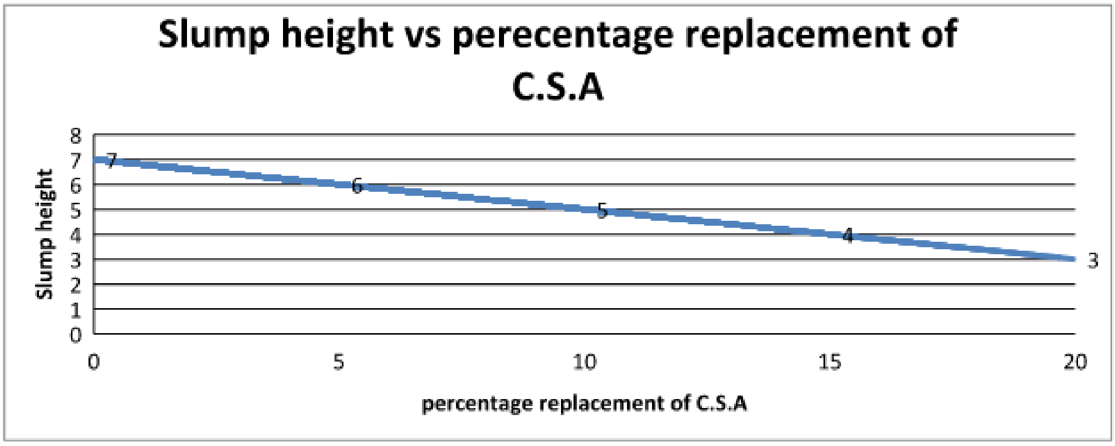

Fig .6: Graph of slump against percentage replacement of CSA in concrete.
It was observed that control has slump height of 7mm and decreased to 6mm at 5% replacement of the C.S.A in concrete then later increased to 5mm at 10%, later dropped to 4mm at 15% and finally declined to slump height of 3mm at 20% replacement.

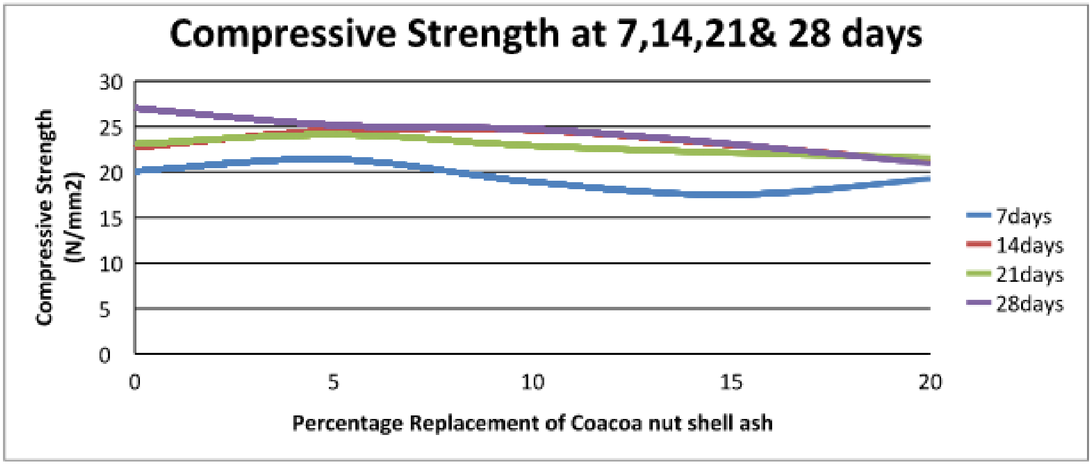

Fig .7: Compressive strength development with the curing days.

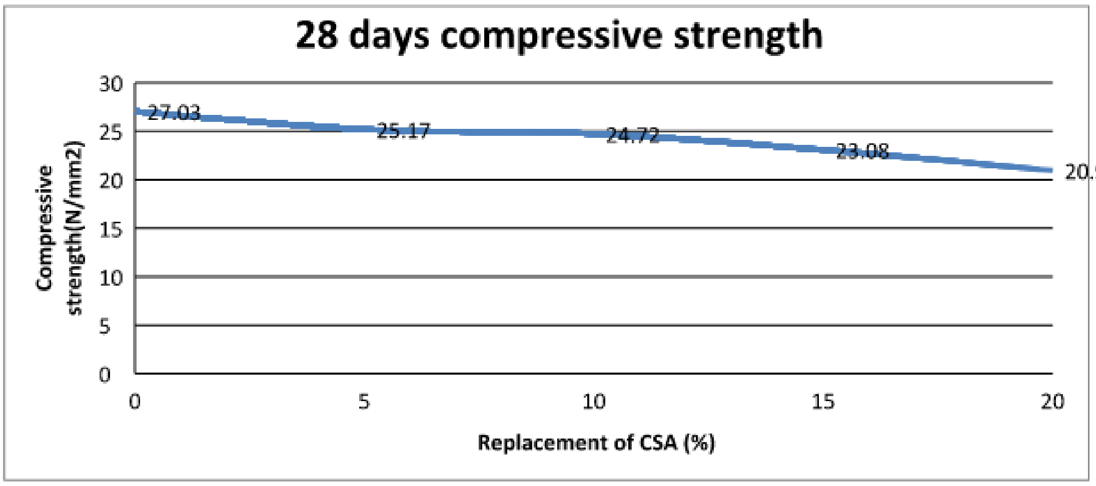

Fig .8: 28 days compressive strength against percentage CSA concrete.

