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Conference Paper · May 2013

DOI: 10.13140/2.1.2742.0804

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Partial Replacement of Sand with Sawdust in Concrete Production

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ABSTRACT

The rising costs of building construction in developing countries have been a source of concern to government and private developers. This study investigated the use of sawdust as partial replacement for fine aggregates in concrete production. Sawdust was used to replace fine aggregates from 0% to 50% in steps of 10%. Concrete cubes measuring 150 x 150 x 150mm were cast and their compressive strengths evaluated at 7, 14, 21 and 28 days. Increase in percentage of sawdust in concrete cubes led to a corresponding reduction in compressive strength values. From the results, the optimum sawdust content was obtained at 10% and its corresponding compressive strength at 28 days is 7.41 N/mm^2 which falls within the characteristic strength of plain concrete (7 – 10 N/mm$^{2)}$. This concrete cannot be used for structural applications.

Key words: Concrete, coarse aggregate, compressive strength

INTRODUCTION

Sawdust is not a familiar material in the construction/building industry. This is either because it is not available in very large quantities as sand or gravel, or because their use for such has not been encouraged. For some time now, there have been calls for the use of local materials in the construction industries especially in developing countries to check costs of construction. Sawdust can be defined as loose particles or wood chippings obtained as by-products from sawing of timber into standard useable sizes [2]. Clean Sawdust with reasonable amount of bark has proved to be satisfactory, since it does not introduce high content of organic material that may upset the reactions of hydration [4].

[3] wrote that sawdust is used mostly as a source of fuel for domestic cooking in most areas where they occur. He stated further that it is often dumped as waste products and that about 105 million tones of sawdust are generated annually in India alone.

[5] investigated the properties of coconut shells (CCS) and palm kernel shells (PKS) as coarse aggregates in concrete. His finding was that cost reductions of 30% and 42% were achieved for CCS and PKS concretes respectively relative to plain concrete.

[6] determined the compressive strength of concrete made with varying percentages of waste wood ash (WWA). They reported that compressive strength generally increased with age but decreased with the increase in the WWA content. Comparisons of the strength of WWA concrete with those of the control (plain) concrete of corresponding ages showed that the strength of WWA concrete was generally less than that of the plain concrete.

[1] studied the influence of wood ash (WA) on the slump of concrete. He used wood ash as partial replacement of cement in varying percentages (0, 10, 20, 30, and 40%) in concrete mixture proportion of 1:2:4. Test result showed that mixtures with greater wood ash content require greater water content to achieve a reasonable workability.

Concrete is any product or mass made by the use of a cementing medium. It is a composite material obtained by mixing together coarse aggregates (e.g. gravel, crushed stones), fine aggregates (e.g. sharp sand), cement and water in suitable proportion. Sometimes additional materials known as admixture are added to modify certain of its properties.

MATERIALS AND METHODS

Sourcing of materials

The sawdust was sourced from timber shade located in kpakungu area of Minna, Niger State, Nigeria. The sawdust consisted of chippings from various hardwoods and softwoods such as Mahogamy, Madobia, Araba, Opepe and Asuelo. It was sun dried and kept in waterproof bags.

Sample Preparation

Results and Discussions

Table 1. Physical properties

Property	Value For sawdust	Value For sand	Value For Gravel
Loose Bulk density Mg/m^3	0.08	0.74	0.81
Compacted Bulk density Mg/m^3	0.12	0.85	0.89
Water content (%)	25.58	4.23	1.54
Water absorption (%)			
Specific gravity	0.37	2.85	2.66

Dry density value of 0.37 places the sawdust in the same category as lightweight aggregate while the specific gravities of the sand and the gravel place them in the category of common rock groups whose gravities range from 2.62-3.00. However

