FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

SCHOOL OF ELECTRICAL ENGINEERING AND TECHNOLOGY & SCHOOL OF INFRASTRUCTURE, PROCESS ENGINEERING AND TECHNOLOGY

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THEME THE ROLE OF ENGINEERING AND TECHNOLOGY IN SUSTAINABLE DEVELOPMENT

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FORWARD

The School of Engineering and Engineering Technology, Federal University of Technology, Minna, organized the 1st and 2nd International Engineering Conference in 2015 and 2017 respectively. With the emergence of the new School of Electrical Engineering and Technology and the School of Infrastructure, Process Engineering and Technology, the two schools came together to organize this 3rd International Engineering Conference (IEC 2019) with the theme: "The Role of Engineering and Technology in Sustainable Development" considering the remarkable attendance and successes recorded at the previous conferences. The conference is aimed at offering opportunities for researchers, engineers, captains of industries, scientists, academics, security personnel and others who are interested in sustainable solutions to socio-economic challenges in developing countries; to participate and brainstorm on ideas and come out with a communiqué, that will give the way forward. In this regard, the following sub-themes were carefully selected to guide the authors' submissions to come up with this communiqué.

1. Engineering Entrepreneurship for Rapid Economic Growth.
2. Regulation, Standardization and Quality Assurance in Engineering Education and Practice for Sustainable Development.
3. Solutions to the Challenges in Emerging Renewable Energy Technologies for Sustainable Development.
4. Electrical Power System and Electronic as a Panacea for Rapid Sustainable Development
5. Promoting Green Engineering in Information and Communication Technology
6. Reducing Carbon Emission with Green and Sustainable Built Environment
7. Artificial Intelligence and Robotics as a Panacea for Rapid Sustainable Development in Biomedical Engineering
8. Petrochemicals, Petroleum Refining and Biochemical Technology for Sustainable Economic Development.
9. Advances and Emerging Applications in Embedded Computing.
10. Traditional and Additive Manufacturing for Sustainable Industrial Development.
11. Emerging and Smart Materials for Sustainable Development.
12. Big Data Analytics and Opportunity for Development.
13. Building Information Modeling (BIM) for Sustainable Development in Engineering Infrastructure and Highway Engineering.
14. Autonomous Systems for Agricultural and Bioresources Technology.

The conference editorial and Technical Board have members from the United Kingdom, Saudi Arabia, South Africa, Malaysia, Australia and Nigeria. The conference received submissions from 4 countries namely: Malaysia, South Africa, the Gambia and Nigeria. It is with great joy to mention that 123 papers were received in total, with 0.9 acceptable rate as a result of the high quality of articles received. Each of the paper was reviewed by two personalities who have in-depth knowledge of the subject discussed on the paper. At the end of the review process, the accepted papers were recommended for presentation and publication in the conference proceedings. The conference proceedings will be indexed in Scopus.

On behalf of the conference organizing committee, we would like to seize this opportunity to thank you all for participating in the conference. To our dedicated reviewers, we sincerely appreciate you for finding time to do a thorough review. Thank you all and we hope to see you in the 4th International Engineering Conference (IEC 2021).

Engr. Dr. S. M. Dauda
Chairman, Conference Organizing Committee

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The Chairman and members of the Conference Organizing Committee (COC) of the 3rd International Engineering Conference (IEC 2019) wish to express our gratitude to the Vice Chancellor and the management of the Federal University of Technology, Minna, the Deans and all staff of the School of Electrical Engineering and Technology (SEET) and the School of Infrastructure, Process Engineering and Technology (SIPET) for the support towards the successful hosting of this conference. We also thank the entire staff of the university who contributed in one way or the other. We are sincerely grateful to you all.

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Federal University of Technology, Minna, Nigeria

EFFECT OF PARTIAL REPLACEMENT OF FINE AGGREGATE WITH SAWDUST IN LIGHT WEIGHT CONCRETE PRODUCTION USING BIDA NATURAL STONE AS COARSE AGGREGATE

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ABSTRACT

This study investigated the effect of sawdust as partial replacement for Fine Aggregate in light weight concrete production. Sawdust was used to replace Fine Aggregate from 0% to 40% in steps of 5%. 150 x 150 x 150mm concrete cubes were cast for each replacement level, the concrete was cured and the compressive strengths were determined at 7, 21 and 28days curing period respectively. Increase in percentage of sawdust in concrete led to a constant reduction in the compressive strength values with a corresponding reduction in weight. From the result obtained, 5% replacement of Fine Aggregate with sawdust gave a maximum compressive strength 13.11 N/mm^2. It was however concluded that the optimum replacement level of 5% can be used as plain concrete for blinding works.

