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Investigation Into the Durability of Laterite Based Interlocking Blocks Blended with Corn Cob Ash in Acid Prone Environment

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Abstract- One of the major aims of a building is that it should satisfy the purpose for which it is built. This can be achieved by the choice of materials that can stand the test of time. The durability of Laterite Interlocking Block (LIB) produced by incorporating Corn Cob Ash CCA was considered in this study. Grain size analysis and Atterberg Limits tests was carried out on the laterite sample. Corn Cob was burnt into ashes to obtain Corn Cob Ash (CCA). CCA was used to replace OPC in five varied percentages of 20, 40, 60, 80 and 100. laterite soil sample with 100% Ordinary Portland Cement (OPC) was used as control sample. LIB of size 225 x115 x 225 mm were produced using laterite, cured and tested for compressive strength before and after immersion in magnesium sulphate - water solution, Density and water absorption were also determined. The % passing sieve No 200 is 20.36%. The coefficient of uniformity (Cu) and coefficient of curvature (Cc) were 5.44 and 0.77. Natural and optimum moisture contents are 12.34 and 9.98% respectively, while maximum dry density is 2.05kg/dm3. 9.40 and 8.57%. Liquid Limit (LL) and Plastic Limit (PL) were 36.00% and 18.88% respectively. Plasticity Index (PI) was 17.12. The soil sample is classified as A – 2 – 6 (0) (AASHTO). The specific gravity is 2.50. CCA was classified as Class - C pozzolan. The 56th day compressive strength at the control and at 20, 40, 60, 80 and 100% CCA replacements before immersion in MgSO4 solution was 7.16, 6.30, 6.35, 5.78, 5.13 and 4.73Nmm-2, respectively; compressive strength after immersion was 3.63, 3.05, 2.86, 2.56, 1.51Nmm-2 respectively and LIB dissolved at 10% CCA replacement. The densities of LIB for control and 2, 4, 6, 8, 10% CCA replacement were 2061.80, 2001.70, 2062.90, 2069.77, 2080.08 and 2093.82Kgm-3, respectively; while water absorptions were 6.58, 5.90, 7.96, 7.20, 7.41,.and 9.69%, respectively. CCA inclusion in LIB production at up to 80% replacement of cement can be used in a non-acidic prone environment. The use of LIB with CCA is not advisable in acid prone environment.

Index Terms- Interlocking blocks, Absorption, Charcoal pot, Pozzolan, Durability

I. INTRODUCTION

The ability of concrete to withstand the condition of the environment for which it is exposed is known as durability. Insufficient durability reveals itself by decaying that can be as a result of external factors or internal forces within the concrete (Adesanya and Raheem, 2010). Chemical attack of concrete occurs by the decomposition of the product of hydration and formation of new compounds, which, if soluble, may be leached out, and if not, may be disruptive in situ (Bapat, 2012). Lateritic soils are known as highly weathered natural material with a high concentration of hydrated oxides of iron or aluminium due to the residual accumulation or absolute enrichment caused by the solution, movement, and chemical precipitation of aluminium, iron, and manganite (Oluyemi – Ayibiowu, 2019) Laterite, being a common material has been used as building construction material because of its availability (Oyebisi *et. al*., 2018). With laterite interlocking block, the use of mortar in block laying for walling and even plastering, is reduced thereby cutting cost of building construction (Ayanlola *et al*., 2024). Corn cob produced yearly after corn is harvested are being disposed improperly as waste product, thereby constituting nuisance to the environment. Corn Cob Ash (CCA) has been used severally as replacement for cement in concrete (Oyebisi, *et. al*., 2018) The use of CCA in laterite has not been fully exploited. Few literatures are available on the use of laterite and CCA, and these are basically in terms of

Compressive Strength and Water Absorption determination. This study considered laterite interlocking block incorporating CCA with a view to evaluate the effect of adverse environmental conditions on its performance. The use of LIB incorporating CCA will afford low income earners to have access to affordable housing because of the reduction in the cost of walling materials. With LIB, plastering materials will no longer be required. Also, provision of clean and free environment is achievable as a result of finding use for corn cob which constitutes environmental pollution. The possibility of combating harsh environmental conditions through the use of LIB incorporating CCA is also made known

