International Journal of Engineering Science Invention
ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726
www.ijesi.org Volume 3 Issue 8 ǁ August 2014 ǁ PP.36-40

Use of Saw Dust Ash as Partial Replacement for Cement In Concrete

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ABSTRACT : *This paper presents the results of the investigation carried out on the use of Saw Dust Ash (SDA) as partial replacement for Ordinary Portland Cement (OPC) in concrete. SDA was used to replace OPC by weight from 0 to 30% in steps of 5%. Compacting factor test was carried out on fresh concrete while compressive strength test was carried out on 150mm concrete cubes after 7, 14 and 28 days curing in water. The results revealed that the Compacting factor decreased as the percentage replacement of OPC with SDA increased. The compressive strength of the hardened concrete also decreased with increasing OPC replacement with SDA. It is recommended that studies on long term strength and durability be carried out to ascertain more facts about the suitability of the use of SDA as a pozzolan in concrete.*

KEYWORDS: *Concrete, Saw Dust Ash, Compacting factor, Compressive Strength*

I. INTRODUCTION

Portland cement as an ingredient in concrete is one of the main construction materials widely used especially in developing countries. The increasing demand for cement is expected to be met by partial cement replacement (Coutinho, 2003). The search for alternative binder or cement replacement materials led to the discovery of potentials of using industrial by-products and agricultural wastes as cementitious materials. If these fillers have pozzolanic properties, they impart technical advantages to the resulting concrete and also enable larger quantities of cement replacement to be achieved (Hossain, 2003). Studies by Arikan, (2004) and Turanli et al. (2004) indicate that substantial energy and cost savings can result when industrial by-products are used as a partial replacement for the energy intensive Portland cement. The presence of mineral admixtures from agricultural waste is also known to impart significant improvement in workability and durability of concrete. Although, technological and economic benefits are the main reasons for the use of mineral additions, Genezzini et al. (2003) observed that the prevention of environment contamination by means of proper waste disposal is an added advantage. The use of industrial and agricultural by-product in cement production is an environmental friendly method of disposal of large quantities of materials that would otherwise pollute land, water and air.

Some of the waste products which possess pozzolanic properties and which have been studied for use in blended cements include fly ash (Wang et al., 2008), Silica fume (Lee et al., 2005), Volcanic ash (Hossain, 2005), Rice husk ash (Akeke et al.., 2013; Rajput et al., 2013), Corn Cob Ash (Raheem et al., 2010; Raheem and Adesanya, 2011).Saw dust is a waste material resulting from the mechanical milling or processing of timber into various shapes and sizes. The dust is usually used as domestic fuel. The resulting ash known as Saw Dust Ash (SDA) is a form of pozzolan. Saw dust is in abundance in Nigeria and other parts of the world. The need to convert this waste product into a construction product is the focus of this study.Elinwa and Ejeh (2004) considered the effect of the incorporation of waste incineration fly ash (SWIFA) in cement pastes and mortar. Cheah and Ramli (2011) investigated the implementation of wood waste ash as a partial cement replacement material in the production of structural grade concrete and mortar. Elinwa et al. (2008) assessed the fresh concrete properties of self-compacting concrete containing Saw Dust Ash. Elinwa and Mahmoodb (2002) considered ash from timber waste as cement replacement material. This research work examined the use of Saw Dust Ash as partial replacement for Ordinary Portland Cement in concrete. It invoved the determination of workability and compressive strength of the concrete at different level of replacement.

II. MATERIALS AND METHODS

Materials

Saw Dust Ash (SDA):The Saw Dust used was obtained from Iree, Nigeria. After collection, the sawdust was openly heated. The ash was ground to the required level of fineness and sieved through 600μm sieve in order to remove any impurity and larger size particles.

Coarse Aggregate : The granite used for this research work was 12mm size. It was sourced from a quarry in Igbajo in Nigeria

Fine Aggregate : The sand used for this research work was sourced from Iree, Osun state, Nigeria. The impurities were removed and it conformed to the requirements of BS 882 (1992).

Cement : The cement used was Ordinary Portland Cement. It was sourced from Iree, Osun State, Nigeria and it conformed to the requirements of BS EN 197-1: 2000.

Water : The water used for the study was obtained from a free flowing stream. The water was clean and free from any visible impurities. It conformed to BS EN 1008 (2002) requirements.

Batching and mixing of materials : Batching of materials was done by weight. The percentage replacements of Ordinary Portland cement (OPC) by Saw Dust Ash (SDA) were 0%, 5%, 10%, 15%, 20%, 25% and 30%. The 0% replacement was to serve as control for other samples.

Concrete Mix Design : The concrete used in this research work was made using Binder, Sand and Gravel. The concrete mix proportion was 1:2:4 by weight.

