

Research Paper

COW DUNG ASH (CDA) AS PARTIAL REPLACEMENT OF CEMENTING MATERIAL IN THE PRODUCTION OF CONCRETE

Abstract

This project research presents the result on the study for the use of Cow Dung Ash (CDA) as partial replacement in production of concrete. The experiment were design for mix ratio of 1:2:4 to study the effects of adding Cow Dung Ash (CDA) in various percentages by weight (10%, 20% and 30%) of cement and cure for the periods of 7, 14, 21 and 28, days respectively before testing for the Compressive strengths. It also involves determination of setting time, Bulk Density, and Workability of Cow Dung Ash (CDA) in various percentages by mixing with Portland cement.

The Compressive test results are 21.33 N/mm², 21.11 N/mm², 11.11 N/mm² and 6.00 N/mm² for 0%, 10%, 20% and 30% replacement of cement with CDA respectively at 28 days. The Workability results gives 40mm, 48mm, 80mm and 100mm respectively for 0%, 10%, 20% and 30% replacement of cement with CDA.

The following were conclusions were drawn that the initial and final setting time increases as the percentage of Cow Dung Ash is added, (CDA) has an advantage that offers lightness of weight and low thermal conductivity, Cow Dung Ash (CDA) requires more quantity of water as the percentage increases in the concrete therefore it has a serious limitation that must be understood before it is put to use. Cow Dung Ash (CDA) concrete is recommended for use only when a ten percentage (10%) of Cow Dung Ash is added. While the concrete is suitable for use on certain floor and wall that will not be subjected to heavy load or structures that are of temporary use. (CDA) concrete is not to be use in a water accumulated area or for structures that are related to water.

Keywords: *Cow Dung Ash (CDA), Compressive Test, Setting Time, Bulk Density and Workability.*

1.0 INTRODUCTION

It is well accepted by everyone that concrete executes outstanding responsibilities for the construction of modern infrastructures and industrialization (M.R Karim *et al.*, 2011). Attempt has been made by various researchers to maintain the durability, strength and stability of concrete structure while also reducing the cost of production. The cement industry has one of the highest carbon footprints which make traditional concrete unsustainable in the future. Materials such as Cow Dung Ash (CDA), Fly Ash, Slag, and Silica Fume, can be used as partial replacement for cementing material (Metha, 2004). Cow Dung Ash (CDA) is obtained from cow excreta which is dried by sunlight and subjected to burning as a result, ash is obtained in black colour. It is bulky and has a large ash content containing a Nitrogen rich material, Potassium, Phosphorous and Calcium (Smith and Wheeler, 1979).

Cow dung is basically the rejects of herbivorous matter which is acted upon by symbiotic bacteria residing within the animal's rumen. Cow/Cattle are mostly found in every part of Nigeria while they are mostly rear in the northern states of the nation such as Plateau state, Nassarawa state, Kaduna state, Jigawa state, e.t.c. (Olawale and Eniola, 2012). Cow dung comprises of organic matter including fibrous material that passed through the cow's digestive system, among other liquid digesta that has been left after the fermentation, absorption and filtration, then acidified, then absorbed again. Exact chemical composition is of mostly carbon, nitrogen, hydrogen, oxygen, phosphorus, etc. with salts, cells sloughed off as the digester went through the digestive tract, some urea, mucus, as well as cellulose, lignin and hemicellulose. (V.S.R Pavan, et al, 2012)

Cow dung was habitually used in concrete and so one may suppose there were particular benefits in its inclusion. Recent publications suggest that dung may improve workability and durability or may act as an additional binder. Knowledge has also been lost as to whether fresh, old or

48 weathered dung was used. Since there is no historic reference to the dung being old or weathered,
49 it is conceivable that this is a recent invention resulting from modern attitudes toward odour and
50 hygiene. In any case, dried and fresh dung differ mainly in the water content and so are likely to
51 affect only the amount of water, if any, added during mixing of the concrete. This illustrates the
52 literature of the active cow dung component in concrete.

53 **2.0 MATERIALS AND METHODS**

54 **2.1 Processing of Cow Dung Ash**

55 Cow dung ash has chemical properties rich in Nitrogen, Potassium and calcium. It has relatively
56 high carbon to the Nitrogen ratio. While it has physical properties such as it is bulky, has large ash
57 content and burning ratio is low. The ones used for this project work is obtained from Bodija
58 abattoir, Ibadan, Oyo state, Nigeria. The cow dung is exposed to sunlight to dry in order to have
59 dung cakes which is then subjected to burning after it is dried to have the cow dung ash which is
60 obtained in black colour.