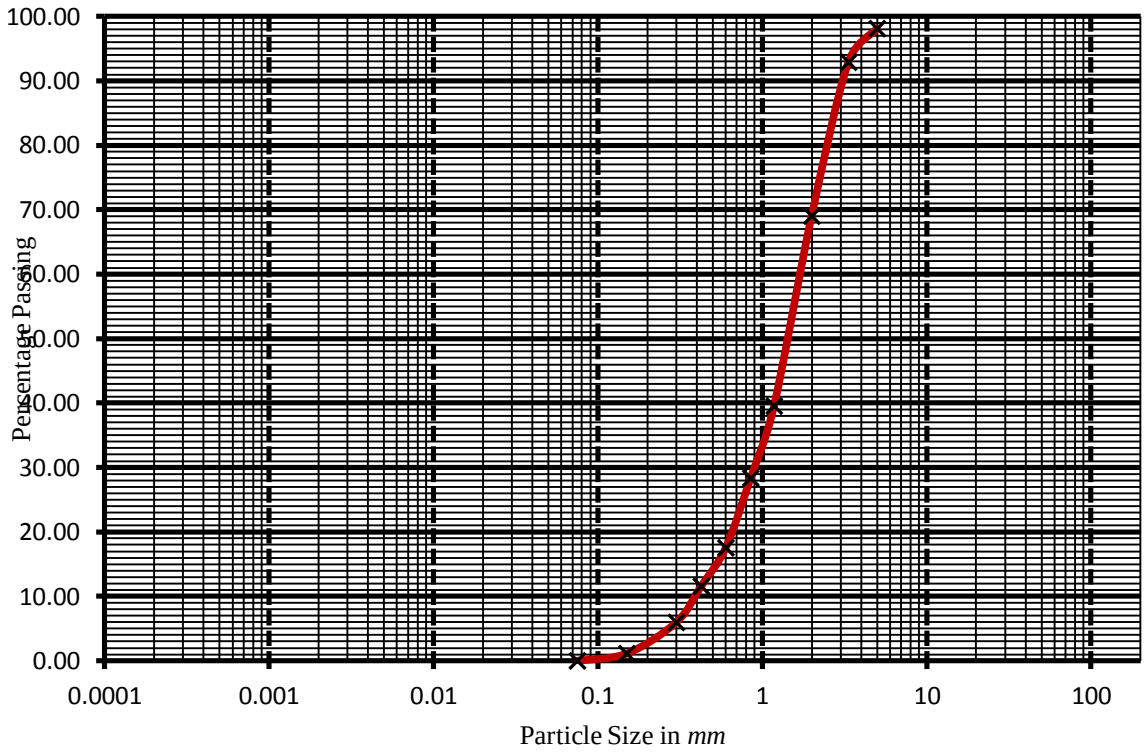

Figure 1: Particle-Size Distribution Curve of the Sawdust

From the particle size distribution the sawdust will act as sand and even as mineral fillers by virtue of the distribution. Proportions of materials retained on 0.00 mm sieve were weighed and used for the mixes. This was done to avoid altering the properties of the other components of the mix. The effect here is that sawdust will replace mostly the fine aggregate.

Table 2: Compacting Factor Test of the Concrete

% Replacement	W/C Ratio	Weight of partially Compacted concrete A (g)	Weight of fully compacted concrete B (g)	Compactive factor A/B
0	0.45	12.60	13.70	0.92
10	0.45	10.00	12.90	0.78
20	0.45	9.47	11.22	0.84
30	0.45	8.42	9.99	0.84
40	0.45	8.56	9.42	0.91
50	0.45	7.69	8.94	0.86