Casting of samples : Cubic specimens of concrete with size 150 x 150 x 150 mm were cast for determination of all measurements. Seven mixes were prepared using different percentages of 0, 5, 10, 15, 20, 25 and 30 SDA. The concrete was mixed, placed and compacted in three layers. The samples were demoulded after 24 hours and kept in a curing tank for 7, 14 and 28 days as required. The Compacting Factor apparatus was also used to determine the compacting factor values of the fresh concrete in accordance with BS 1881: Part 103 (1983).

Testing of samples : The compressive tests on the concrete cubes were carried out with the COMTEST Crushing Machine at The Sammya Construction Company, Osogbo, Nigeria. This was done in accordance with BS 1881: Part 116 (1983). The sample was weighed before being put in the compressive test machine. The machine automatically stops when failure occurs and then displays the failure load.

III. RESULTS AND DISCUSSIONS

Results of compacting factor test on fresh concrete samples

The results obtained from the compacting factor test on fresh concrete samples are given in Table I.

Table I: Compacting factor values of SDA concrete

Percentage replacement of SDA (%)	Compacting Factor values
0	0.91
5	0.89
10	0.88
15	0.87
20	0.86
25	0.86
30	0.85

The table indicates that the compacting factor values reduce as the SDA content increases. The compacting factor values reduced from 0.91 to 0.85 as the percentage SDA replacement increased from 0% to 30%. These results indicate that the concrete becomes less workable (stiff) as the SDA percentage increases meaning that more water is required to make the mixes more workable. The high demand for water as the SDA content increases is due to increased amount of silica in the mixture. This is typical of pozzolan cement concrete as the silica-lime reaction requires more water in addition to water required during hydration of cement (Bui et al. 2005).

Bulk Densities of Concrete Cubes

The Bulk Densities of the Concrete Cubes cast at various days of curing are shown in Table II and Figure 1.

Table II. Bulk Densities of Concrete Cubes with various percentages of SDA

Saw Dust Ash Replacement (%)	BulkDensity(g/cm^3)		
	7 days	14 days	28 days
0	2.32	2.37	2.43
5	2.27	2.29	2.31
10	2.21	2.22	2.25
15	2.19	2.20	2.22
20	2.19	2.20	2.20
25	2.18	2.18	2.19
30	2.17	2.18	2.19

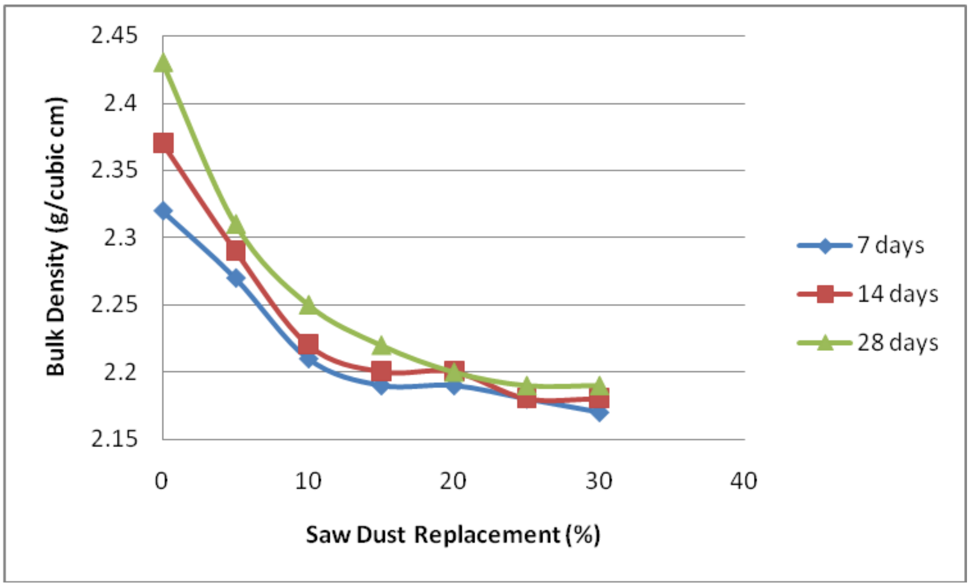

Figure 1: Effect of SDA content on Bulk Density of Concrete at different curing age

The results of the bulk densities show that the bulk density reduces as the percentage SDA increases. This could be attributed to the increase in voids in the concrete cubes as the percentage SDA increases. However, the bulk densities increase as the number of days of curing increase as the concrete cubes become denser.

