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PERFORMANCE OF COW DUNG ASH ON COMPRESSIVE STRENGTH OF BLENDED CONCRETE

Ayeni I. S.* and Akinlolu S. O.

Civil Engineering Department, Federal Polytechnic Ado-Ekiti, Ekiti State, Nigeria.

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***Corresponding Author**
Ayeni I. S.
Civil Engineering Department, Federal Polytechnic Ado-Ekiti, Ekiti State, Nigeria.

ABSTRACT

This research work aims at using Cow Dung Ash (CDA) as partial replacement for cement in concrete production. The percentage replacements were varied from 0%, 5%, 10%, 15%, 20%, 25% and 30% with water cement ratio varied from 0.54, 0.57, 0.60, 0.64, 0.68, 0.72 and 0.77 respectively. The mixing ratio was 1:2:4. The result of chemical analysis conducted on cow dung ash shows that it is pozzolanic. The Workability results gives 20mm, 18mm, 17mm, 15mm, 14mm, 11mm, and 10mm for CDA with 0%, 5%, 10%, 15%, 20%, 25% and 30% replacements. Concrete cubes of size 150X150X150 were cast, cured and tested at different maturing ages of 7, 14, 28, 56 and 112 days. The compressive strength results for 0%, 5%, 10%, 15%, 20%, 25% and 30% replacement for CDA varied from 15.12-32.44, 14.86-31.95, 10.37-30.35, 9.39-26.13, 8.72-23.39, 8.24-14.72 and 7.20-12.79(N/mm^2) for CDA respectively. The 20% replacement meets the strength requirement (17N/mm^2) for light weight concrete.

KEYWORDS: Cow dung ash, cow dung powder, concrete, chemical analysis, pozzolanic.

INTRODUCTION

Significant increases in cement production have been observed and are anticipated to increase due to the massive increase in infrastructure and industrialization in India, China, South America etc, (Portland Cement Association, 2006). It is generally agreed that the production of Portland cement clinker is expensive and ecologically harmful (Mehta, 2001). The emissions generated by Portland cement productions are principal contributors to the greenhouse gas (GHG) effect. For instance, the production of Portland cement for concrete accounts for an estimated 5 percent of global anthropogenic carbon dioxide (Karsteen,2006). Recent estimates of the emissions from cement production reveals that 377 million metric tons of carbon was generated in 2007; this indicates that emissions have more than doubled since the mid 1970s from fossil -fuel burning and cement production (Boden, 2010). Whilst measures may be undertaken to reduce the generation of carbon dioxide from cement kilns, carbon dioxide emission is still in the order of 600 kg of carbon dioxide per ton of cement of which 400 kg per tonne is the result of the calcination of limestone (Lieblang, 2009). Developing countries such as; Nigeria, Sudan, Republic of Benin, etc are seeking to improve their inadequate infrastructures, they are faced with many challenges which include high cost of cement, diminishing national income due to the global economic recession, rising debt profile, decreasing foreign aid, scarcity of building materials-Cement, etc. In order to improve their infrastructure, cement (binder) and related materials are needed. Cement is the main binder in the production of concrete. The production of strong and durable concrete is fundamental to building better roads, bridges, houses, and civil infrastructure. The rising cost of cement particularly in the developing countries has made it difficult for majority of the populace whom are low income earners to own houses (Omoniyi, Duna & Mohammed, 2014). For instance, a 50kg bag of cement, had, at a time, been sold for $17(N2700) in Nigeria, In the Republic of Benin and Ghana, the same quantity sells for about $10(4500CFA) and $10.63(GH¢25.00) respectively as compared to 6$(N800.00) international price. Meanwhile, despite the huge increase in supply, the price of cement locally remains at least N2,000 per 50 kg bag, almost twice the international price of the same size of cement (Omoniyi, Duna & Mohammed, 2014). It can be duly noted that the exorbitant cost of cement production, government policies, among other factors have made housing developers build or construct structures with low quality concrete which manifest in weak sub-structures and super-structures, alike thus, leading to failures, total collapse of buildings and in worse cases, leading to loss of lives and property (Ayuba, Olagunju & Akande, 2012). Concrete's main environmental impacts are greenhouse gas emissions from cement production, and the mining of raw materials. Replacing a proportion of cement with waste products can significantly reduce embodied energy and greenhouse gas emissions (Dick Clarke, 2013). The global warming is caused by the emission of greenhouse gases such as CO_2 to the atmosphere by human activities. Among the greenhouse gases, CO_2 contributes about 65% to global warming. The cement industry is responsible for about 6% of all CO_2 emissions, for instance the production of one tonne of portland cement emits approximately

