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COMPRESSIVE STRENGTH EVALUATION OF CONCRETE: A PARADIGMATIC USE OF WASTE (SAWDUST AND COW DUNG)

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ABSTRACT

This research aims to find out the optimum compressive strength of concrete produced with partial replacement of cement with cow dung and fine aggregates with sawdust. The concrete mix of 1:2:4 was prepared using water/cement ratio of 0.65 with 0%, 2%, 4% and 6%.Sawdust and cow dung were used concurrently as partial replacement for fine aggregates and cement respectively. The specific gravity values of cement, cow dung, stone dust (fine aggregates) and sawdust are 3.13, 1.33, 3.00 and 1.25 respectively. The compressive strength obtained for different percentages of replacement with cow dung and sawdust are; 8.56N/mm^2 , 14.11N/mm^2 , 17,33N/mm^2 ,18.89N/mm^2 for 0% replacement, 7.56N/mm^2 , 10.89N/mm^2 , 14.22N/mm^2 , 17.55N/mm^2 for 2% replacement, 5.22N/mm^2 , 8.72N/mm^2 , 12.22N/mm^2 , 15.72N/mm^2 for 4% replacement and 3.33N/mm^2 , 7.08N/mm^2 , 10.83N/mm^2, 14.58N/mm^2 for 6% replacement at 7,14,21 and 28 days respectively. It was also discovered that as curing age increases, the compressive strength increases and increase in percentage replacement caused a corresponding decrease in the compressive strength. The Compressive strength value obtained were found to conform to the minimum requirement of 17N/mm^2 for light weight concrete especially when 2% cement and fine aggregate were replaced with cow dung and sawdust respectively.

KEYWORDS: Optimum Compressive Strength, Curing, Water/Cement Ratio, Saw Dust, Cow dung.

INTRODUCTION

The cost of building construction is increasing daily as a result of increasing in the cost of building materials such as cement, granite, fine aggregates etc. This has prevented the low income earners to have their own house (Olutoge, 2010). Also, the agricultural and industrial wastes pose great hazard to environment and man as a result of improper management even when these wastes are burnt, they release carbon-monoxide to atmosphere which depletes the ozone layer(Elinwa & Abdulkadir, 2011). If these wastes are processed, they may be suitable for construction purpose (Turgut, 2007).

Base on these two major points given above, there is a need to investigate the use of alternative building materials which are locally available such as sawdust, cow dung, wastes from demolished building, palm kernel shell, mining wastes etc that can be used in concrete production. Since most building construction works consists of concrete work which happens to be the most expensive aspect, therefore, reduction in cost of concrete production will reduce the cost of building construction and paves ways for low income earners to become landlords and if these wastes are used in concrete production, there will be drastically reduction in amount of carbon emission, our environment will more friendly and depletion of ozone layer will seize.

The overall relevance of concrete in virtually all Civil Engineering practices and building construction cannot be over-emphasized (Adewuyi & Adegoke, 2008). Concrete is a mixture of cement, fine aggregates, coarse aggregates and water in a right proportion to get a particular strength (Toman U. Ganiron Jr.,2014). The paste formed as a result of reaction between water and cement binds the aggregates together. The mixture sets into a rock-like solid mass, which has considerable compressive strength but little resistance in tension (Agbede & Menessh, 2009)

However, the construction industry relies heavily on conventional materials such as cement, granite, and for production of concrete (Oyedepo, Oluwajana & Akande, 2014), in some areas, the demand for these conventional materials is higher than supply (Divakar, 2007) and this has hindered the development of shelter and other infrastructural facilities in such areas (Olutoge, 2010). The growing concern of resource depletion and global pollution has challenged many researchers and Engineers to seek and develop locally available materials to suit engineering purpose. Many of these locally available materials are used as coarse aggregates, fine aggregates and cement for the production of light weight concrete. Abdulkardir, (2011) observed that sawdust is an industrial waste in timber industry constitute a nuisance to both the man's health and environment when not properly managed. It is one of the major underutilized by-products from saw milling operations. Generation of wood wastes in sawmill is an unavoidable hence a great effort must made in the utilization of such wastes. (Zziwal, 2006). Also, generation of cow dung as agricultural waste is increasing as a result of increasing in the number of people who engage in rearing cows. Cow dung is the undigested residue of plant matter which has passed through the cow gut. This cow dung is rich is calcium, potassium, phosphorus, carbon and nitrogen (Smith & Wheel, 1979). A full grown well fed cow produces between 10-15kg of dung per day. Nigeria has an estimated cow population of 16million and is expected to produces an estimated 264,000tons of dung per day.