Results of Compressive Strength Tests on Concrete Cubes : The results of the compressive strength tests on concrete cubes are shown in Table III and Figure 2

Table III: Compressive Strength of Concrete Cubes with various percentages of SDA

Saw Dust Ash Replacement (%)	Compressive Strength (N/mm^2)		
	7 days	14 days	28 days
0	17.51	21.60	29.15
5	17.23	17.85	21.02
10	16.89	16.96	20.64
15	14.38	15.87	19.05
20	10.59	11.63	13.56
25	9.35	9.83	12.42
30	7.02	7.61	10.19

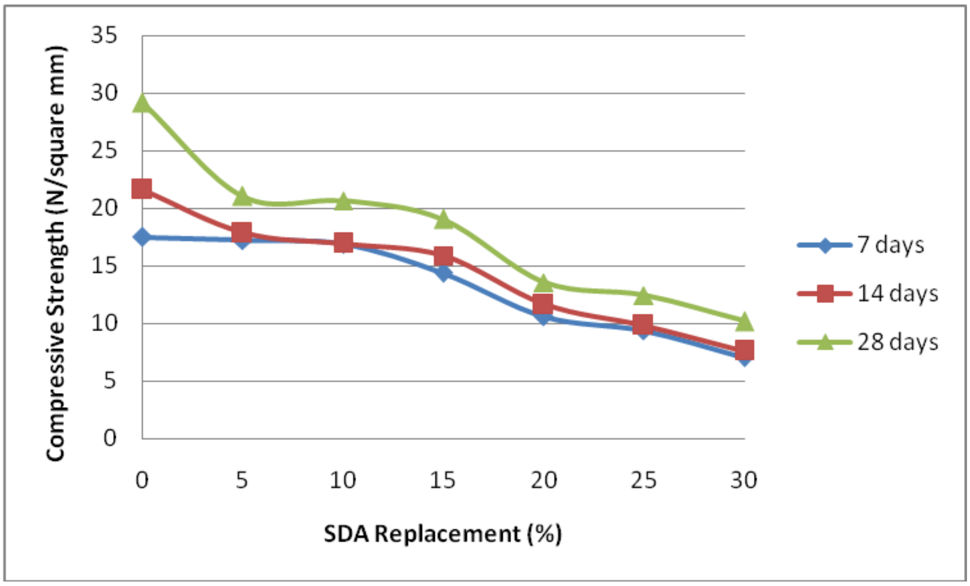

Figure 2: Effect of SDA content on Compressive Strength of concrete at different curing age

The results of the compressive strength of concrete cubes show that the compressive strengths reduced as the percentage SDA increased. However, the compressive strengths increased as the number of days of curing increased for each percentage SDA replacement.It is seen from Table III that for the control cube, the compressive strength increased from 17.51 N/mm^2 at 7 days to 29.15 N/mm^2 at 28 days (i.e. about 66% increment). The 28 day strength was above the specified value of 25N/mm^2 for grade 25 concrete (BS 8110, 1997) as shown in Table 4. The strength of the 5% replacement by sawdust ash showed increase in compressive strength from 17.23 N/mm^2 at 7 days to 21.02 N/mm^2 at 28 days (22% increment).The 28 day strength was above the specified value of 20N/mm^2 for grade 20 concrete (BS 8110, 1997) as shown in Table 4. The strength of the 10% replacement by sawdust ash showed increase in compressive strength from 16.89 N/mm^2 at 7 days to 20.64 N/mm^2 at 28 days (22% increment).The 28 day strength was above the specified value of 20N/mm^2 for grade 20 concrete (BS 8110, 1997) as shown in Table IV.The strength of the 15% replacement by sawdust ash showed increase in compressive strength from 14.38 N/mm^2 at 7 days to 19.05 N/mm^2 at 28 days (32% increment).The 28 day strength was above the specified value of 15N/mm^2 for light weight concrete (BS 8110, 1997) as shown in Table 4.

Table IV: Recommended grade of concrete (BS 8110, 1997)

Grade	Characteristic strength	Concrete class
7 10	7.0 10.0	Plain concrete
15	15.0	Reinforced concrete with lightweight aggregate
20 25	20.0 25.0	Reinforced concrete with dense aggregate
30	30.0	Concrete with post tensioned tendons
40 50 60	40.0 50.0 60.0	Concrete with pre tensioned tendons

IV. CONCLUSIONS

From the investigations carried out, the following conclusions can be made:
The optimum addition of SDA as partial replacement for cement is in the range 0-15%.
The compacting factor values of the concrete reduced as the percentage of SDA increased.
The Bulk Densities of concrete reduced as the percentage SDA replacement increased.
The Compressive Strengths of concrete reduced as the percentage SDA replacement increased.

V. RECOMMENDATIONS

The following are recommended from this study:

The use of local materials like SDA as pozzolans should be encouraged in concrete production.

Similar studies are recommended for concrete beams and slab sections to ascertain the flexural behaviour of lightweight concrete made with this material.

Durability studies of concrete cubes made with SDA as partial replacement for cement should be carried out.