0.9tonnes of CO_2 into the atmosphere (Nazee & Kumar, 2014). Agricultural and industrial wastes pose great hazard to the environment and man as a result of improper management even when these wastes are burnt. They release CO_2 to atmosphere which also deplete the ozone layer (Elinwa & Abdulkadir, 2011). If these wastes are processed, they may be suitable for construction purpose (Turgut, 2007). However, the increase in popularity of using environmental friendly, light weight construction materials in building industry has brought about the need to investigate how this can be achieved by benefiting environment as well as maintaining the materials requirement affirmed in the standards (Shakir et al., 2013).

MATERIALS AND METHOD

MATERIALS

The following materials were obtained and used for the research work:

- **Cow Dung Ash (CDA)**

The cow dung was exposed to sunlight to dry in order to have dung cakes which was then subjected to burning after drying**.** The percentage replacements for cement by cow dung ash (CDA) were varied from 0%, 5%, 10%, 15%, 20%, 25%, and 30%.

- **Cement**

The dangote brand of ordinary Portland cement grade 42.5 conforming to BS EN 197-1 (2000) requirement was used.

- **Water**

The water used for this research work was portable, clean, and free from any visible impurities conforming to BS EN 1008, (2002) requirement

- **Fine aggregate**

The fine aggregate used for this research work was river sand retained on a 600 microns sieve. These particles bond very well and increase the strength of the concrete. They are the filler materials.

- **Coarse aggregate**

This comprises of natural and crushed stones. The coarse aggregate used in this study is granite of size 20mm. Particles with larger sizes cause reduction in strength of concrete.

METHODS

The following tests were conducted for the purpose of this research work:

Chemical Analysis: Chemical analysis of a representative sample of the cow dung Ash was carried out using XRF Spectrometer (AAS Buck Scientific 210VGP & Flame Photometer Fp 902PG) to ascertain the chemical constituents. The test was conducted at the Chemistry/Quality control laboratory of Afe Babalola University Ado-Ekiti, Ekiti State, Nigeria.

Slump: This is the most widely used test for determining the workability of concrete. It is a measure of the resistance of concrete to flow under its weight. The apparatus used is a hallow cone shaped mould. It was conducted at Concrete Laboratory of Civil Engineering Department, Federal Polytechnic, Ado Ekiti, Nigeria.

Compressive strength: The compressive strength of concrete is one of the most important and useful properties of concrete. The primary purpose for design concrete is to resist compressive strength in structural members. Hence it is the role of a concrete designer to specify the expected characteristics strength of concrete / mix proportion to enable it resist external force. The concrete cubes of sizes 150mmX150mmX150mm were cast by partial replacing cement with cow dung ash with percentage replacement of 0%, 5%, 10%, 15%, 20%, 25%, and 30% and cured by immersion in clean and portable water. These cubes were tested at maturing ages varying from 7days, 14days, 28days, 56days and 112days. The crushing test was carried out on an electric crushing machine (made in Italy by control Milano with serial no CR 2-029) with maximum load capacity of 1500KN. The crushing was done at Concrete Laboratory, Civil Engineering Department, Afe Babalola University Ado-Ekiti, Ekiti State, Nigeria.

