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Evaluation of Lime Treated Mixed Sawdust as Fractional Replacement for Sand in the Production of Sandcrete Hollow Blocks

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Abstract- The study investigated sawdust as an inclusion in producing sandcrete blocks which are required for internal wall partitions of high rise building. Large volumes of sawdust which are generated by sawmill activities causes' environmental menace but may serve as an inclusion to sandcrete production. The blocks were produced with cement, sand and sawdust at constant mixing ratio of 1:8 respectively. The sand sawdust were varied in volume proportion of 100:0%, 98:2%, 96:4%, 94:6%, and 92:8% respectively while cement was kept constant throughout the mixture. The properties tested were density, water absorption, and compressive strength of the blocks carried out using the compression testing machine after 28 days of curing period. Water absorption test carried out showed that the sandcrete blocks produced from 100% sand and cement showed the least absorption of 8.6% while 92% sand replacement had the highest absorption of 11.27%. The density values obtained showed that 92% sand replacement has the least density at $1083kg/m^3$ and the highest value was observed at 0% sawdust replacement level at $1385kg/m^3$. The compressive strength for the replacement at 2.95 and $3.4N/mm^2$ which are within the standard values of $2.5N/mm^2$ and $3.45N/mm^2$ in the Nigeria Industrial Standard (NIS 87, 2000) while 96 to 4% sawdust showed 0.81 to $1.08N/mm^2$ which are far below the specified value. However, blocks produced with sawdust inclusion could be suitable for construction where light weight is of utmost importance as it can reduce the weight on the building foundation. Incorporating sawdust into sandcrete block production in certain proportion could help to produce light density and thermal insulating material required for comfort in building.

Keywords- *Blocks, Building Code, Cement, Compressive Strength, Sand, Sawdust*

I. INTRODUCTION

Sawdust or wood dust is a by- product of cutting, grinding, drilling, sanding, or otherwise pulverizing wood or any other material with a saw or other tool. Sawdust as an industrial waste in the wood industry constitutes a harmful impacts to both the human health and environment when not properly managed [1]. Sawdust from wood wastes is a buildup heap from different countries across the world. This causes some serious environmental challenges as well as health related hazards to man-kind. Sawdust is one of the major underutilized by products from sawmilling and Timber Shed operations. The creation of wood wastes in form of sawdust in sawmill industries and Timber Shed is an inevitable or cannot be totally eradicated, hence immense efforts are made in the utilization of such waste [2]. Finding suitable use of sawdust would help to reduce production costs and increase the profitability of sawmilling and Timber Shed operations in developing countries. Where there is forest industry clusters, the quantity of wood waste generated is very massive and constitute a nuisance to the environment. In most cases, the wood waste piles up to form big heaps which disturb activities within the mills. The heaps of the waste are burnt for days, disturbing visibility and causing pollution, thereby endangering health of residents, motorists and passersby. Wood waste that entered into water ways leached their extractives in the water, thereby, polluting the water; all these necessitated need for integrated and economic management of wood waste in Nigeria [3].

High demand has been placed on building material industry especially in the last decade because of increasing population that causes a serious deficiency of building materials such as river sand, cement among others. Civil Engineers are faced with the challenges of converting industrial wastes to resourceful building and construction materials as reported by [4,5]. Application of mixture of sawdust, sand and cement in making bricks, blocks or wall panels has been moderately widespread in parts of African countries. This technology dates back to the 1930's. Research have been carried out in this area and applied in parts of the USA, UK and Germany. In some instances, the materials (with various adaptations) have been used for flooring as well as walling. The possibilities for this innovation are perhaps continuous.

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 as reported by [5]. These include the use of by-products and waste materials such as sawdust in building construction. Wood waste in form of sawdust would not be totally eliminated in terms of wood utilization. Therefore, finding an appropriate use of sawdust would help to offset production costs and increase the profitability of sawmilling operations in Nigeria. The partially replacement for sand would highly reduce the unit weight and ensure a better and smoother surface of wall panel. This combination provides a unique kind of building material which exhibits concrete-like appearance. Recycling of sawdust wastes resource for building materials appears to be one of the practicable solutions to pollution problem and the challenge of economic design of buildings. The upsurge in the attractiveness of using environmentally friendly, low-cost and lightweight construction materials in building industry has resulted need to examine how the use of hard-wood sawdust from some forest trees species can be achieved by benefiting to the environment and maintaining the material requirements asserted in the standards [5].