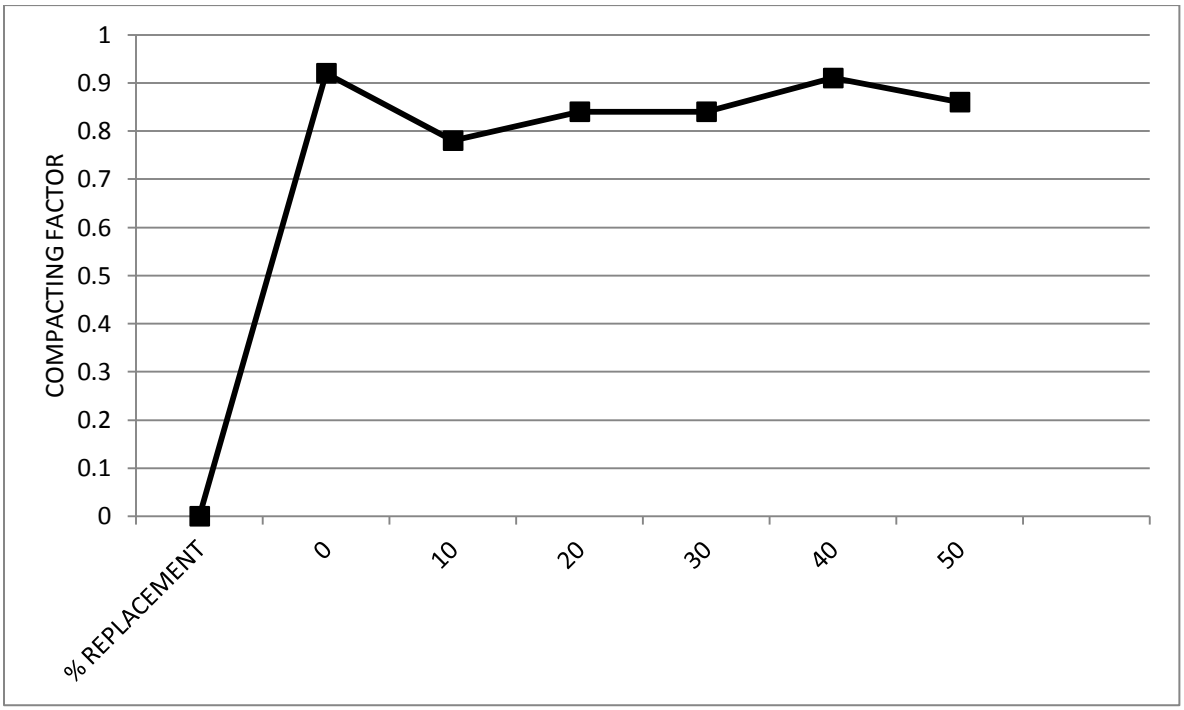

Figure 2: Compacting Factor as a Function of Percentage Replacements

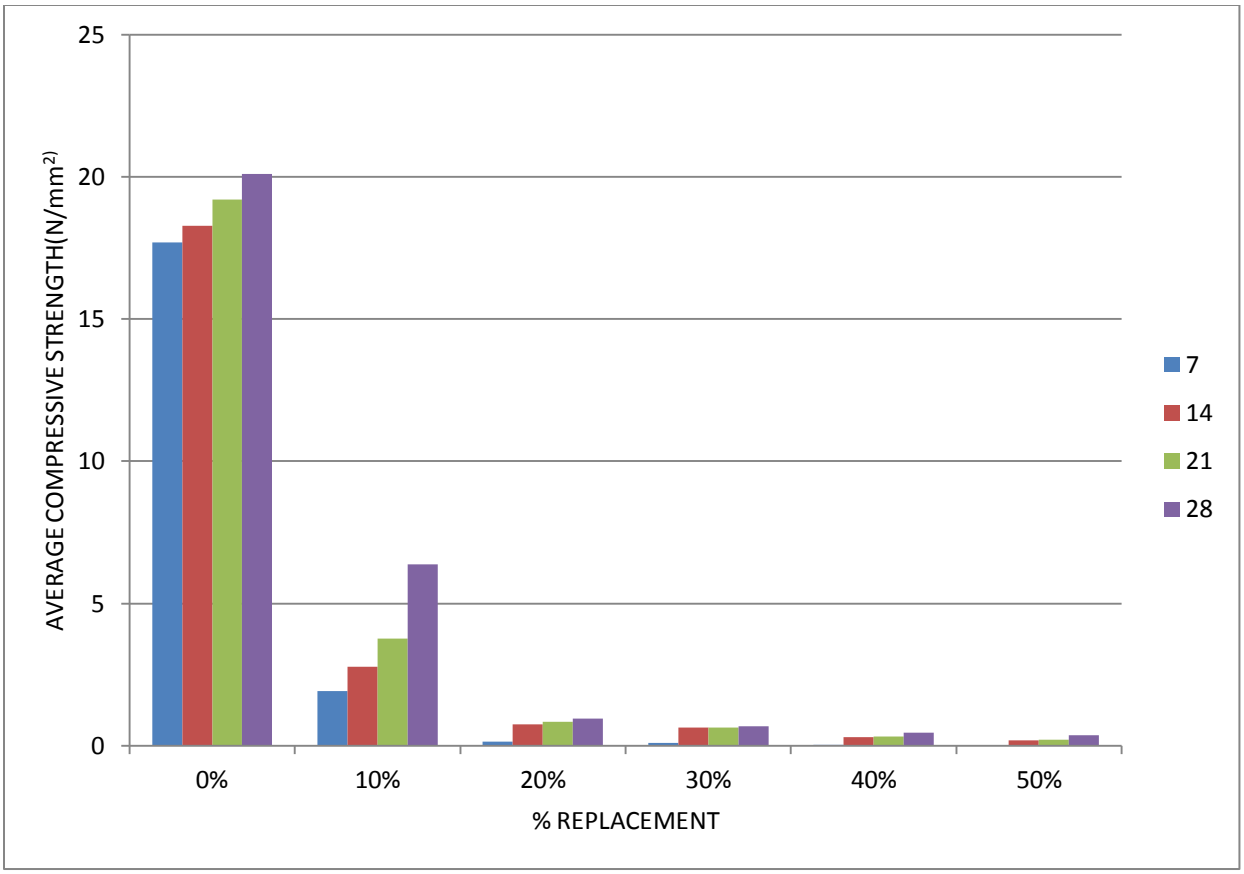

Figure 3: Effect of Replacement of sand with sawdust on Compressive Strength.

The compressive strength values show that the inclusion of sawdust in the concrete did not enhance its compressive strength. As the percentage sawdust content increased in the mix the compressive strength decreased.

The low values of the compressive strength of the concrete used in this investigation could be attributed to the fact that sawdust contains some substances which are injurious to the cement. These substances actually inhibit the hydration of cement and hence the development of strength. Furthermore the low compressive strength values could be due to the air entrapped in the mortar mix which is known to cause a reduction in strength.

In addition it is difficult to obtain sawdust which is not a mixture of several species. As a result there is bound to be a considerable variation in the results obtained from batch to batch.

Conclusions

1. Sawdust as an air-entraining agent has no appreciable positive effect on the compressive strength of concrete.
2. Variation in the compressive strength results is traceable to the fact that it is difficult to obtain sawdust which is not a mixture of several species
3. A possibility exists for the partial replacement of sand with sawdust in the production of lightweight concrete
4. Optimum replacement of sand with sawdust has been found to be 10%. Beyond this limit, the concrete produced did not meet code requirements for strength as per BS 8110 (1997).

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