61 **2.2 Laboratory Tests**

62 The following laboratory tests were carried out on percent mix for 0%, 10%, 20% and 30%
63 replacement of cement with CDA respectively.

- 64 a. Sieve analysis test
- 65 b. Bulk Density
- 66 c. Compressive cube test
- 67 d. Workability test

68 a. **Sieve Analysis:** Sieve analysis test is the separation of aggregate into fraction. Each
69 fraction consists of particles with specific limit, these being openings of standard test sieves. The
70 CDA was placed in BS sieve which has sieves mount in frame so that they are place on one above
71 the other with large sieve size at the top and the smallest at the bottom. The material is poured
72 from the top and the sieve is given a vigorous shake mechanically. After shaken the material
73 retained on BS sieve represent the function of the fine aggregate.

74 b. **Bulk Density:** The CDA aggregate are gently lowered into the metal mould to over flow
75 and then level rolling a rod across the top to level it. Care is taken as far as possible segregation of
76 the size of the sample is compacted. The net weight of the aggregate in the mould is use to
77 determine the density in kg/m^3 . The bulk density by this method is loose or uncompacted density.

78 c. **Compressive Cube:** Steel mould of cast iron of dimension 150mmx150mmx150mm is
79 used for casting a total of 16 concrete cubes of 0%, 10%, 20% and 30% percent replacement of
80 cement with CDA respectively. The mould and its based are rigidly clamped together so as to
81 reduce leakage during casting. The sides of cube are thinly oiled before casting so as to prevent
82 the development of bond between the concrete and the mould. B.S 1881-108:1983 stipulates that
83 the cubes should be filled in three layer is compacted by 25 strokes of 25mm square inches steel.
84 The ramming is done efficiently to ensure full compaction. The cubes are cleaned of excess
85 concrete by passing an iron in a sawing motion over the top of the cubes. The free surface is finish
86 using hand trowel. The cubes are stored 24 hours undisturbed at temperature 18° C to 22° C and
87 relative humidity of not less than 90 percent. The mould is stripped off after 24 hours and the
88 cubes are to be stored in water for curing in a curing tank at 19° C to 21° C (B.S 1881-111: 1983).
89 At the end of the test the cubes are crushed with the crushed faces in contact with the platens of
90 the testing machine. The B.S 1881:1977 states that the load on the cubes can be applied at the rate
91 of 15N/mm²/min. The rate of increase in strain is progressively increased as failure is approached.
92 This is due to the non-linearity of the stress- strain relationship for the concrete at high stress. The
93 strength at failure is reported to the nearest 0.5N/mm (Neville, 1977).

d. **Workability:** Neil Jackson and R.K. Dhir (2002); defines workability as the ease with which a concrete mix can be handle from the mixer to its finally compacted shape. Measurement of workability can be through slump test, compacting factor test, veebe time test, for this research, slump test was adopted because it is the most suitable for quality control purpose. The slump cone was held down against it base with the small opening at the top. It was filled with the fresh concrete in the three layers being tampered 25 times with the help of a standard 16mm diameter steel rod rounded at the bottom end. The top of the cone was struck off with a trowel and the spilt concrete around the base of the cone was cleaned off. The cone was lifted slowly, the reduction in height (slump) between the cone mould and carried concrete mould were measured.

3.0 RESULTS AND DISCUSSIONS

3.1 Bulk Density Results

Below tables express the results as obtained before and after crushing the cubes. The curing days for the cubes are 7, 14, 21 and 28 days respectively

TABLE 1: Density of Cubes at 7 days (12 – 06 – 2013)

Specimen	Weight of Cube (kg)	Crushing load (kN)	Crushing strength (kN/mm ²)	Density of cube (kg/m ³)
0%	8.380	325	14.44	2,488.9
10%	8.300	305	13.56	2,459.3
20%	8.150	150	6.67	2,414.8
30%	8.010	115	5.11	2,373.3

The Density of the cubes is low due to the number of curing days

TABLE 2: Density of Cubes at 14days (19 – 06 – 2013)

Specimen	Weight of Cube (kg)	Crushing load (kN)	Crushing strength (kN/mm ²)	Density of cube (kg/m ³)
0%	8.700	350	15.56	5, 577.80
10%	8.550	342	15.20	2, 533.30
20%	8.000	208	9.24	2, 370.40
30%	7.800	122	5.42	2, 311.11

The Density of the cubes increases compare to the 7 days curing.