The worldwide consumption of sand as fine aggregate in brick production is very high, and several developing countries including Nigeria have encountered some strain in the supply of natural sand in order to meet the increasing needs of infrastructural development in recent years [6]. Therefore, the use of sawdust as a partial replacement to sand will provide an economic use of the by-product and consequently produce cheaper bricks for low cost buildings; also, the use of mixed sawdust common in Makurdi metropolis have not been used in brick making elsewhere, therefore, this study if successfully completed would cleanse our environment of sawdust pollution. The objectives of this study therefore were to produce hollow blocks from mixed sawdust using partial replacement for sand and Portland cement as a binder. Percentage water absorption, bulk density and compressive strength of the hollow blocks were determined at various levels of replacement for sand to ascertain their quality.

II. MATERIALS AND METHODS

A. *Study Area*

The experiment was carried out at the Federal University of Agriculture Makurdi (FUAM). FUAM is located between Longitude 8° 33N and between Latitude 7° 44E in Benue State, which lies in the middle belt of Nigeria. The area is typified by two different seasons: dry and wet in the southern guinea savannah. The climate of the area is tropical sub-humid climate with high temperatures, high humidity, the average maximum and minimum daily temperature of 35 and 21 ^oC in wet season, 37 ^oC and 16 ^oC in dry season respectively. The mean annual rainfall value is 1200mm to 1500mm. The vegetation of the area has been described as Northern Guinea savannah [7].

B. *Materials*

The materials used in this research include the following: fine aggregates sharp sand free of clay, loam, dirt and any organic or chemical matter, obtained from a local supplier. Ordinary Portland cement (OPC) from Dangote Portland Cement Company, Benue State, with properties conforming to BS 12 [8]. Fresh, colourless, odourless and tasteless potable water freed from organic matter was used for mixing. Saw dust, sieve, weighing scale, vibrating block molding machine.

Figure 1. Heap of sawdust at Timber Shed along New Bridge road Wurukum, Makurdi

C. *Collection and Treatment of Saw dust*

The saw dust used for this study was collected manually from timber shed along Wurukum (new bridge), Makurdi. Samples were carefully collected to avoid mixing with sand by collecting the newly produced ones with shovel and packing into sand bags. To eliminate or reduce the retarding effect of the extractable substances in sawdust on setting and hardening of concrete [10]. The sawdust collected was pretreated by boiling 25kg by weight of hydrated lime with 30kg by weight of sawdust in a drum for a period of about one hour to dissolve and extract organic harmful soluble carbohydrates, tannins, waxes and resins in wood, that affect the hydration of cement [9,10]. The saw dust treated was collected was sieve using British Standard test sieve of 3.35mm zone.

III. III. METHODOLOGY

A. *Experimental Design*

Five levels of sand substitution with sawdust 0%, 2%, 4%, 6%, and 8% by weight were used. The mix ratio used was 1:8 (one part of binder to eight part of sand) at different replacement levels of sand and sawdust. Moulding vibrating machine of 6 inches" (450mm x 225mm x 150mm) design was used. Eighteen block samples were cast from each replacement levels. A Total of 88 number of 6" sandcrete blocks were produced. The replacement levels and water/binder ratios used are as shown in Table 1.

TABLE I. PERCENTAGE REPLACEMENT OF SAND WITH SAWDUST AND CEMENT/WATER RATIO

Replacement level	Cement to sand ratio	Add mix of sand and sawdust		Water to binder ratio
		Sand(kg)	*sawdust(kg)*	
100%sand 0%sawdust	1:8	160	0	0.64
98%sand 2%sawdust	1:8	158	2	0.84
96%sand 4%sawdust	1:8	156	4	1.00
94%sand 6%sawdust	1:8	154	6	1.16
92%sand 8%sawdust	1:8	152	8	1.52

B. Production of Sandcrete Hollow Blocks

A mix proportion of 1:8 cement-sand ratio; was used. The block has one-third of the volume void so as to produce the type of hollow sandcrete blocks commonly used for construction of buildings in Nigeria. Hand mixing was employed and the materials were turned over a number of times until a homogeneous mix with uniform colour and consistency was attained. Water was added in sufficient quantity to ensure workability of the mixture. The blocks were manufactured with the use of a vibrating block moulding machine with single 6 inches" (450mm x 225mm x 150mm) mould. The water was judged to be sufficient when a quantity of the mixture pressed between the palms caked without bringing out water according to [11]. The composite mixture was then introduce into the mould in the block moulding machine and the block was vibrated for one minute to ensure adequate compaction as practiced by [11]. The sandcrete hollow block on wooden pallet was removed from the block moulding machine and placed on the ground for curing. Water was sprinkled on the blocks, at least twice a day for proper curing for 28 days.