Nonetheless, accumulation of unmanaged wastes especially in developing countries has resulted in an increasing environmental problem (Elinwa et al 2011). 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 maintain the materials requirements affirmed in the standards.

MATERIALS AND METHODS

Cow dung: This is obtained from the cow excreta. It was sundried and grounded to fine powder form like cement. The grounded cow dung particles were sieved through 90microns and used for concrete production without further treatment. The percentage replacements for cement were varied from 0%, 2%, 4% and 6%. The cow dung was obtained from the farm of department of Agricultural&Bio-environmental engineering of the Federal Polytechnic, Ado-Ekiti, Ekiti State, Nigeria.

Sawdust: It was obtained from saw mill industry in Ado-Ekiti, Ekiti State, Nigeria and sieved and retained on sieve aperture of 600microns, sundried, then kept in waterproof bags and used without further treatment. The percentages of replacements of fine aggregates by sawdust were varied from 0%, 2%, 4% and 6%.

Cement: Portland cement was used for this research work and it was found to confirm with the requirements of BS EN 197-1(2000)

Water: The water used for this work is potable, clean and free from any visible impurities. It confirmed to BS EN 1008(2000).

Fine aggregates: The fine aggregates used for this work is stone dust. It was retained on a 600microns sieve. The impurities were removed and found confirmed to the requirements of BS 882 (1992).

Coarse aggregates: Granites were used for this work of size12.5mm. They are free from debris and other impurities. They are angular in shape.
The tests carried out on these materials are slump test, sieve analysis, specific gravity and compressive strength

Slump test: The most widely used test for determine the workability of concrete. The test is a measure of the resistance of concrete to flow under its weight. The apparatus used is a hallow cone shaped mould test.

Compressive strength test: 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.

Sieve analysis: This is a test that is performed to determine the percentage of different grain sizes contain within the material. The mechanical or sieve analysis is performed to determine the distribution of coarser, larger-sized particles. The sieve analysis of this study was carried out on saw dust.

Specific gravity test: This is a test that is performed to determine the density of the soil particle finer than 2mm. At least two specimens, each between 5g and 10g shall be obtained by riffling. The specimens shall be oven dried or sundried at 105^0c to 110^0c and stored in an airtight container.

RESULTS AND DISCUSSION

From the analysis done on the compressive strength of concrete using 0%,2%,4% and 6% replacement of cement and fine aggregate with cow dung and saw dust respectively. It was observed that the compressive strength of concrete at 0% replacement of cement and fine aggregate with cow dung and saw dust was 18.89N/mm2 after curing for 28 days, while the compressive strength of the concrete at 2% replacement of cement and fine aggregate with cow dung and saw dust was 17.55N/mm2 after curing for 28 days as shown on table 1.2 and 1.3.

It was also observed that the compressive strength of the concrete at 4% replacement of cement and fine aggregate with cow dung and saw dust was 15.72N/mm2 after curing for 28 days, while the compressive strength of concrete of the concrete at 6% replacement of cement and fine aggregate with cow dung and saw dust was 14.58N/mm2 after curing for 28 days as shown on table 1.2 and 1.3.

Table 1.1 Summary of specific gravity test result for different material used

Materials	Specific gravity
Cow dung	1.33
Stone dust	3.00
Saw dust	1.25
Cement	3.13

Table 1.2: Summary of compressive strength at different percentages of replacement

% Replacement	Compressive strength @7days curing(N/mm^2)	Compressive strength @14days curing (N/mm^2)	Compressive strength @ 21days curing(N/mm^2)	Compressive strength @ 28days curing(N/mm^2)
0	8.56	14.11	17.33	18.89
2	7.56	10.89	14.22	17.55
4	5.22	8.72	12.22	15.72
6	3.33	7.08	10.83	14.58

