PERFORMANCE EVALUATION OF EGG-SHELLS AND COW BONE ASHES AS POZZOLANA IN CONCRETE PRODUCTION

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Abstract

Concrete is a composite material made with cement, aggregates and admixture in some cases. Due to day by day innovation and development in construction field, the global consumption of natural aggregate is very high. Extensive use of concrete leads to depletions of natural resources and high cost of construction material such as ordinary Portland cement for construction. therefore, this paper study the possibility of utilizing cow bone and egg shell ashes in production of concrete having sufficient qualities for construction. Partial replacement of cement by ashes from cow bones, and egg shell will not only provide affordable concrete, but also provide better way of managing the waste from the present nuisance it constitute to the environment. The chemical composition of cow bone and egg shell ashes and compressive strength of the concrete produced were determined. In this experimental study, cement is partially replaced by 0%CBA/ESA, 15%CBA/5%ESA, 20%CBA/0%ESA, 10%CBA/10%ESA , 15%ESA/5%CBA and 20%ESA/0%CBA respectively for production of concrete, using a mix ratio of 1:2:4 and a water cement ratio of 0.5was adopted. The concrete gave maximum compressive strength for each batch in the range of 31.26N/mm^2,28.37N/mm^2, 32.84N/mm^2, 24.22N/mm^2, 27.77N/mm^2.and 22.87N/mm^2 respectively at 28 days curing periods. From the result of 28 days curing, it can be concluded that although ESA and CBA are week pozzolanic materials, thus but can still replace cement up to 20% replacement of CBA only and 15% of CBA with 5% of ESA.

Keyword: Aggregate Cow Bone Ash, Compressive strength, Egg Shell Ash, Pozzolana

1.0 **Introduction**

As a result of the depletion of natural resources which is a common phenomenon in a developing countries coupled with the environmental effects associated with a cement manufacturing, there is need to develop alternative binder to make concrete industry suitable. In view of this, researchers have been searching for suitable materials which could be used as either an additives or as partial replacement to conventional ingredients of concrete so that the existing natural resources be saved to the possible extent, and could be made available for future generation. In view of this process, different agricultural waste materials such as rice husk, cassava peal, coconut, groundnut, corn cob and egg shells have been tried as a viable substitute material to conventional material in concrete and has been succeeded (Sekar, 2011). The cement reacts chemically with water and other ingredients to form a hard matrix which binds all the materials together into a durable stone-like material that has many uses. Often, additives (such as pozzolanas) are included in the mixture to improve the physical properties of wet or the finished material (Kosmatka and Panarese, 2002). The use of alternative binders that are less pollutant and/or the use of residues could impact the construction industry towards the production of concrete with less environmental impact. In order to achieve this, concrete must have adequate characteristics, implying that certain mechanical characteristics and water behavior must be achieved.

According to (Abid, 2009), eggs shell is the outer covering of a hard-shelled egg. It is a natural porous bio ceramic which has largely been studied since 1964. Egg shells are bye product generated from food restaurant, bakeries and chick hatcheries, egg shells used in producing concrete made the constructional materials more economical and hence reducing the environmental pollution (Mazizah, 2016).

Therefore, this research will be directed at utilization of egg shells Ash (ESA) blended with cow bone ash (CBA) in Concrete production.

2.0 Material and Methods

The composition of materials used for this research includes fine aggregate (Sharp sand) coarse aggregate (crush granite stones not exceeding 19.50mm) according to BS 882:1992, and water. Ordinary Portland cement (in accordance with codes of practice ASTM C150) for the production of concrete in the addition to egg shell ash (ESA), and Cow bone ash (CBA) used here as supplementary cementitious materials.

Egg shell is a by- product of waste egg shells collected from local meal provider "Mai shai" and bread bakery around Bida metropolis Niger State. The ash was obtained through closed incineration at the temperature of 650^oC at National cereal Research Institute (NCRI) Baddegi Bida Niger State, and the ash was sieved through 75µm sieve. Cow bone ash is a by- product of wastes bones collected from abattoirs in Bida Niger state. The waste bones were sun-dry after carefully separation from flesh, tissues, and fats. The sizes were gradually reduced by mortar and the ash was obtained through closed incineration at the temperature of 650^oC at National cereal Research Institute (NCRI) Baddegi Bida Niger State, the ash was sieved through 75µm sieve.