C. Testing of the Blocks

1) Water absorption:

Five sample per mix (0%, 2%, 4%, 6%, 8% replacement level) content were removed from the curing site and sun dried until there is no further loss in their dry weight. The samples were them immersed in water for 24hours and allowed to drain for 1 minute before taking the weight (wet weight). The difference in weight is used to calculate the percentage water absorbed. This is calculated using the formula.

$$\%\, Water\ absorption = \frac{ws - wd}{wd} \times \frac{100}{1} \quad (1)$$

Where,

wa=water absorption ratio

ws=weight of wet block

wd=wet of dry block

The ASTM C140 recommended maximum water absorption capacity of 240kg/m^3.

2) Bulk Density

Sandcrete hollow blocks produced from various levels of replacement were dried to constant mass in the curing site or environment. The weight of the sandcrete hollow blocks was determined at the FUAM Civil Engineering laboratory using a weighing balance. Dimensional volume will be determine by measuring the length, breath and height of the hollow blocks using measuring tape and density determined using

$$Density = \frac{weight\ of\ block}{dimensional\ volume\ of\ block} \quad (2)$$

BS 2028 recommends a maximum bulk density of 1500kg/m^3 for load bearing sandcrete blocks considered for this research.

3) Compressive strength

Five samples hollow blocks from each replacement were used to determine their compressive strength at Civil Engineering laboratory of University of Agriculture Makurdi. The compression machine was connected to the main and the pointer on the reading calibration scale was adjusted to the zero mark. The metal sheet placed on top of the block (to spread the load) wss weighed so as to add it to the compressive strength value read from the machine and the sum wss taken as the compressive strength value of each block sample. The block was weighed and recorded and then placed between the metal plates that completely cover the area of the block and fed into the compression zone and locked with the block centralized within the compression zone.

The start button wss depressed to initiate the electronic compression and as the compressive force was applied to the block. The pointer reading the compressive strength value in kilo-Newton (KN) gradually rises till it reached its peak and then begins to drop back. The maximum value just before the pointer begins to drop or the pointer reading when visible cracks is evident on the block is taken as the compressive strength of the block which is indicated by another pointer in the former case. The compression was then powered off by depressing the red button and the block released and the crushed blocks poured out for disposal. This was calculated using the next relationship

The hollow blocks were crushed using the compressive strength machine and the compressive strength was calculated using the equation

$$Compressive\ strength = \frac{load\ at\ failure(in \frac{N}{mm2})}{Net\ area} \quad (3)$$

IV. RESULTS

Mean percentage of water absorption results are shown in table 2. Mean percentage water absorption was least (8.66%) in 0% sawdust and highest (11.27%) in 6% sawdust replacement levels. Others were 9.92%, 10.89% and 10.82% for 2%, 4%

sawdust replacement for sand respectively. There is significant ($p>0.05$) among the means of % water absorption.

Results of density of hollow blocks produce are presented in table 3. The result reveals that 0% sawdust replacement level had the highest mean density of 1385.55kg/m^3, followed 2% (1329.51kg/m^3), 4% (1224.33kg/m^3), 6% (1187.28kg/m^3), and 8% (1083.03kg/m^3) respectively. There is no significant ($p<0.05$) between mean density of 0% and 2% sawdust replacement levels but differ significantly from means of 4%. 6% and 8% sawdust replacement levels.

Compressive strength of hollow blocks produced in this study are presented in table 4. Mean compressive strength was highest (3.04N/mm^2) in 0% and least (0.50N/mm^2) sawdust replacement levels. Mean compressive strength for 2%, 4%, and 6% were 2.83N/mm^2, 0.96N/mm^2, and 0.65N/mm^2 respectively. Mean compressive strength differ significant ($p>0.05$).

Figure 2 and 3 show hollow blocks produced from 100%:0% and 98%:2% sand and sawdust replacement levels respectively.