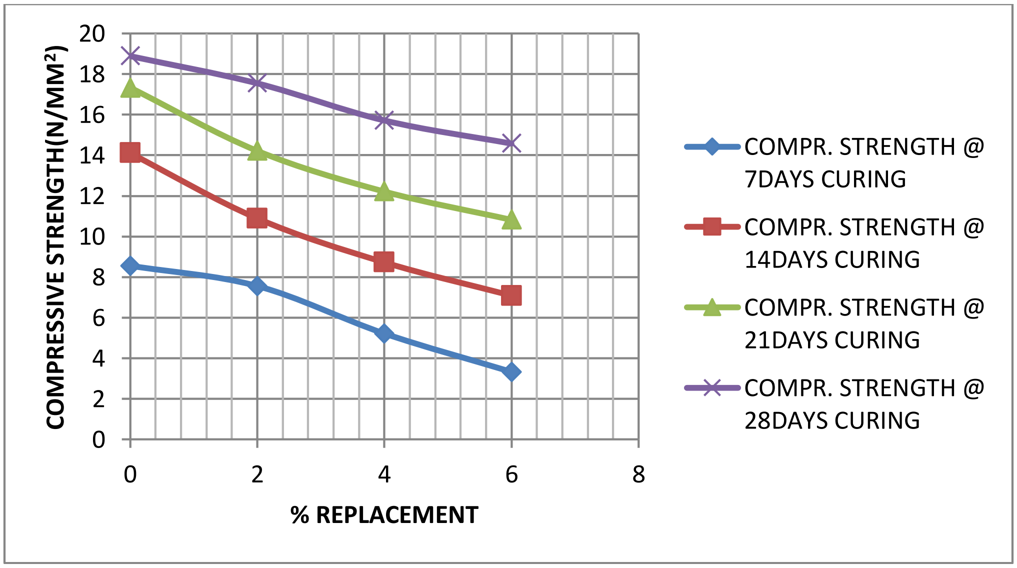

FIG. 1.1: Graph of compressive strength against % replacement

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Table 1.3: summary of compressive strength at different curing days

Curing days	Compressive strength @0% replacement (N/mm^2)	Compressive strength @ 2% replacement(N/mm^2)	Compressive strength @ 4% replacement (N/mm^2)	Compressive strength @ 6% replacement(N/mm^2)
7	8.56	14.11	17.33	18.89
14	7.56	10.89	14.22	17.55
21	5.22	8.72	12.22	15.72
28	3.33	7.08	10.83	14.58

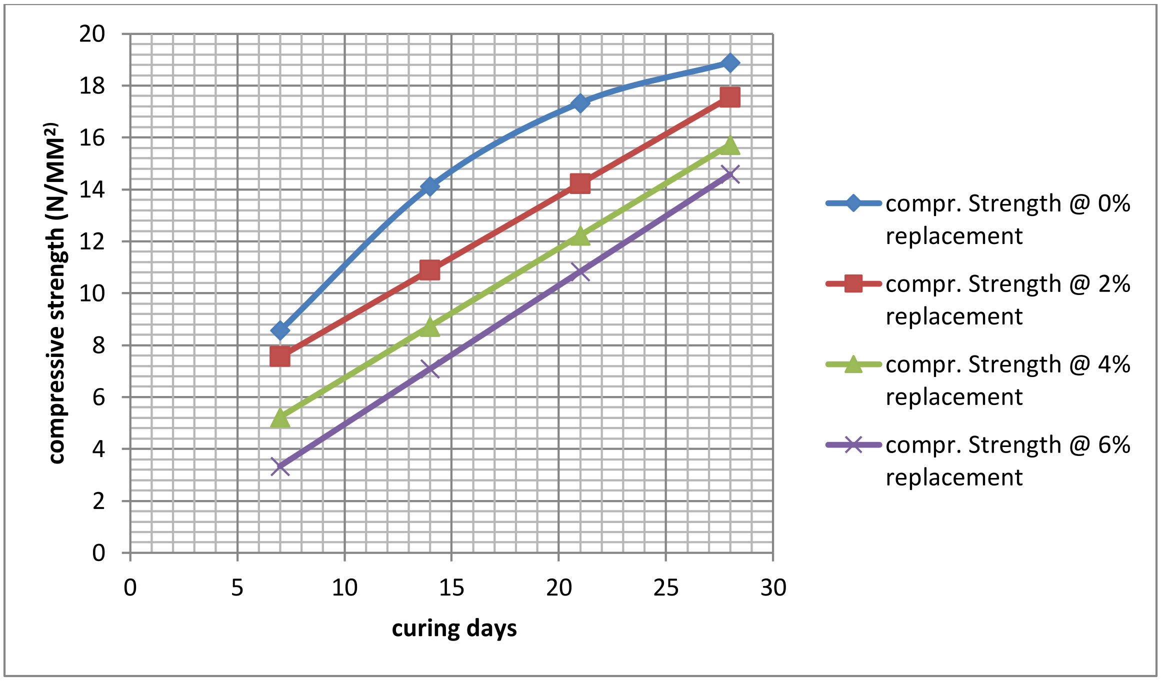

FIG. 1.2: Graph of Compressive strength against curing days

SIEVE ANALYSIS TEST (saw dust) RESULT

Weight of saw dust = 500g
Weight of top cover = 388g

Sieve sizes(µm)	Initial wt. of sieves (g)	Final weight of sieve(g)	Weight retained(g)	% retained	% passing
2360	470	613	141	28.20	100
1180	440	574	134	26.80	71.80
600	402	480	78	15.60	45.00
300	442	497	55	11.00	29.00
212	355	377	22	4.40	18.40
150	422	445	23	4.60	14.00
75	426	451	25	5.00	9.40
Base plate	241	263	22	4.40	4.40
			500	100	0

