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# Saw Dust As Full Replacement Of Fine Aggrgate In Lightweight Concrete: Any Comparable Strength?

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----------**ABSTRACT**: ----------
*This study is on the experimental investigation of fully replacing sand with sawdust on the compressive property of concrete. Design mix ratio 1:2:4 and w/c of 0.58 were used and 24 concrete cubes were cast. 12 cubes were for the sand concrete used as control samples and 12 cubes for the sawdust concrete. The compressive strength of the sawdust concrete was compared with the sand concrete to check their strength gain. The result of the study gave that both the weight and compressive strength of sawdust concrete decreased significantly and the gain in strength was very poor. The gap in the strength gain between the two concrete cannot be compared at all hence, some percentage replacement using sawdust is needed to ascertain its optimum for use as lightweight concrete.*
***KEYWORDS:*** *Sawdust, Pollution, Environment, Lightweight Concrete, Aggregate*.
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## I. INTRODUCTION

The use of waste materials in construction especially in concrete works has been recognised as one of the meaningful ways of disposing wastes from industries. This contributes to the conservation of natural resources and protecting the environment [1,2]. Sawdusts are those small sized and powdery wastes from timber production [3] which most times are dumped or burnt in the open. This practice has dangerous effects on the environment by air and land pollution. In terms of its flammability, sawdust presents a very big hazard in the manufacturing industries, hence the need for proper and adequate handling of this material [4]. The use of wastes such as corn-cobs, palm kernel shells, coconut shells, and sawdust in construction would help to reduce over reliance on traditional materials such as cement, sand and crushed rock aggregates whose exploitation has resulted in negative environmental consequences. Sawdust can be used in variety of ways like serving as mulch, fuel, in icehouses to keep ice frozen during the summer before the advent of refrigerators, to soak up liquid spills, allowing the spill to be easily collected. Sawdust can be used as alternative substitute for fine aggregate in concrete production as lightweight aggregate in flooring and manufacture of precast products [5] for development of sustainable concrete and construction of eco-friendly structures.

Concrete obtained from sawdust is a mixture of sawdust, gravel, cement and water to entrance the workability and full hydration of the cement which aids bonding of the concrete. Sawdust concrete weighs less than normal concrete with satisfactory heat insulation and resistance with fires. Sawdust concrete when compared to other lightweight concrete would hold driven nails firmly. Also if each sawdust particle took up enough water during hydration, they could aid the hydration process especially in the centre parts of concrete that is impossible to cure with water thus eliminating the need of curing because water deposited in sawdust particles are being harvested by cement particles. Daniel and Emmanuel, 2016 investigated compressive strength of concrete using sawdust as aggregate and found that density and compressive strength of concrete decreased as the percentage replacement increased but replacement of sand by sawdust produced a higher percentage reduction in compressive strength. Sawdust can potentially be used as aggregate in the production of both non-structural lightweight concrete.

Bechio et. al., 2009 found that recycling of wastes as building materials appears to be a viable solution not only to such pollution problem but also to economic design of buildings. In using sawdust as sand replacement to produce low-cost and lightweight concrete for use in construction, Adebaku et al (2012) found that at 10% sawdust replacement, production costs and weight reduced by 3% and 10% respectively. The strength of concrete was found to be reduced with sawdust as fine aggregate due to its higher rate of water absorption [9]. Increase in wood aggregate content reduces weight of concrete by distinctly decreasing its density while compressive strength test indicates mechanical properties drop with decrease in density [7]. The type of wood from which sawdust is gotten is an important parameter as a result of the amount of extractable sugar present. Sawdust containing oak wood particles failed to harden 24 hours after mixing [10].

The research will analyse the compressive strength property of concrete with sawdust as full replacement of sand by assessing the strength capacity of the resulting lightweight concrete.

## II. MATERIALS

The materials include:

- Unicem Ordinary Portland Cement
- Sawdust as full replacement of fine aggregate. This was gotten from Maryland saw-mill at timber market in Enugu state. They are powdery and graded zone 4 with specific gravity of 0.75
- Coarse aggregate (crushed). From Abakaliki, Ebonyi state. Maximum aggregate size is 20mm and specific gravity of 2.62
- Sand as fine aggregate for the control. It is graded zone 3 and specific gravity of 2.645.
- Good water supply.