TABLE II. % OF WATER ABSORPTION OF HOLLOW BLOCKS PRODUCED FROM SAWDUST REPLACEMENT

Replacement level (%)	Block No	Dry weight (kg)	Wet weight (kg)	water absorbed (kg)	Water Absorption (%)	water absorption mean±SD
0	1	17.89	19.43	1.54	8.60	8.66±0.162^a
	2	17.82	19.37	1.55	8.69	
	3	17.52	19.00	1.57	8.45	
	4	17.52	19.08	1.56	8.90	
	5	17.52	19.04	1.52	8.67	
	Mean	17.65	19.18	1.55	8.66	
2	1	16.98	18.65	1.67	9.84	9.92±0.158^b
	2	16.94	18.67	1,73	10.2	
	3	16.93	18.60	1.67	9.84	
	4	16.90	18.57	1.67	9.86	
	5	16.94	18.61	1.67	9.85	
	Mean	16.94	18.62	1.68	9.92	
4	1	15.65	17.35	1.70	10.86	10.89±0.324^c
	2	15.55	17.25	1.70	10.93	
	3	15.57	17.27	1.70	10.91	
	4	15.57	17.27	1.70	10.91	
	5	15.56	17.35	1.70	10.86	
	Mean	15.58	17.30	1.7	10.89	
6	1	15.65	17.35	1.70	10.86	10.82±0.554^c
	2	15.23	16.93	1.70	11.16	
	3	14.90	16.62	1.72	11.5	
	4	14.86	16.41	1.55	10.48	
	5	14.97	16.48	1.51	10.09	
	Mean	15.12	16.76	1.64	10.82	
8	1	13.86	15.49	1.63	11.76	11.27±0.112^e
	2	13.82	15.41	1.59	11.50	
	3	13.82	15.41	1.59	11.51	
	4	13.86	15.46	1.6	11.54	
	5	13.63	15.22	1.59	11.66	
	Mean	13.80	15.40	1.6	11.59	

Figure 2. Blocks produced from 100% sand and 0% sawdust replacement

Figure 3. Blocks produced from 98% sand and 2% sawdust

TABLE III. RESULTS OF THE DENSITY OF SANDCRETE HOLLOW BLOCK

Replacement level (%)	Block Number	Dry weight(kg)	Volume(m^3)	Bulk density(kg/m^3)	Mean density(kg/m^3)
0	1	17.89	0.01274	1404.24	1385.55±14.68[a]
	2	17.82	0.01274	1398.74	
	3	17.52	0.01274	1375.19	
	4	17.51	0.01274	1332.81	
	5	17.52	0.01274	1329.67	
	Mean	17.65	0.01274	1368.13	
2	1	16.98	0.01274	1332.81	1329.41±1.01[a]
	2	16.94	0.01274	1329.67	
	3	16.93	0.01274	1328.89	
	4	16.90	0.01274	1326.53	
	5	16.94	0.01274	1329.67	
	Mean	16.94	0.01274	1329.51	
4	1	15.65	0.01274	1228.41	1224.33±3.76[b]
	2	15.55	0.01274	1220.57	
	3	15.57	0.01274	1222.14	
	4	15.57	0.01274	1222.14	
	5	15.65	0.01274	1228.41	
	Mean	15.60	0.01274	1223.93	
6	1	15.65	0.01274	1228.41	1187.28±25.92[c]
	2	15.25	0.01274	1197.02	
	3	14.90	0.01274	1169.54	
	4	14.86	0.01274	1166.41	
	5	14.97	0.01274	1175.04	
	Mean	15.13	0.01274	1187.28	
8	1	13.86	0.01274	1087.91	1083.03±3.38[d]
	2	13.82	0.01274	1084.77	
	3	13.82	0.01274	1084.77	
	4	13.86	0.01274	1087.91	
	5	13.63	0.01274	1069.8	
	Mean	13.80	0.01274	1083.03	