RESULT AND DISCUSSION

Chemical analysis Result

Table 1.0: Chemical composition of cow dung ash (CDA)

Oxide Percentage	Mn_2O_5 (%)	SiO_2 (%)	CaO (%)	MgO (%)	Al_2O_3 (%)	K_2O (%)	Na_2O (%)	P_2O_5 (%)	SO_3 (%)	Fe_2O_3 (%)
CDA	2.06	79.90	18.99	3.12	6.88	3.97	0.98	1.64	1.56	3.11

The chemical composition of Cow dung ash reveals the presence of similar oxides to those of cement and other supplementary cementing materials which implies that it can be used as a cement replacement material if used in the right proportion. The sum of the oxides of silicon, Iron and Aluminum in cow dung ash (CDA) is 79.90% which exceed the 70% minimum specified by ASTMC618-12 for raw or calcined pozzolana (class N).The combined alkali (Na_2O+ K_2O) percentage of 4.95 for cow dung ash is low and thus reduces the possibility of the destructive aggregate alkali reaction which causes disintegration of concrete. Also, high alkalis percentage has been observed to affect the setting time and the rate of strength gain. One other interesting chemical present is sulphur trioxide (SO_3). The SO_3 in CDA is 1.56% which is below the 4% maximum specified by ASTM C618-12 which shows the tendency for improved durability and prevent unsoundness of the paste.

SLUMP VALUES

Table 1.1: Slump values for cow dung ash and cow dung powder.

Percentage for slump test replacement	CDA replacement slump result (mm)
0%	20
5%	18
10%	17
15%	15
20%	14
25%	11
30%	10

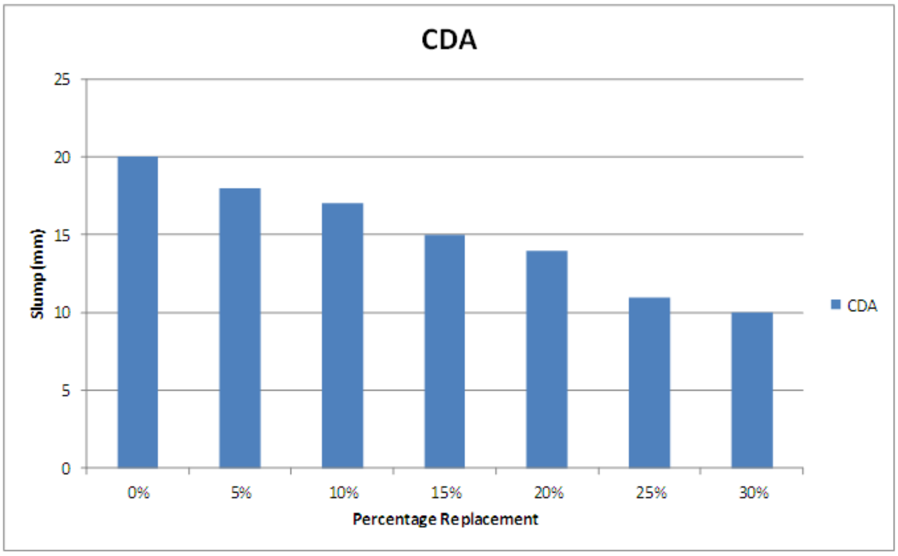

Figure 1: Bar chart for slump test of concrete produced using cow dung ash and cow dung ash.

The table 1.1 and figure 1 above show that as the percentage replacement is increasing, the workability is decreasing.

Table 1.2: Result of compressive strength test performed on concrete produced with cow dung ash as partial replacement for cement.

Percentage of replacement	Compressive strength				
	7 Days (N/mm^2)	14 Days (N/mm^2)	28 Days (N/mm^2)	56 Days (N/mm^2)	112 Days (N/mm^2)
0%	15.12	17.57	27.04	30.01	32.44
5%	14.86	15.16	26.91	30.00	31.95
10%	10.37	12.27	19.81	25.88	30.35
15%	9.39	12.06	17.64	23.05	26.46
20%	8.72	11.39	14.92	19.19	23.39
25%	8.24	8.51	10.49	11.18	14.72
30%	7.20	7.28	8.07	10.22	12.79