Keywords: *Bida, Compressive Strength,* Light Weight *Concrete, Sawdust*

1. INTRODUCTION

The overall relevance of concrete in virtually all Civil Engineering Practice and Building Construction Works cannot be overemphasized (Adewuyi and Adegoke, 2008). Concrete is a combination of cement, aggregates and water, which are mixed in a right proportion to arrive at the strength. The cement and water react together chemically to form a paste, which binds the aggregate particles together. The mixture sets into a rock-like solid mass, which has considerable compressive strength but little resistance to tension (Agbede and Menessh, 2009). However, the construction industry relies heavily on conventional materials such as cement, granite and sand for the production of concrete. The high and increasing cost of these materials has greatly hindered the development of shelter and other infrastructural facilities in developing countries (Olutoge, 2010). Scientists,

Engineers and Technologists are continuously on the lookout for new materials which can be used as substitutes for conventional materials, especially where their properties would enable their use in new designs and innovative applications. There is also an increasingly awareness of the need to re-use or recycle waste. The growing concern of resource depletion and global pollution has challenged many researchers and engineers to seek and develop new materials relying on renewable resources. These include the use of bye-products and waste materials in building construction. Many of these bye-products are used as aggregates for the production of light weight concrete (Adewuyi and Adegoke, 2008). The most widely used fine aggregate for the making of concrete is the natural sand mined from the river beds. However, the availability of river sand for the preparation of concrete is becoming scarce due to the excessive nonscientific methods of mining from the river beds, lowering of water table and sinking of the bridge piers among others, is becoming common treats (Mageswari and Vidivelli, 2010). The Worldwide consumption of sand as fine aggregate in concrete production is very high and

several developing countries have encountered some strain in the supply of natural sand in order to meet the increasing needs of infrastructural development in recent years (Divakar *et al.*, 2012). Nonetheless, accumulation of unmanaged wastes especially in developing countries has resulted in an increasing environmental concern. However, the increase in the 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 material requirements affirmed in the standards. Sawdust is an industrial waste in the timber industry constitute a nuisance to both the health and environment when not properly managed (Elinwa and Abdulkadir, 2011). Wood sawdust wastes are accumulated from the countries all over the world and cause certain serious environmental problems and health hazards. Generation of wood waste in sawmill is an unavoidable hence a great efforts are made in the utilization of such waste (Zziwal *et al.*, 2006). Thus, this research investigates the potential use of wood sawdust wastes to produce a low cost and light weight concrete for construction and engineering purpose.

2. MATERIALS AND METHOD

2.1 Sourcing of materials

The sawdust for this study was collected from a saw mill point at Gidan Kwano, opposite Federal University of Technology Minna, Niger State Nigeria. The sample was carefully collected to avoid mixing with the sand. The natural stones of maximum size of 20mm used as coarse aggregate were obtained from Bida Niger state, Nigeria. Natural sand (having smooth and more rounded particles) passing sieve 5mm used and was collected from a river bed at Gidan Kwano road, Federal University of Technology Minna, Niger State. For use in this concrete production, it was ensured that the sand was clean, sound and well graded according to requirement set by BS812, 1990. Ordinary Portland cements (OPC) conforming to BS12, 1996 was used.

Dangote was used being the most widely recommended material of its kind. Bags of the cement were bought at a retail store in Minna, Niger State.

The water which is used for mixing the materials was obtained from a borehole at Gidan Kwano Campus which confirmed to BS3148 (1980) requirements. Therefore, the water is fit for drinking, free from suspended particles and organic materials which might affect hydration of cement.

2.2 Sample preparation

Prior to mixing of the concrete components, tests such as specific gravity tests, moisture content, particle size analysis, loose and compacted bulk density tests, water absorption of aggregates were conducted on sand, saw-dust and gravel. Fine aggregates, cement, sawdust, and water were mixed to from a paste (on which slump and compacting factor tests were conducted) which used to fill the voids around the coarse aggregates. A chemical process called hydration occurred which transformed the semi- liquid mass into a hard, strong engineering material. In this investigation, sawdust was used as partial replacement for the fine aggregate (sand). This work attempts to establish that the mixture of cement, sand – sawdust and gravel might have an equal advantage as the standard mix of cement, sand and gravel. Both mixes are in the proportion 1: 2: 4 (cement, fine aggregate and coarse aggregate) respectively. Eighty one cubes were cast with the same volume proportions. After placing in 150 x 150x 150mm moulds, they were left to set for 24 hours, and kept afterwards in a curing tank. The cured samples were tested after 7, 21 and 28 days for compressive strengths in accordance with BS1881, 1983.