REFERENCES

[1] Akeke, G.A., Ephraim, M.E., Akobo, I.Z.S. and Ukpata, J.O. (2013).Structural Properties of Rice Husk Ash in Concrete, International Journal of Engineering and Applied Sciences, Vol. 3, No. 3, pp. 57-62.

[2] Arikan, M. (2004).Feasibility Analysis of Manufacturing High Performance Ecological Cement in Turkey, Building and Environment, Vol 39, pp. 1125-1130.

[3] British Standard Institution (2002). Methods of test for water for making concrete, BS EN 1008, British Standard Institution, London.

[4] British Standard Institution (1983). Methods for Determination of Compacting Factor, BS 1881, Part 103, British Standard Institution, London.

[5] British Standard Institution (1983). Methods for Determination of Compressive Strength of concrete cubes, BS 1881, Part 116, British Standard Institution, London.

[6] British Standard Institution (1992). Specifications for aggregates from natural sources for concrete, BS 882, Part 2, British Standard Institution, London.

[7] British Standard Institution (2000). Specification for Portland cement, BS EN 197-1, British Standard Institution. London.

[8] **British Standard Institution (1997).** The Structural Use of Concrete, BS 8110, Part 1, British Standard Institution, London.

[9] Bui, D.D.; Hu, J. and Stroeven, P. (2005).Particle Size Effect on the Strength of Rice Husk Ash Blended Gap-Graded Portland Cement Concrete,Cement and Concrete Composites, Vol. 27, pp 357-366.

[10] Cheah, C.B. and Ramli,M. (2011). The implementation of wood waste ash as a partial cement replacement material in the production of structural grade concrete mortar: an overview Review Article, Resources, Conservation and Recycling. Vol. 55 Issue 1, pp 669-685.

[11] Coutinbo, J.S. (2003).The Combined Benefits of CPF and RHA in Improving the Durability of Concrete Structures,Cement and Concrete Composites, Vol. 25, pp. 51-59.

[12] Elinwa, A.U. and Ejeh, S.P. (2004).Effects of the incorporation of sawdust waste incineration fly ash in cement pastes and mortars. Journal of Asian architecture and Building Engineering, Vol. 3 No. 1, pp. 1-7.

[13] Elinwa, A.U. and Ejeh, S.P. and Mamuda, A.M. (2008).Assesing of the fresh concrete properties of self-compacting concrete containing sawdust ash, Construction and Building Materials, Vol. 22 Issue 6, pp. 1178-1182

[14] Elinwa, A.U. and Mahmmodb, Y.A. (2002).Ash from timber waste as cement replacement material, Cement and Concrete Composites, Vol. 24 Issue 2, pp. 219-222.

[15] Genezzini, C.; Zerbino, R.; Ronco, A.; Batic, O. and Giaccio, G. (2003).Hospital Waste Ashes in Portland Cement Mortars,Cement and Concrete Research, Vol. 33, pp 1643 – 1650

[16] Hossain, K.M.A. (2003).Blended Cement using Volcanic Ash and Pumice, Cement and Concrete Research, Vo. 33, pp. 1601-1605.

[17] Hossain, K.M.A (2005).Chloride Induced Corrosion of Reinforcement in Volcanic Ash and Pumice Based Blended ConcreteCement and Concrete Composites, Vo. 27, pp. 381-390.

[18] Rajput, J., Yadav, R.K. and Chandak, R. (2013).The Effect of Rice Husk Ash used as Supplementary Cementing Material on Strength of Mortar, Internal Journal of Engineering Research and Applications, Vol. 3, Issue 3, pp. 133-136.

[19] Lee, S.T.; Moon, H.Y and Swamy, R.N (2005).Sulfate Attack and Role of Silica Fume in Resisting Strength Loss, Cement and Concrete Composites, Vol. 27, pp. 65 – 76.

[20] Raheem, A.A., Oyebisi, S.O., Akintayo, S.O. and Oyeniran, M.I. (2010).Effects of admixtures on the properties of corn cob ash cement concrete, Leonardo Electronic Journal of Practices and Technologies, Vol. 16, pp. 13-20.

[21] Raheem, A.A. and Adesanya, D.A. (2011).A study of thermal conductivity of corn cob ash blended cement mortar, The Pacific journal of Science and Technology, Vol. 12 No. 2, pp. 106-111.

[22] Turanli, L., Uzal, B., and Bektas, F. (2004).Effect of Material Characteristics on the Properties of Blended Cements Containing High Volumes of Natural Pozzolans,Cement and Concrete Research, Vol. 34, pp. 2277-2282.

[23] Wang, S., Miller, A., Liamazos, E., Fonseca, F. And Baxter, L. (2008). Biomass fly ash in concrete: Mixture proportioning and mechanical properties, Fuel, Vol. 87, pp. 365-371.