Materials and Methods

The materials for this study include Corn Cob, Laterite soil, Ordinary Portland Cement (OPC), Water and Magnesium Sulphate. Corn cob was obtained at Maya Village (Ibarapa East Local Government) Laterite sample was locally obtained from a borrow pit at Olomi area, Ordinary Portland Cement and Magnesium sulphate were purchased in a local store at Sabo area, while water was obtained at the concrete laboratory of Civil Engineering Department, Ladoke Akintola University of Technology, Ogbomoso, Southwestern Nigeria. Soil identification and description were carried out by visual observation and physical feeling.

Tests on Materials

The geotechnical and physical tests carried out on the laterite soil include: Grain Size Analysis, Atterberg Limits (Liquid and Plastic limits), Specific Gravity, Optimum Moisture Content and (AASHTO, 2015) Classification. All tests were carried out in accordance with (BS 1377, 1990) of the Method of Testing Soils for Civil Engineering purposes

II. GRAIN SIZE ANALYSIS

The laterite sample taken was air dried, a known grammes (200g) was placed on a set of sieves and the system was shaken in a sieve shaker for 10 minutes. The sieves were carefully removed and weighed with the retained soil. The percentage by mass retained on each sieve was calculated and tabulated. The test provides a gradation of the soil particles used in soil identification and classification.

Weight of material passing = weight of dry sample – weight retained on the sieve

$$\% \text{ weight retained} = \frac{weight\ retained}{total\ dry\ weight\ of\ sample} \times 100\%$$

% weight passing = 100% - percentage retained

$$\text{cumulative } \% \text{ retained} = \frac{cumulative\ weight}{total\ dry\ sample} \times 100\%$$

Liquid limit

A sample weighing 20g was taken from the material passing through 425mm BS test sieve. The sample was mixed with drinkable water to a consistency of a thick paste and allowed to stand in an airtight container for 24 hours to allow the water to permeate throughout the soil mass. A portion of the mixed soil was placed in the cup of Casangrandes apparatus and level, after which the grooving tools was used to divide the sample along the diameter through the center of the hinge. The crank was turned at the rate of two revolutions per second, the cup was then lifted and dropped until the two part of the soil came into contact at the bottom of the groove along a distance of 13mm. the number of blows with which this occurred was recorded. A little extra of the soil mixture was added to the cup and mixed with the soil in the cup. The operation was repeated until two consecutive runs give the same number of blows for closure. A quantity of soil from the sample that flowed together was removed with spatula and placed in container and the moisture content was determined.

Plastic limit test

A sample weighing 20g was taken from the material passing through 425mm BS test sieve. The sample was mixed with water to make a malleable but not sticky ball. This was rolled between the palms of the hand until it began to dry and crack. Half of the sample was rolled further to a length of 5cm and thickness of 6mm. the thread formed during this process was then rolled between the tip of the finger of one hand and the surface of a clean glass plate.

The thread was rolled to about 3mm in five to ten complete (forward and backward) movement of the hand. The procedure was repeated until the thread sheared both longitudinally and transversely when it had been rolled to about 3mm diameter. The portion of crumbled soil thread was gathered together and transferred immediately to the container for moisture determination.

Plastic Index

After the determination of Liquid Limit (LL) and Plastic Limit (PL), the Plastic Index (PI) was calculated from equation

$$PI = LL - PL$$

Optimum Moisture Content

Two 2.5kg of air dried soil samples passing the 4.75 mm BS sieve were taken, the samples were each mixed thoroughly with different amount of water to give a suitable range of moisture content. A mould with base plate attached, was weighed to the nearest mg. The mould was then placed on a solid base, e.g. concrete floor, and the soil were compacted into the mould with extension attached, in five layers of approximately equal mass, each layers being given 25 blows from the rammer dropped from a height of 450mm above the soil. The blows were distributed evenly over the surface of each layer. The range of moisture content was such that the Optimum Moisture Content, at which the Maximum Dry Density occurs, is within that range. The procedure was repeated for the same sample, but with gradual increase in water content. The Bulk Density ρ in mg/m^3 of each compacted specimen was calculated from the equation below:

$$\rho = \frac{m2 - m1}{1000}$$

where:

m_1 is the mass of mould and base(g)

m_2 is the mass of mould, base and soil (g)