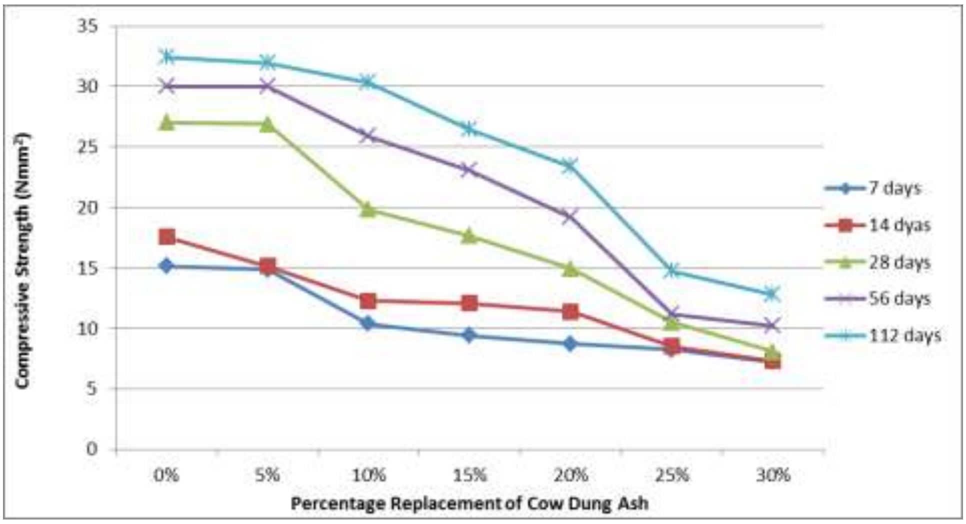

Figure 2: Graph of compressive strength against percentage of replacement of Cow Dung Ash.

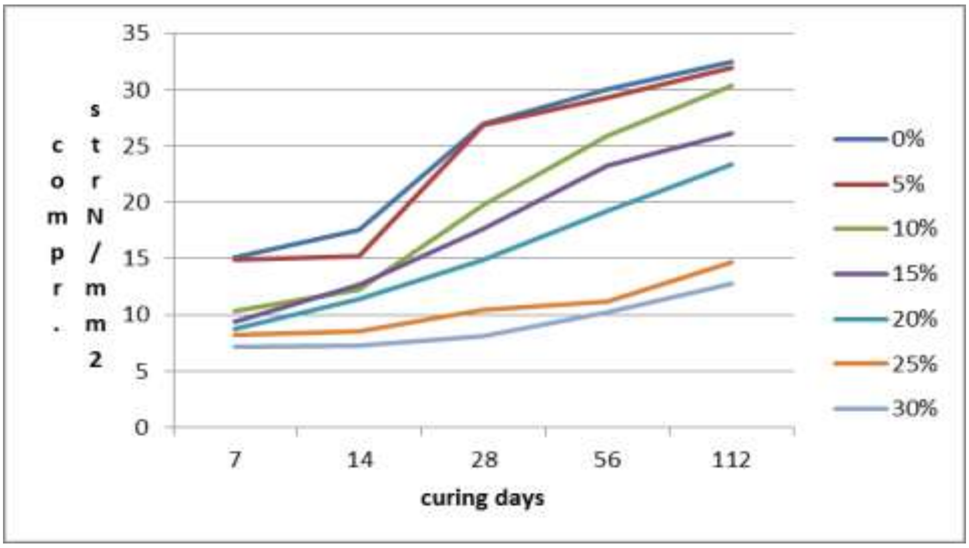

Figure 3: graph of compressive strength against curing days for concrete produced with CDA.

From figures 2 and 3 above, it is shown that as percentage replacement is increasing compressive strength is decreasing. Also, as the curing days was increasing, the compressive strength was increasing.

CONCLUSION AND RECOMMENDATION

Conclusion

From the results obtained from the study (test), it is obvious that the compressive strength of concrete increases with increase in curing days and decreased as percentage replacement increases. The Compressive strength value obtained at 20% replacement CDA was found to conform to the minimum requirement of $17N/mm^2$ for light weight concrete after 28days of curing. The workability decreases with increase in percentage replacement, this requires more water to have a workable concrete.

Recommendation

CDA can be a useful pozzolana up to 20% replacement for cement in concrete production. The use of Cow dung ash reduces cost of materials for production of concrete, it also reduces the amount of cement used in concrete production and invariable reduces total tones of cement produced this leads to reduction in carbon monoxide emission that depletes the ozone layer. The use of CDA should be encouraged for the following reasons; reduction is cost of building, reduction in energy consumption, reduction in CO_2 emission.

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