Chemical composition analysis of the Cow Bone Ash (CBA), and egg shell ash (ESA) was conducted by the use of X – Ray Refraction analytical method using X – Ray spectrometer at Chemistry National Laboratories Centre, Ahmadu Bello University Zaria Kaduna State.

The mix was designed using the absolute volume method, a mix ratio of 1:2:4 using a water /cement ratio of 0.5 was also adopted in this work, and cement was partially replaced by 0%CBA/ESA, 15%CBA/5%ESA, 20%CBA/0%ESA, 10%CBA/10% ESA, 15%ESA/5%CBA and 20%ESA/0%CBA respectively for production of concrete.

The mixing was done mechanically and slump test was carried out to assess the workability of the fresh concrete. 18 concrete cubes of 150mmx 150mm x150mm were casted for each batch respectively. The specimen was demoulded after 24hours, and cured in a curing tank containing clean water, curing improves the physical and chemical properties of concrete. The compressive strength were determined by crushing concrete cubes at different curing periods of 7, 14, 28days. The results presented were the average of the three tests.

3.0 Discussion of Results

3.1 Chemical Analysis of Egg Shell and Cow Bone Ashes

The results of the oxides composition of egg shell, cow bone ash, and cement is shown in table 1.

Table 1: oxides composition of CBA, ESA, and Dangote 3x Cement

OXIDES	ESA	CBA	CEMENT
NA_2O	0	0.488	0
MgO	0.688	0.765	1.023
Al_2O_3	0.313	0.339	3.262
SiO_2	1.766	1.548	14.381
P_2O_5	0.328	36.438	0.169
SO_3	0.18	0.056	3.097
Cl	0.13	0.159	0.123
K_2O	0.09	0.096	0.235
CaO	96.123	59.912	74.229
TiO_2	0	0.049	0.2
Cr_2O_3	0	0	0.02
Mn_2O_3	0	0	0.093

Fe_2O_3	0.061	0.06	3.011
ZnO	0	0.007	0.005
SrO	0.322	0.083	0.91

3.2 Workability of fresh concrete

The workability of fresh concrete made with egg shell and cow bone ash partially replacing cement in a predetermine percentage is shown in table 2. Table 2 shows that the workability decreases with percentage replacement, and lower at 20% replacement of ESA only. This shows that ESA absorbed moisture more than CBA. The result of the compressive strength is shown in Table 3 and figure 1.

Table 2: Workability Test for concrete of Various Batches

Batch No.	% Replacements	Slump (mm)	Slump type
1	Control	30	low
2	15% CBA, 5% ESA replacement	20	low
3	20% CBA, 0% ESA replacement	20	low
4	10% CBA, 10% ESA replacement	10	very low
5	5% CBA, 15ESA replacement	20	low
6	0% CBA, 20% ESA replacement	10	very low

Table 3: Compressive strength results (N/mm^2) for 7days and 28 days curing period

Curing period	**Percentage replacement**					
	0%	15%CBA/ 5%ESA	20%CBA/ 0%ESA	10%CBA/ 10%ESA	5%CBA/ 15%ESA	0%CBA/ 20ESA
7days	27.93	26.31	26.55	27.56	23.47	16
28days	31.26	28.37	32.84	24.22	27.77	22.87