The Dry density, ρ_d in M_g/m^3 shall be calculated from the equation

$$\rho_d = \frac{100\rho}{100 + w}$$

where:

w is the moisture content of the soil (%)

ρ_d is the dry density in $Mg/m3$

Preparation of Corn Cob Ash (CCA)

The *corncob* was obtained locally from Maya market in Lanlate, Oyo State, Nigeria. It was burnt into ashes by an open fire in a charcoal pot, the red hot burnt corncob ash was allowed to cool down for twelve hours to obtain corncob ash.

Production of Laterite Interlocking Blocks

The method of weight batching was adopted throughout, the mould was 225 × 115 ×225 mm in dimension and twelve different types of mixtures were prepared for the experimentation. The water proportion in the mix was taken as constant and the replacement ratios between Ordinary Portland Cement (OPC) and Corncob Ash (CCA) and Laterites samples were taken by the percentage volume in the mix design. All blocks specimens were made with 1.5: 0.55 volume ratios for cementitious materials to water. The OPC was used at the constant weight of 10% as control while CCA was added in five varied percentages 2, 4, 6, 8 and10% A total of 90 laterite interlocking blocks were moulded and cured for 56 days.

Plate 2: Produced LIB

Curing of LIB

The LIB produced were allowed to dry naturally in the laboratory floor for 24 hours. Curing was carried out by sprinkling water on them twice daily (wetting). The blocks were later arranged in rows and columns before testing

Plate 3: Curing of LIB

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Compressive Strength

The compressive strength was measured with the aid of a compressive machine of 1,500kN, Model – Cal. 034A2, a product of NTROLS. The average compressive strength of three samples were obtained at 7, 14, 21, 28 and 56 days curing respectively.

Chemical Attack

Magnesium Sulphate was used for the test. The acid water was prepared by measuring 100ml of Magnesium Sulphate to 500ml of distilled water. More water was added until the desired concentration is achieved (0.1Mole). The acid solution was allowed to cool down for 1 hour. The LIB, after 56 days curing were weighed, then soaked into the acid solution in a plastic container and the container was closed for 24 hours. The specimens were removed from the acid solution, wiped dried crushed, all crushing was done on the edge face with a 3mm thick flat plate placed at the top and bottom of sample for even distribution of load (Olugbenga, 2014).

Plate 4c: Immersion of LIB in $MgSO_4$ Water Solution

Density

The samples were weighed after which the mass was determined and the density was calculated using the equation:

$$D = \frac{mass, m(kg)}{volume, v(m3)}$$

Water Absorption

Water absorption of the blocks was measured in accordance with [11] at 23±5^{0}C for 24 hours and the average result on three specimens was obtained and presented in tabular form.

$$\% \ water \ absorbed = \frac{wetn \ mass - Dry \ mass}{Dry \ mass} x \ 100$$

III. RESULTS AND DISCUSSIONS

SOIL DESCRIPTION

The soil sample was identified visually and by physical feeling as reddish brown gravely clay granular soil. The reddish brown colour indicated the presence of iron in large quantity which is one of the properties that make laterite to be useful structurally in engineering (Adesope and Ayanlola, 2024).

3.1 Grain Size Analysis

The sieve analysis result of the soil sample is presented in Figure 1. The percentage of soil sample that passed through sieve number 200 was 20.36% which is lesser than 35%. The coefficient of uniformity (Cu) and coefficient of curvature (Cc) are 5.44 and 0.77 respectively. This showed that the laterite is well graded (Raheem and Sulaimon, 2013) therefore it can be used for making good concrete. According to American Association of State Highway Transportation Officials (AASHTO, 2015) classification system, the soil sample is silty or clayey gravel and sand (A – 6). The sample is suitable for sub – grade, but may require stabilization before it could be used for sub – base and base courses.