TABLE 3: Density of Cubes at 21 days (26 – 06 – 2013)

Specimen	Weight of Cube (kg)	Crushing load (kN)	Crushing strength (kN/mm ²)	Density of cube (kg/m ³)
0%	8.900	392	17.42	2, 637.00
10%	8.700	385	17.11	2, 577.80
20%	7.800	228	10.13	2, 311.11
30%	7.450	130	5.78	2, 207.40

There is an increase in the Density of the cubes compare to the 14 days

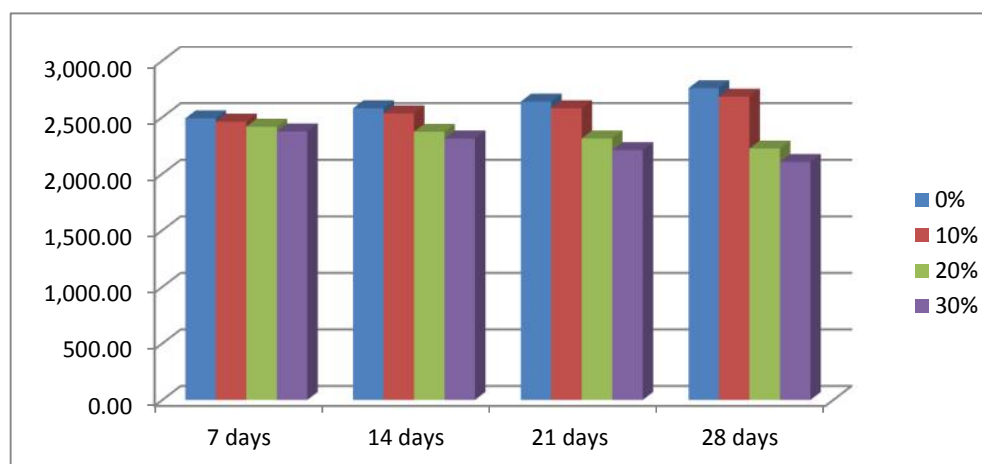
TABLE 4: Density of Cubes at 28days (03 – 07 – 2013)

Specimen	Weight of Cube (kg)	Crushing load (kN)	Crushing strength (kN/mm ²)	Density of cube (kg/m ³)
0%	9.300	480	21.33	2, 755.6
10%	9.050	475	21.11	2, 681.5
20%	9.500	250	11.11	2, 222.2
30%	7.100	135	6.00	2,103.7

This also increases compare to previous number of curing days.

122 **TABLE 5: Results Obtained for Density of Cubes for Each Curing Periods**

Curing period	0%	10%	20%	30%
7 days	2,488.90	2,459.30	2,414.80	2,373.30
14 days	2,577.80	2,533.30	2,370.40	2,311.11
21 days	2,637.00	2,577.80	2,311.11	2,207.40
28 days	2,755.60	2,681.50	2,222.20	2,102.70



127 **Fig 1: Bar Chart Representation of Density of Cubes against Curing Periods**

129 3.2 Compressive Cube Results

130 The following tables showed a detailed result presentation of the research project work after the
 131 practical and laboratory test. See as follows per the curing days of 7, 14, 21 and 28 days
 132 respectively.

TABLE 6: Cube Strength of CDA Varying the Percentage for Replacement of Cement at 7 Days of Curing

%CDA in cement	Cube Sizes(mm ²)	Cube Area(mm ²)	Water/cement	Weight of cube (kg)	Density of cube (kg/mm ³)	Crushing load (kN)	Cube strength (N/mm ³)
0%	150mm x 150mm	22500	0.5	8.38	2,488.90	325	14.44
10%	150mm x 150mm	22500	0.5	8.3	2,459.30	305	13.56
20%	150mm x 150mm	22500	0.5	8.15	2,414.80	150	6.67
30%	150mm x 150mm	22500	0.5	8.01	2,373.30	115	5.11