The control has compressive strength of 27.03N/mm 2 and dropped to 25.17 N/mm 2 at 5% decreased in the same trend to 24.72 N/mm 2 at 10% still maintained at 15% with strength of 23.08 N/mm 2 and finally dropped to 20.94 N/mm 2 at 20%.

Fig 9: Regression analysis showing relationship between compressive strength and C.S.A percentage replacement.

It was observed that the relationship has been obtained using polynomial regression analysis as F st = 0.2866x + 27.06 with R 2 = 0.9653 which show that there is strong correlation between compressive strength and percentage replacement of cocoa nut shell ash in concrete.From regression analysis above, it was shown that 6% of CSA will produce maximum compressive strength of 25N/mm 2 .

Water Absorption test

It was deduced that concrete with 15% Cocoa nut husk ash has the highest water absorption rate of 1.7% and 10% CSA concrete has the lowest water absorption rate of 0.66%. It was shown that increase in cocoa nut shell ash led to reduction in water absorption of concrete as shown in Table 4 below.

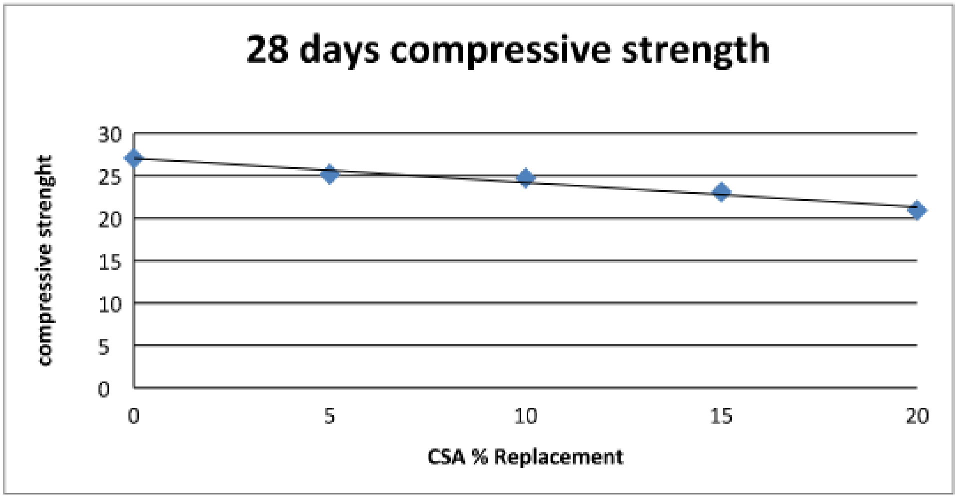

Fig. 9: Regression analysis that show relationship between compressive strength and percentage replacement of CSA

In fig .9 above, there is strong correlation between compressive strength of modified concrete and percentage replacement of CSA in concrete.

Table 4: Water Absorption of concrete

	Weight (g)		
% Replacement	Before curing	After curing	% Water absorption
0	8176	7966	2.1
5	8138	7958	1.8
10	7951	7960	0.11
15	7758	7893	1.7
20	7117	7113	0.06

Density

Density is measured of ratio of mass of substance to its volume. It was observed that the control specimen has the highest density of 2423kg/m 3 and which decreased to 2411kg/m 3 by replacing cement with C.S. A and which then declined to 2356 kg/m 3 at 10% replacement of C.S.A. At 15% replacement of C.S.A it reduced to 2299 and finally dropped to 2109 kg/m 3 .As the C.S.A increased in the concrete matrix the density of specimen decreased

Table 5: Densities of specimen

% Replacement	Density (kg/m³)
0	2423
5	2411
10	2356
15	2299
20	2109

V. Conclusion

This research investigated the effect of CSA on fresh and hardened concrete. The effects of CSA on workability, water absorption and mechanical property such as compressive strength of the concrete were investigated.

From the results and discussions of this research, it can be concluded that
(1) Concrete containing 10% of CSA has lowest water absorption rate.
(2) Modified Concrete of 5% and10% has compressive strength of 25.17N/mm 2 and 24.72N/mm 2 respectively.
(3) The CSA affects the workability of fresh concrete i.e. increase in CSA content in the concrete matrix led to decrease in workability.
(4) The multiple regression curve F st = 0.2866x + 27.06, can be used as a first hand approximation to establish the trend of compressive strength at varying percentage. (Fig.6)

Acknowledgements

The author acknowledges the contribution of Rasheed Odesile for data collection and Adeyinka A.O for technical assistance in laboratories.

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1adeala A.J " Potential Of Coconut Shell Ash As Partial Replacement Of Ordinary Portland Cement In Concrete Production. " *International Journal of Engineering Science Invention (IJESI)*, Vol. 09(01), 2020, PP0 47-53