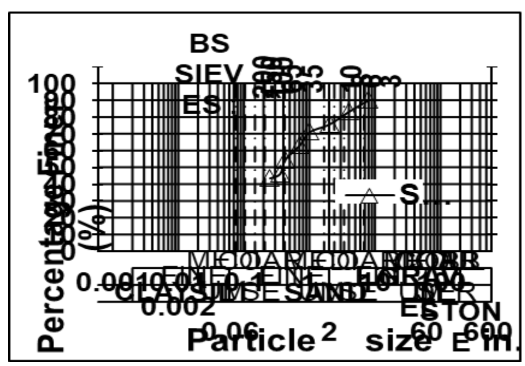

Figure 1: Grain Size Analysis result

Atterberg's Limits of Laterite Soil

The result of Liquid Limit (LL) and Plastic Limit (PL) were presented in Figure 2. it was shown that the values of LL were 36.00% and 18.88%. Also, Plasticity Index (PI) is 17.12 (36.00 - 18.88%,). This PI value met the requirement specifies material for subgrade course which is below 30% (Olaniyan *et al*., 2020).

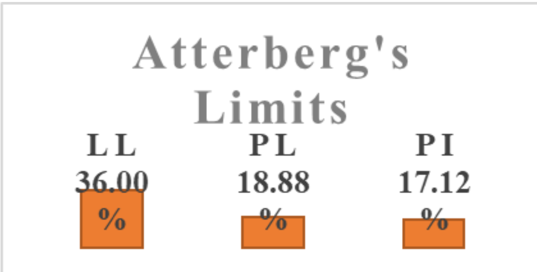

Figure 2: Atterberg's Limits of Laterite Soil

Table 1: Engineering Properties of Natural Soil Sample

Optimum Moisture Content OMC (%)	Maximum Dry Density MDD (%)	Specific Gravity	%Passing Sieve No. 200 (%)	AASHTO Classification
9.98	2.05	2.50	20.36	A – 2 – 6 (0)

Pozzolanicity of CCA

The result of CCA pozzolanicity is presented in Table 1. It is observed that the CCA is suitable as it satisfied the ASTMC classification, which specifies that $SiO_2 + AlO_3 + FeO_2 \geq 70$ as class F. Since the corncob ash sample used has the addition of the three materials to be 56.32%. it is therefore classified as class - C pozzolan

Table 2: Pozzolanicity (Chemical Analysis) of CCA used

Material	Properties %	ASTMC 618 – 91 Specification
CaO	14.97	
SiO_2	43.14	$SiO_2 + AlO_3 + FeO_2 < 70$
Al_2O_3	10.35	
Fe_2O	2.83	
TiO_2	1.05	
MgO	0.39	≤ 4%
K_2O		

$SiO_2 + Al_2O_3 + Fe_2O = 56.32\%$

Compressive Strength of LIB

The compressive strength of specimens tested at 7, 14, 21, 28 and 56 days is presented in Figure 3. it is observed that the compressive strength generally increased with curing age and decreases with increasing corn cob ash (Subramani *et al.,* 2021). The results also indicate that the compressive strength of LIB with 4% CCA replacement is the highest at all levels. Similarly, both 4% and 8% corn cob ash concrete have higher strength than the control at 7 days. This results are in agreement with Raheem and Adenuga (2013).

At 28 days, the compressive strength ranges from $6.89N/mm^2$ – $4.55N/mm^2$ for 10% corn cob ash replacement. The 4% and 8% corn cob ash replacement has value $5.59N/mm^2$ and $4.95N/mm^2$. These values are supposed to be greater than that of the control as reported by Raheem and Adenuga (2013). But they are not, probably because of the CCA used was Class – C pozzolan i.e. $SiO_2 + AlO_3 + FeO_2 = 56.32\%$ as specify by AASHTO and not Class – F i.e. $SiO_2 + AlO_3 + FeO_2 \geq 70$. The value of 4% CCA is closer, and it showed the commencement of pozzolanic action as evident from the higher percentage of strength increase by the corn cob ash which can be as a result of the action of CCA with calcium hydroxide liberated during the hydration of cement. This is in agreement with Raheem and Adenuga (2013).