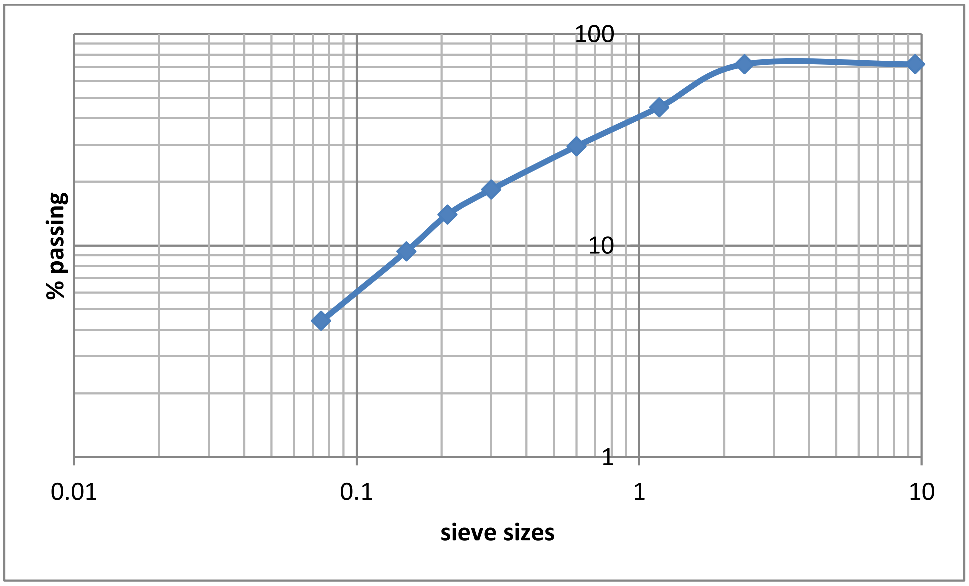

Fig. 4.3.2 showing sieve analysis graph

SLUMP TEST RESULT

Portions	Volume of water used (liters)	Slump type	Different in height (mm)
A	6.0	True	85
B	6.0	True	90
C	6.0	True	84

Average = (85 + 90 + 84)/3 = 86.33mm.

CONCLUSION AND RECOMMENDATION

CONCLUSION

From the computed results and charts obtained from the study (test), it is obvious that the compressive strength of concrete increases with increase in curing days.

Also, the compressive strength of concrete at 0% replacement of cement and fine aggregate with cow dung and saw dust is greater than the compressive strength of concrete at 2% replacement of cement and fine aggregate, while the compressive strength of concrete at 2% replacement of cement and fine aggregate with cow dung and saw dust is also greater than the compressive strength of concrete at 4% replacement of cement and fine aggregate with cow dung and saw dust. The compressive strength of concrete at 4% replacement of cement and fine aggregate with cow dung and saw dust was greater than the compressive strength of concrete at 6% replacement of cement and fine aggregate with cow dung and saw dust.

In other words, the compressive strength of concrete reduces with increase in the percentage of replacement of cement and fine aggregate with cow dung and saw dust (i.e. the higher the percentage of replacement of cement and fine aggregate with cow dung and saw dust the lower the compressive strength of the concrete).

RECOMMENDATION

The compressive strength obtained for different percentages of partial replacement with cow dung and saw dusts are:
(1) 8.56N/mm^2,14.11N/mm^2,17,33N/mm^2,18.89N/mm^2 for 0% replacement at 7,14,21 and 28days of curing,
(2) 7.56N/mm^2,10.89N/mm^2,14.22N/mm^2,17.55N/mm^2 for 2% replacement at 7,14,21 and 28days of curing
(3) 5.22N/mm^2,8.72N/mm^2,12.22N/mm^2,15.72N/mm^2 for 4% replacement at 7,14,21 and 28days of curing
(4) 3.33N/mm^2 , 7.08N/mm^2 , 10.83N/mm^2, 14.58N/mm^2 for 6% replacement at 7,14,21 and 28days of curing. The Compressive strength value obtained at 2% replacement was found to conform to the minimum requirement of 17N/mm^2 for light weight concrete after 28days of curing. Using sawdust and cow dung in a proportion of 2%

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replacement of fine aggregate and cement respectively is however suitable to strength and density properties of lightweight and non-structural concrete.

We now recommend that concrete produced with 2% replacement of cement and fine aggregate with cow dung and saw dust respectively can be used for the following concrete works; flooring, fish pond, poultry house, grouting ,kerbs, inter-locking tile e.t.c.

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