TABLE IV. RESULTS OF COMPRESSIVE STRENGTH OF SANDCRETE HOLLOW BLOCKS

Replacement level (%)	Block No	Net area(mm^2)	Crushing load (KN)	Compressive strength (N/mm^2)	compressive strength (N/mm^2) mean±SD
0	1	36900	116	3.14	3.04±0.04[a]
	2	36900	115	3.11	
	3	36900	112	3.04	
	4	36900	110	2.98	
	5	36900	109	2.95	
	Mean	36900	112.4	3.03	
2	1	36900	107	2.89	2.83±0.03[b]
	2	36900	105	2.85	
	3	36900	105	2.85	
	4	36900	104	2.82	
	5	36900	101	2.74	
4	Mean	36900	104.4	2.83	0.96±0.46[c]
	1	36900	40	1.08	
	2	36900	38	1.03	
	3	36900	35	0.95	
	4	36900	35	0.95	
	5	36900	30	0.81	
6	Mean	36900	35.6	0.96	0.65±0.02[d]
	1	36900	25	0.68	
	2	36900	22	0.59	
	3	36900	24	0.65	
	4	36900	24	0.65	
	5	36900	25	0.68	
8	1	36900	18	0.49	0.50±0.01[e]
	2	36900	19	0.51	
	3	36900	19	0.51	
	4	36900	20	0.54	
	5	36900	17	0.46	
	Mean	36900	18.6	0.50	

V. DISCUSSION

A. *Water absorption*

Water absorption was observed to increase as the sand replacement with sawdust increases. Sandcrete hollow blocks produced from 92% sand 8% sawdust replacement showed highest affinity. The sandcrete hollow blocks produce from 0%, 2%, 4%, 6%, and 8% sawdust replacement levels had water absorption values higher than the maximum water absorption value of 7% specified for blocks by [12].The water absorption values obtained from this study are less than 16.95% as obtained by [13,14] and the acceptable value of 12% according to BS 5628: part 1. The reason for the increase in absorption rate may be due to porosity of sandcrete and the hygroscopic nature of sawdust mixture from different wood species.[15] asserted that when sandcrete units are exposed to persistent flood, a highly porous block could absorb much water and consequently become weakened and eventually fail. The hollow blocks produced from 0%, 2%, 4%, 6% and 8% sawdust replacement levels were not porous, this could be due to the lower percentage weight of sawdust inclusion in the production of sandcrete hollow blocks.

B. *Density*

Density of hollow blocks as obtained in this study decreased with increase in sawdust inclusion similar to the result of [16] reported from a study on investigation of properties of concrete using sawdust as partial replacement for sand. However, the values are lower than those observed by [11] for commercially produced sandcrete which ranged from 2073.5 to 2166.3kg/m^3. Hollow block densities obtained in this study for all levels of sawdust replacement for sand are also below the minimum densities specified for light weight concrete i.e. 1480 to 1840 kg/m^3 as reported by [16] and minimum value of 1500kg/m^3 recommended for first grade sandcrete blocks by [17]. Density of a material is a major determinant of strength and material usage in construction. Both high and low density materials have their special applications while high density blocks could be used for external and load bearing members, low density blocks could be used for interior and non-load bearing.

C. *Compressive strength.*

In the hardened state, sandcrete block had a high compressive strength and this strength increase with density. Mean compressive strength of 0% sawdust replacement level (3.04N/mm^2) can be compared with 3.45N/mm^2 which was the minimum strength specified in NIS [17] for a load bearing sandcrete block. This value is above the minimum compressive strength at 28days of 2.75N/mm^2 recommended for load bearing blocks by the [18]. Interestingly, the compressive strength of 2% sawdust replace level of this study (2.74 to 2.89N/mm^2) meets the minimum compressive strength at 28days of 2.75N/mm^2 recommended for load bearing blocks by the Ghana building Code and the minimum required standard of 2.0N/mm^2 specified by the Nigeria National Building Code [19] for non-load bearing walls. Compressive strength results of 4%, 6% and 8% sawdust replacement which ranged between 0.96 N/mm^2 - 0.50 N/mm^2 are similar to the ones obtained by [20] for commercial sandcrete blocks in Minna, Nigeria, which were found to vary between 0.11 to 0.75N/mm^2. These values did not meet the required minimum standard of 2.0N/mm^2 as specified by the Nigerian National Building Code [19] for non-load bearing walls.

Compressive strength is said to be influenced by the level of quality control employed in selection of materials and adequate curing is a factor to put in place when producing sandcrete block [21] while [20] also stated that the quality of sandcrete blocks is consistent due to different production methods employed and the properties of constituent materials.

VI. CONCLUSION

Increase in the replacement level of sawdust, increased the rate of water absorption or water ratio used. It was observed that the percentage water absorption increases as the percentage replacement of sawdust for sand increases. It was also observed that the density of sandcrete hollow blocks decreased as the percentage replacement levels of sand with sawdust increased. The compressive strength of sandcrete blocks also decreased as the percentage replacement levels of sawdust increased. The best sawdust replacement level in this study was 2%. Therefore, 2% sawdust replacement level as obtained in this study is recommended for non-load bearing walls.