At 56 days, the value obtained at the 2% CCA replacement was $6.30N/mm^2$. This is higher than $5.08N/mm^2$, the value at 7 days curing (24.02% increase). There was continuous and significant improvement in strength development of all LIB produced with curing age. This confirms the continuous pozzolanic reaction in CCA. As the CCA increase, more silica is available to react with the lime produced during hydration of cement, thereby producing more cementing materials that contributes to higher compressive strength. It is clear from Figure 3 that CCA specimen cured for a longer 56 days gained higher compressive strength than those cured from 7 – 28 days (Hannesson, *et. al*., 2012). this is attributed to delay in gaining strength by CCA when mixed with cement and water because of its small composition of CaO (calcium oxide) that is essential in early development of strength. At the early stage, corncob ash only acts as a filler (contributes no strength), so it has to wait for the products of hydration of cement i.e. calcium hydroxide [Ca(OH)], that will react with silicon oxide (SiO_2) of CCA later to form a compound called Calcium Silicate Hydroxide (C – S – H) (Arayeola, 2012).

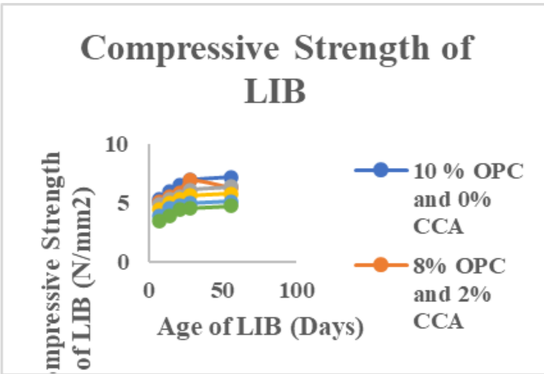

Figure 3: Compressive Strength of LIB result

Chemical Attack on LIB

From Figure 4, when samples were immersed in acid water solution of Magnesium sulphate of $0.1M$ for 24 hours, there was a significant reduction in the compressive strength of the LIB at all CCA reduction (about half of the compressive strength at the control). The reductions were 49.30%, 48.41%, 54.96%, 55.54%. and 70.57% for 10% OPC, 8% OPC + 2% CCA, 6% OPC + 4% CCA, 4% OPC + 6% CCA, 2% OPC + 8% CCA respectively. At 0% OPC + 10% CCA, the LIB dissolved. It can be observed that CCA replacement performance in $MgSO4$ solution was below that of control at all stages. This is in line with (Kamau *et. al*., 2019) that reported significant deterioration in strength of CCA specimen when subjected to attack by Na_2SO_4 and $MgSO_4$. The rate of strength deterioration was lower than that of the control specimens in $NaSO_4$ solution but was higher in $MgSO_4$ solution (Ayanlola *et al*., 2025). also reported a good performance of CCA replaced specimens in hydrochloric acid (HCl) for replacement up to 20% after which there was a significant reduction in the compressive strength (Kamau *et. al*., 2014).

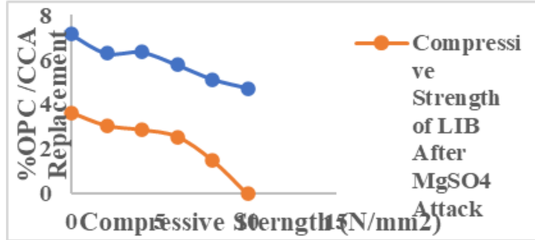

Figure 4: Compressive Strength of LIB Before and After Chemical Attack at 56 days Curing

Density of LIB

From Figure 5, The density of LIB produced ranges from 2200.31kgm^{-3}-2001.07kgm^{-3}.