Source: Researcher lab experiment 2017

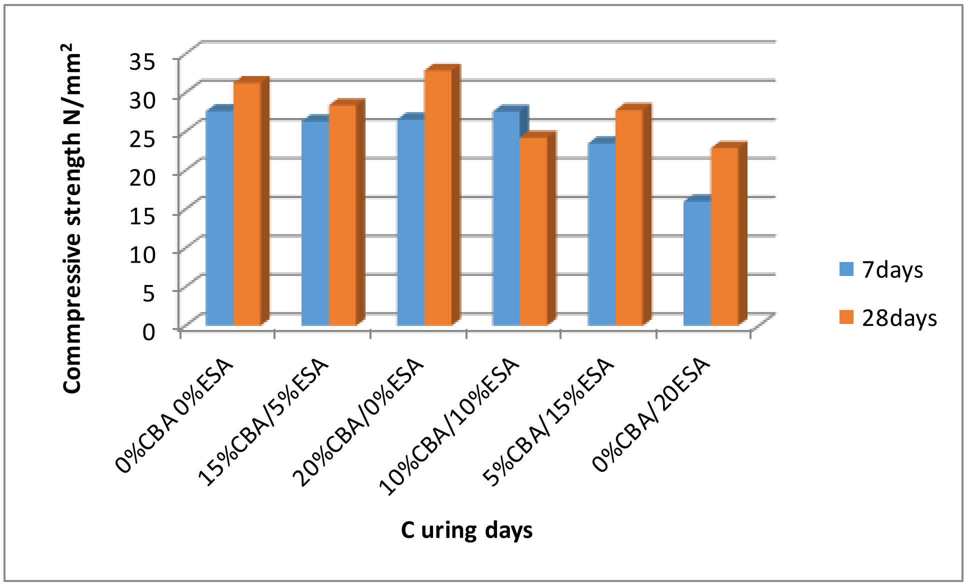

Figure 1: Compressive strength and percentage replacement at various batches.

The compressive strength increases as the percentage replacement of CBA in the batches increases, while that of ESA also increases as the replacement increases up to 15%. The highest strength of 32.81N/mm^{2}, and 27.79N/mm^{2},27.77N/mm^{2} obtained for 20%CBA only, 15CBA and 5%ESA, 5%CBA and 15%ESA, 5%CBA respectively at 28days curing period. This shows that CBA has more significant influence on the compressive strength of concrete.

The Britsh Standard BS 8110 specified a minimum compressive strength of 26N/mm^{2} for concrete at 28 days curing period; therefore, it is adequate for general construction work.

4.0 Conclusion and Recommendation

4.1 Conclusion

From the results of the test and analysis carried out on CBA, and ESA Concrete to realize the aim and objectives set out for this study; the followings conclusion were drawn:

i. The CBA, and ESA both has low reactivity, with a combined SiO2, Al2O3, and Fe2O3 contents of (1.947%), and (2.14%) respectively, which indicate that do not satisfied the minimum value of 70% recommended in ASTM 618 for a good pozzolana.

ii. The consistency, initial and final setting time of cement increased with the combined effect of CBA and ESA Contents. This indicates that combined CBA and ESA extended setting time of cement paste and would be useful as retarder AC1 318, (2005), also according to Alp et al, (2009) the setting time tends to increase with the natural pozzolan replacement level of up to 25%w/w. it was also observed ESA absorbed more water as compared to control concrete.

iii. The compressive strength of concrete increased with increase in CBA content, and decreased with increased in ESA contents as shown in table 2. However, the 28 days compressive strength of concrete mixes with CBA replacement up to 20% produce concrete of higher the characteristic strength; when compared to the normal concrete produced from a mixture of cement, sand, and normal coarse aggregate. Therefore, any replacement more than 20% will give strength less than the $26N/mm^2$ recommended by BS 8110.

iv. Also inclusion of CBA, and ESA as admixture in concrete has improved the compressive strength of concrete .Concrete with combined mixes of CBA, and ESA for 15%CBA/5%ESA, 20%CBA/0%ESA,15%ESA/5%CBA and 20%ESA/0%CBA as partial replacement of cement showed the highest compressive strength of 28.37N/mm2, 32.84N/mm2, 27.77N/mm2, and 22.87N/mm2 respectively, as compared to 24.60N/mm^2 at 10% optimum from the study of cow bone powder as pozzolana in concrete production carried out by Tsado, (2017).

v. The workability decreases as the percentage replacement of ESA increases.

4.2 Recommendations

On the basis of the investigation carried out on ESA, and CBA as a pozzolana for partial replacement of cement in concrete production, the following recommendation were drawn:

Replacement of CBA content up to 20% is recommended for structural concrete. Since the compressive strength of 32.81N/mm^{2,} 27.79N/mm^2 was achieved for 20%CBA only, and 15CBA and 5%ESA respectively at 28days curing period.

For structural concrete works, CBA content up to 20% is recommended for partial replacement of cement to act as a retarder suitable for hot weather concreting, mass concrete and long haulage of ready mixed concrete, but a small amount of plasticizer may be added to improved workability of concrete.

There is need for further research on investigating the pozzolanicity, and performance of CBA and ESA combined in concrete production.

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