## III. METHODS

The above materials were gotten and prepared for the laboratory tests. Tests performed include; particle size distribution, specific gravity, slump test, compressive strength. Design mix ratio 1:2:4 and w/c of 0.58 used. About extra 2kg of mixing water was added when needed because the sawdust aggregate absorbed a lot of water. Concrete cubes mould 150 x 150 x 150 was used and for concrete strength of 25N/mm$^2$. Two sample cubes were cast;

- Concrete with sand as fine aggregate used as control sample (12 cubes)
- Concrete with saw-dust fully replacing fine aggregate (12 cubes)

Before using the saw dust it was washed and cleaned because large amount of barks are present which can affect setting time and heat of hydration of cement. The concretes cubes were cast and removed from the mould after 24 hours. The sand concrete cubes were put in the curing tank immediately until the age of testing. Sawdust concrete cubes were left for another 24 hours before they were placed in the curing tank. This is because they have not hardened enough. A total of 24 concrete cubes were made. At each testing age, three sample cubes were used and reported results at any age are the mean of the three samples. This is for 7, 14, 28 days concrete compressive strength. 21 days strength age was not done because of the low gain in strength.

## IV. RESULTS AND OBSERVATIONS

Table 1: Sand concrete, using sand as fine aggregate

| Concrete Age (days) | Average weight of cubes (kg) | Average crushing load (kN) | Average compressive strength (N/mm$^2$) |
|---|---|---|---|
| 7 | 8.630 | 395.000 | 17.560 |
| 14 | 8.250 | 540.000 | 24.000 |
| 28 | 8.625 | 566.650 | 25.200 |

**Table 2:** Sawdust concrete, using sawdust as fine aggregate

| Concrete Age (days) | Average weight of cubes (kg) | Average crushing load (kN) | Average compressive strength (N/mm$^2$) |
|---|---|---|---|
| 7 | 5.925 | 0 | 0 |
| 14 | 6.075 | 18.356 | 0.816 |
| 28 | 6.050 | 33.050 | 1.469 |

The above data are presented in the Fig.1.

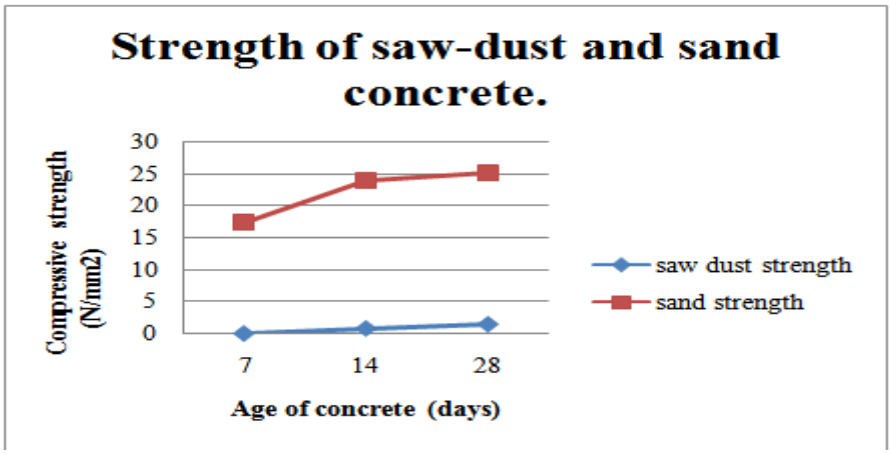


**Fig.1:** compressive strength of sawdust and sand concrete

- The saw-dust material has a specific gravity of 0.75 and this is not up to the minimum value which is 2.49 0r 2.50.
- The sawdust used was powdery greenish brown black material, during sieve analysis, very little sawdust particle was retained in sieve No.4.75mm and large proportion of sawdust particle retained on sieve No.150μm.
- The saw-dust used is graded zone 4 material. It absolved a lot of water during mixing. The workability was very low hence the extra water added.
- The saw-dust concrete cubes did not harden after 24 hours of mixing unlike the sand concrete cubes.
- After bringing the saw-dust concrete cubes out from curing water for crushing, the cubes were swollen and dropping a lot of water. This can be seen in Table.2, there was no strength gain at the 7 days age.
- The cubes were kept in dry airy place for 24hrs to allow excess water to drip after removing from curing tank.
- The 21 days strength was purposely left out because of the low strength gain at 14 days strength.

## V. DISCUSSION AND CONCLUSION

The use of saw-dust as full replacement of sand in concrete works was presented in this analysis. Table 1, showed concrete strength characteristics when sand was used as fine aggregate and there's normal increase in concrete strength. For the sawdust concrete strength, there was increase in strength with age but the strength produced was very poor. The increase in strength of concrete comes from the continued reaction between the cement and water to form C-S-H gel which increases the bond between the cement paste and aggregate. This happens as curing time increases.

Fig.1 shows the wide gap between using sawdust concrete and sand concrete. This gap can be filled by partially replacing sand at some percentages with sawdust material. Although full replacement using sawdust as fine aggregate in concrete is not at all advised, some percentage replacement is recommended to ascertain the optimum percentage replacement for lightweight concrete. With this, some appreciable strength will be achieved for suitability and sustainability. Also pollution problems will be greatly reduced and economic design of building achieved. Using sawdust will give low construction cost, but it's necessary to consider strength first before material cost to avoid failures.

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