The figure indicates decrease in density with increase in CCA replacement. For all specimen tested after 56 days curing, the minimum density obtained was 2001.07kgm^{-3}, this is above the minimum value of 1500kgm^{-3} for first grade sandcrete blocks by NIS (2004). All LIB produced, satisfied the minimum bulk density of 1810Kgm^{-3} recommended by the (NBRRI,2006).

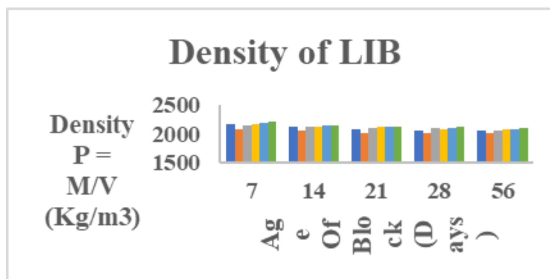

Figure 5: Density of LIB

Water Absorption of LIB

The results of water absorption are presented in Figure 6. water absorbed at 28 days for all specimens produced at the control $are\ 6.58, 5.90, 7.96, 7.20, 7.41\ and\ 9.69kg$. respectively. It can be observed that water absorption increase as the as the percentage replacement of CCA for OPC increases. The result supports the observations of Kamau *et. al*., (2017) that at higher CCA substitution, calcium hydroxide was insufficient in quantity to react with the excess CCA thereby creating voids in the mixture that led to the increasing water absorption

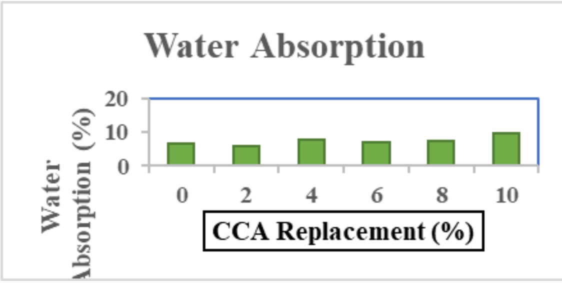

Figure 6: Water Absorption of LI

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Based on the findings from this study, it is concluded that:

1. Corn Cob Ash (CCA) used belongs to Class C type of pozzolan
2. Compressive strength of Laterite Interlocking Blocks increases with curing age but decreases with increase in Corn Cob Ash (CCA) addition.
3. There is a significant reduction in the compressive strength of Laterite Interlocking Block (LIB) at all CCA replacement when immersed in $MgSO_4$ solution.
4. Density of the Laterite Interlocking Blocks (LIB) produced decreases as the Corn Cob Ash increases but increases with curing age.
5. Water Absorption decreases with the addition of Corn Cob Ash (CCA)
6. Corn Cob Ash replacement is adequate up to 80% for Laterite Interlocking Block for normal environment.
7. LIB is not advisable in acid prone environment.

Recommendations

It is hereby recommended that:

1. CCA inclusion in LIB production can be used at 80% replacement
2. LIB at all CCA replacement is not advisable at acid prone environment
3. This research work can further be worked upon either by the used of laterite soil from another area or other pozzolans. i.e. wood ash, rice husk ash. etc.

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REFERENCES

[1] Adesanya, D.A., and Raheem, A.A., (2010). "A study of the permeability and acid attack of corncob ash blended cement. *Construction and Building Materials*. 24: 403 – 409.

[2] Adedeji, Y. M. D. (2007). Materials Preference Options for Sustainable Low – Income Housing in Selected Cities in Nigeria. *Published Doctoral Dissertion*, Federal University of Technology, Akure, Nigeria.

[3] Adesanya, D.A., and Raheem, A. A., (2008): "Development of corn cob ash blendend cement," *Construction and Building Materials*. 23, 347-352.