TABLE 7: Cube Strength of CDA Varying the Percentage for Replacement of Cement at 14 Days of Curing

%CDA in cement	Cube Sizes(mm ²)	Cube Area(mm ²)	Water/cement	Weight of cube (kg)	Density of cube (kg/mm ³)	Crushing load (kN)	Cube strength (N/mm ³)
0%	150mm x 150mm	22500	0.5	8.700	2,577.8	350	15.56
10%	150mm x 150mm	22500	0.5	8.550	2,533.8	342	15.2
20%	150mm x 150mm	22500	0.5	8.000	2,370.4	208	9.24
30%	150mm x 150mm	22500	0.5	7.800	2,311.11	122	5.42

TABLE 8: Cube Strength of CDA Varying the Percentage for Replacement of Cement at 21 Days of Curing

%CDA in cement	Cube Sizes(mm ²)	Cube Area(mm ²)	Water/cement	Weight of cube (kg)	Density of cube (kg/mm ³)	Crushing load (kN)	Cube strength (N/mm ³)
0%	150mm x 150mm	22500	0.5	8.900	2,637.0	392	17.42
10%	150mm x 150mm	22500	0.5	8.700	2,577.8	385	17.11
20%	150mm x 150mm	22500	0.5	7.800	2,311.11	228	10.13
30%	150mm x 150mm	22500	0.5	7.450	2,207.4	130	5.78

TABLE 9: Cube Strength of CDA Varying the Percentage for Replacement of Cement at 28 Days of Curing

%CDA in cement	Cube Sizes(mm ²)	Cube Area(mm ²)	Water/cement	Weight of cube (kg)	Density of cube (kg/mm ³)	Crushing load (kN)	Cube strength (N/mm ³)
0%	150mm x 150mm	22500	0.5	9.300	2,755.6	480	21.33
10%	150mm x 150mm	22500	0.5	9.050	2,681.5	475	21.11
20%	150mm x 150mm	22500	0.5	7.500	2,222.2	250	11.11
30%	150mm x 150mm	22500	0.5	7.100	2,103.7	135	6.00

3.3 Workability Results

Workability implies the ease with which concrete mix is handling and it can be determine by slump test. Slump test as for IS: 1199 – 1959 is followed, the used of slump core and tamping rod. The table below has shown the workability of each mix of concrete varying the percentage of Cow Dung Ash (CDA).

TABLE 10: Workability Result of CDA

0% of CDA in cement	Slump (mm)
0%	40
10%	48
20%	80
30%	100

3.4 Consistency Limit Results

Consistency limit is basic aims to find out water content require to produce a cement paste of standard consistency as specified by the IS:4031 (part 4) – 1988. The table below showed the results obtained by varying the percentage of Cow Dung Ash (CDA) added in as cement replacement.

TABLE 11: Consistency Limits Result of CDA

0% of CDA in cement	Consistency limit
0%	0.34
10%	0.46
20%	0.62
30%	0.78

4.0 CONCLUSION AND RECOMMENDATION

4.1 Conclusion

From the analysis of the result, one can rightly conclude as follow;

- ✚ Cow Dung Ash (CDA) concrete can be made to perform well in certain floor and wall applications when a ten percentage (10%) only of Cow Dung Ash (CDA) are added.
- ✚ The Cow Dung Ash (CDA) requires more quantity of water as the percentage increases in the concrete, therefore it has a serious limitation that must be understood before it is put to use.
- ✚ The Cow Dung Ash (CDA) has an advantage that offers lightness of weight and low thermal conductivity that makes it useful construction material.

4.2 Recommendations

The following recommendations below is based on the outcome from the research and practical work been carried out as highlighted in the result presented in chapter Four.

- ✚ Cow Dung Ash (CDA) concrete is recommended for use only when a ten percentage (10%) of Cow Dung Ash is added. While the concrete is suitable for use on certain floor and wall that will not be subjected to heavy load or structures that are of temporary use.
- ✚ Cow Dung Ash (CDA) concrete is not to be use in a water accumulated area or for structures that are related to water.
- ✚ Cow Dung Ash (CDA) concrete of high percentage over 10% are not suitable for concrete production due to the increase in the ash content.

170  In general Cow dung Ash (CDA) concrete is not suitable for use where high structural
171 strength is required or where it would be subjected to heavy traffic and several abrasive
172 actions.

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