3.0 RESULTS AND DISCUSSION

Table 1: Physical properties of Constituent Materials

Properties	Sawdust	Sand	Gravel
Loose bulk density (g/cm^3)	1.225	1.264	1.367
Compacted bulk Density (g/cm^3)	1.414	1.415	1.488
Water content (%)	7.79	6.19	1.57
Water absorption (%)	14.95	13.55	5.07
Specific gravity	1.37	2.66	2.17

Specific gravity value of 1.37 place the sawdust in the same category as lightweight aggregate while the specific of the sand and the gravel place them in the category of common rock group whose gravities range from 2.62- 3.00 (Neville, 2000). However, the loose and compacted bulk densities for both Sawdust and that of sand are relatively the same, which makes the two material complimentary. Saw dust was found to have a greater water content value than sand with the difference in the region of 0.19%. This, thus, will cause a reduction in the workability of the fresh concrete.

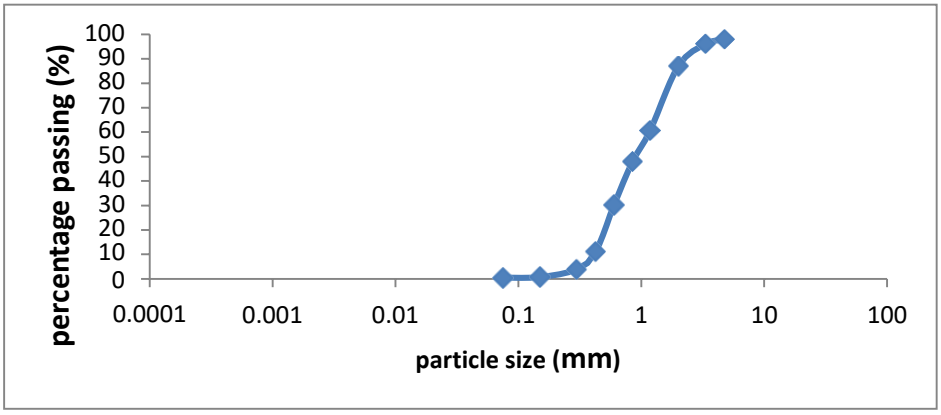

Figure 1: Particle Size Distribution Curve for Saw dust

It can be seen from the particle size distribution that the sawdust can act as sand and even as minerals fillers by virtue of the distribution.

Table 2: Result of Compressive Strength Test

% Replacement	7 Days Curing	21 Days Curing	28 Days Curing
0	15.69	21.82	26.27
5	9.20	12.58	13.11
10	6.31	5.73	7.4
15	4.09	5.20	5.42
20	2.98	4.13	5.40
25	2.76	3.02	3.24
30	2.40	2.76	2.93
35	2.09	2.31	2.53
40	1.60	2.13	2.22

It is seen from Table 2 that for control cube, the compressive strength increased from 15.69N/mm^2 at 7days to 26.27N/mm^2 at 28 days (about 10.58% increment). This is equivalent to grade 25 concrete that has a specified value of 25N/mm^2 (BS 8110, 1997). The 10% replacement sample gave a value of 7.4N/mm^2 at 28days which is equivalent to grade 7 concrete that has a value of 7N/mm^2 specified for plain concrete. It could also be observed that the weight of the cube reduced from 8.5kg for 0% replacement to 7.53kg for 10% replacement at 28 days, which is about 20% reduction in weight. This is evident that presence of sawdust in concrete hinders strength development of cement, thus causing decrease in the compressive strength.

4. CONCLUSION

From the results of the physical and mechanical property test conducted, it was concluded that sawdust is a light weight aggregate which is in agreement with the work of Mageswari amd Vidivelli (2010) and thus, could be used as partial replacement for sand in plain concrete for blinding work.

However, to achieve best result in the use of sawdust in concrete production, optimum replacement level of 5% is recommended. It is also recommended that further works should be conducted with varying w/c rations to determine the optimum.

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