[4] Adesope, A J., and Ayanlola, J. A. (2024). Investigation into the Performance Characteristics of Laterized Concrete Using Cement Blended with Glass Powder. *Journal of Environmental Science, Computer Science and Engineering and Technology.* 13 3 201 - 209

[5] American Association of State Highway and Transportation Officials AASHTO (2018) AT – TC3CNO25 – 18 – T1 – JA02. Earthwork Series – Fill Placement

[6] Arayela, O. (2005). "Laterite Bricks: before now and hereafter." *Inaugural Lecture Series*, Federal University of Technology, Akure, 40. 5 – 15.

[7] American Society for Testing and Materials. "ASTM C618. Standard specification for coal fly ash or calcine natural pozzolan for use in concrete research. *American Society for Testing and Materials,* ASTM International, West Conshohocken, PA, 2012.doi: 10.1520/C0618 – 12," ed 2006.

[8] Ayanlola, J. A., Otunla, A. I., Salaam, D. A., Adesope, A J., Ogunremi, M. (2024). Impact of Compaction Time Lag on Strength Characteristics of Cement Stabilized Lateritic

Soils. OYSCATECH *Journal of Engineering and Environmental Studies*. 2 1 27 – 31

[9] Ayanlola, J. A., Adesope, A. J., Balogun, L. A., and Ogunjimi, M. O. (2025). Production and Evaluation of the Durability of Laterite Interlocking Paver Block Incorporating Glass Powder. *African Journal of Advances in Science and Technology Research*. 19 1 181 - 192

[10] Bapat, J.D. (2012): Mineral admixtures in cement and concrete. CRC Press, Boca Raton, Florida, United States.

[11] British Standard 1377 (1990). “Methods of testing soils for civil engineering purposes”. British Standard Institution, 2 Park Street, London.

[12] British Standard 1881 (1983). “Methods for determination of water absorption”. British Standard Institution, 2 Park Street, London.

[13] Hannesson, G., Kuder, K., Shogren, R., and Lehman, D., (2012). “The influence of high volume of fly ash and slag on the compressive strength of self – consolidating concrete.” *Construction and Building Materials*. 30. 161 – 168.

[14] Kamau, J., Ahmed, A., Hirst, P., and Kangawa, J., (2017) “Suitability of maize cob ash as a Portland cement Replacement. Juniper Online. *Journal Material Science*. 2(5): 001 - 003

[15] Kamau, J., Ahmed, A., Hirst, P., and Kangawa, J., (2014) “Permeability of corn cob ash, anthill soil and rice husk ash replaced concrete. *International Journal of Science, Environment, and Technology*. 6: 1299– 1308

[16] Olugbenga, A.T.A (2014). “Durability of Laterite/Sand Hollow Blocks in Magnesium Sulphate Environment”. *American Journal of Engineering Research*, e – ISSN: 2320-0847:2320-0936, 3, Issue-08, 263 – 266

[17] Oluyemi – Ayibiowu (2019). Stabilzation of Laterite Soils with Asphalt – Emulsion. *Nigerian Journal of Technology*, 38 613 - 608

[18] Oyebisi, S. O., Olutoge, F. A., Ofuyantan, O. M., and Abiote, A.A., (2018). Effect of corncob ash blended cement on the properties of lateritic interlocking blocks. *Progress in Industrial Ecology – An International Journal,* 11, No. 4.

[19] Raheem, A. A., and Sulaimon, O. K., (2013).” Saw Dust Ash as Partial Replacement for Cement in the Production of Sandcrete Hollow Blocks”. *International Journal of Engineering Research and Applications* (IJERA). 3, 4. 713 - 721.

[20] Raheem, A.A. and Adenuga, O.A., (2013). Wood Ash from Bread Bakery as Partial Replacement for Cement in Concrete. *International Journal of Sustainable Construction Engineering and Technology.* 1. 1 75 – 81. ISSN: 2180 – 3242.

[21] Nigerian Building and Road Research Institute NBRRI (2006). Interlocking Block Making Machine, *Nigerian Building and Road Research Institute Newsletter*, 1, Issue 1, 2006. 130 – 139.

[22] Nigerian Industrial Standard (2004). Standard Order for Sandcrete Blocks. ICS 91. 100.20, NIS: Abuja, Nigeria.