VII. RECOMMENDATIONS

From the result of this study, we recommend that:

1. Block industries in Makurdi, Benue State should adopt 2`% sawdust level for sand for hollow block production for no-load bearing walls.
2. Researcher should carry out further studies on varied sawdust replacement levels for sand from sawdust of different wood species.
3. Since sawdust has high percentage water absorption, sandcrete blocks made from sawdust inclusion should not be used in water flooded and water logged areas for building purposes.

REFERENCES

[1] Elinwa A.U and Abdulkadir S., (2011): Characterizing saw dust Ash for Use as an inhibitor for Reinforcement Corrosion; New Clues in Sciences,1 1-10.

[2] Zziwal A.; Kizito S.;Banana, A.Y.; Kaboggoza, J.R.S.; Kambugu, R.K. and Sseremba, O.E (2006): Production of composites bricks from sawdust using Portland cement as a binder; Uganda Journal of Agricultural Science. 12(1); 38-44.

[3] Ogunwusi, A.A. (2014): Wood waste generation in the Forest Industry in Nigeria and Prospects for its Industrial Utilization; Civil and Environmental Research. 6(9); 62-70.

[4] Turgut, P. (2007). Cement Composites with Limestone Dust and Different Grades of wood sawdust; Building and the Enviroment. 42, 3801-3807.

[5] Olugbenga, J.O; Seun, D.O. and Sunmbo,P.A. (2014): Investigation of properties of Concrete Using Sawdust as partial Replacement for Sand; Civil and Enviromental Research. 6(2); 35-42.

[6] Divatar .Y., Manjunath S., Aswath, M.U.,(2012). Experimental Investigation on behavior of Concrete with the Use of Granite fines; International journal of Advance Engineering Research.1(14).

[7] Gyang, E.O. (1997). Students information handbook (1996-1998). University of Agriculture, Makurdi. 1-3.

[8] British standard institutes (BSI) 1996. Specifications for aggregates from natural sources for concrete; BS 882. London.

[9] Vaickelionis G. and Vaickelioniene R.(2006).Cement hydration in the presence of wood extractives and pozzolan mineral additives; ceramics-silikay. 50(2);155-122.

[10] Haitham, H.S. (2013): Pretreatment of sawdust for producing concrete; *Engineering and Technology journal,* Vol.31 (3);

[11] Raheem, A.A. (2006).Comparison of the Quality of Sandcrete Blocks Produced by LAUTECH Block Industry with others within Ogbomoso Township", Science Focus. 103-108.

[12] British standard Institutes (BSI) (1975). Precast concrete blocks: BS 2028. London.

[13] Anosike, M.N, (2011). Parameters for Good Site Concrete Production Management Practice in Nigeria. Unpublished PhD Thesis, Covenant University, Ota, Nigeria.

[14] Ekhuemelo, D.O, Aemu O. and Tembe, E.T, (2016) Physical and strength properties of bricks produced from Portland cement and saw dust of *Danielia oliverii* wood. PRO LIGNO **(***Scientific Journal in the field of wood engineering)*12(4). Pp 53 - 60.

[15] Oyekan G.L. and Kamiyo O.M. (2011): A study on Engineering properties of sandcrete Blocks Produced with Rice Husk Ash Blended Cement. Journal of Engineering Technology Research. 3(3), 88-98.

[16] Oyedepo, O. J., Oluwajana S. D., and Akande, S. P. (2014). Investigation of properties of concrete using sawdust as partial replacement for sand. Civil and Environmental Research. 6(.2).

[17] Nigerian Industrial Standards. NIS 087:2000. Specification for Sandcrete Blocks. Standards Organisation of Nigeria.

[18] Ghana Building Code (1989). Ministry of Works and Housing: Kumasi, Ghana. 541-549.

[19] National Building Code (2006) The National Building Code of Federal Republic of Nigeria. NBC, 1st Edn., Lexis, Nexis, Butterwoths. South Africa.

[20] Abdullahi, M. (2005).Compressive Strength of Sandcrete Blocks in Bosso and Shiroro Areas of Minna, Nigeria, *AUJT.* 9(2), pp 126-131.

[21] Afolayan, J.O., Arum, C., and Damaola, C.M. (2008) characterization of the Compressive Strength of Sandcrete Blocks in Ondo State, Nigeria Journal of CER and P. 5(1) 15-28.