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DURABILITY AND FLEXURAL STRENGTH PROPERTIES OF "EJULE" LATERIZED CONCRETE.

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ABSTRACT*:* Crushed granite is highly utilized construction material for producing concrete in Nigeria. The continuous use of this material may lead to its depletion, hence the need for researchers to seek for an alternative local material which has the tendency of replacing granite either partially or fully in concrete production. Laterite belongs to a category of such materials. This study investigated the durability and flexural performance of "Ejule laterite" as coarse aggregate in concrete production. Flexural strength and water absorption tests were conducted on the concrete using 0, 10, 20, 30, 40, 50, 60, 70, 80, 90 and 100% EL content to replace coarse aggregate (granite). The samples were cured for 7, 14, 28, 56 and 90days before testing. The results indicated that flexural strength of concrete decreased with increase in EL content and increased with curing period. The optimum blend was obtained at 20% EL and 80% granite content. Water absorption of concrete increased with increased in EL content and decreased with curing age. MINITAB statistical software was used to carry out regression analysis and analysis of variance (ANOVA). Models were developed to predict flexural strength and water absorption with curing period and EL content as predictors at 5% level of significance. The result showed that there is no significant difference between the predicted and the experimental values. The coefficients of determination, R^2 of 96.3%, and 88.0% for the models of flexural strength and water absorption indicating a good relationship between the response and predictors. Ejule Laterite (EL) is recommended for use as coarse aggregate replacement in concrete. With respect to strength, not more than 20% EL content is recommended as coarse aggregate replacement in concrete.

KEYWORDS: Laterized Concrete, Flexural strength, Water absorption, Granite.

I. INTRODUCTION

The term lateritic has been put into diverse usage and controversially defined since it was first coined by Buchanan in 1807 from the latin word 'later' which means a brick because it was easily moulded into brick-shaped blocks for building. It was originally described as a ferruginous vesicular unstratified and porous material with yellow ochre due to high iron content. Categorizing laterite, lateritic and non-lateritic soil based on their silica-sesquioxide ratios, which is represented by SiO_2 / (Fe_2O_3+Al_2O_3). Ratio less than 1.33 indicates laterites, those between 1.33 and 2.00 indicate lateritic soils and above 2.00 indicate non-lateritic soils, which have also been tropically weathered. In Nigeria, crushed granite is one of the highly patronize construction material use as coarse aggregate in producing concrete. Crushed granites are usually grey in colour most of which are irregular in shapes with rough edge surface (Ettu *et al.,* 2013). The continuous use of these materials without substitute or alternative might lead to over depletion of the material, hence the need for researchers to seek for an alternative locally available material, which has the tendency of replacing the

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conventional material either fully or partially in concrete production. This quest for alternative construction material is due to the global sustainability as it relates to the preservation of the environment and non-renewable natural resources which has been depleting in quality and quantity as a result of human activities, (Aginam *et al.,* 2016). Among the components of concrete, aggregates occupy about 70-75% of the total volume of concrete as such the properties of aggregates has tremendous influence on the properties of concrete (Biju *et al.,* 2013).

Adoga, (2008), defined laterite as a highly weathered material rich in secondary oxides of iron, aluminum or both. Laterites occurs naturally mostly in the tropics and subtropics region such as Malaysia, Indonesia, Thailand, Nigeria, India and Australia (Olugbenga *et al.,* 2007). Since aggregate are produced from rock origin such as igneous, sedimentary and metamorphic, some environments and locations in Nigeria have little or no rock presence at times, one needs to travel a long distance before procuring the material, thus making the aggregates scarce and expensive in such locations. Therefore, getting an alternative aggregate if found or identified to be suitable would surely reduce the cost associated with long distances covered before obtaining the aggregate. One of the alternatives identified is the possibility of using laterite as coarse aggregate in concrete.

Plate I.: Laterite borrow pit at Ejule, Kogi State Nigeria.

II. LITERATURE REVIEW

2.1 Formation of Laterite

Tropical weathering otherwise referred to as laterization is a prolonged process of chemical weathering which produces a wide variety in the thickness, grade, chemistry and ore mineralogy of the resulting soils (Dalvi *et al*.,2004; Schellmann, 2008). The initial products of weathering are essentially kaolinized rocks called saprolites. A period of active laterization extended from about the mid-Tertiary to the mid-Quaternary periods [35 to 1.5 million years ago] (Dalvi *et al*. 2004). Lateritic are formed from the leaching of parent sedimentary rocks (sandstones, clays, limestones); metamorphic rocks (schists, gneisses, migmatites); igneous rocks (grainites, basalts, gabbros, peridotites); and mineralized proto-ores; which leaves the more insoluble ions, predominantly iron and aluminum (Whittington and Munir, 2000).

2.2 Mineralogical Composition of Laterite

The mineralogical and chemical composition of lateritic is dependent on their parent rocks. Laterites consist mainly of quartz and oxides of titanium, Zircon, iron, tin, aluminum and manganese, which remain during the course of weathering (Hill *et al*., 2000). Quartz is the most abundant relic mineral from the parent rock. Laterites vary

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significantly according to their location, climate and depth. The main host minerals for nickel and cobalt can be either iron oxides or clay minerals or manganese oxides.

Iron oxides are derived from mafic igneous rocks and other iron-rich rocks, bauxites are derived from granitic igneous rock and other iron-poor rocks (Yamaguchi, 2010). Nickel laterites occur in zones of the earth which experienced prolonged tropical weathering of ultramafic rocks containing the ferro-magnesian minerals olivine, pyroxene and amphibole (Hill *et al*., 2000; Dalvi *et al.*, 2004).

Table 1 Oxide Requirement of laterite

SN	Chemical compound	Typical range in % of mass
1	H_2O	20 – 30
2	Al_2O_3	50 – 60
3	Fe_2O_3	35 – 80
4	SiO_2	Very low
5	TiO_2	About 2
6	Cr_2O_3	0 – 5.3
7	V_2O_5	0.01– 0.65
8	Alkali and Alkaline Earths	0.02Do not exceed 1

2.3 Laterite Aggregate

Schellmann, (2013), defined laterite as the end or epical product of a process of rock degradation which may stop short at the formation of the hydrated silicates like clays or litho-marges, or continue to hydrate according to chemical and physical environment and nature of the parent rock. It was locally used by the natives as brick for building and hence he named it laterite from a Latin word “later” meaning brick. Steven (2005), compiled the physical, chemical and morphological definitions from various researchers and then redefined laterite as a highly weathered material, rich in secondary oxides of iron, aluminum, or both, it is nearly void of buses and primary silicates, but it may contain large amount of quartz and kaolinite, and it is either harder capable of hardening on exposure to wetting and drying.

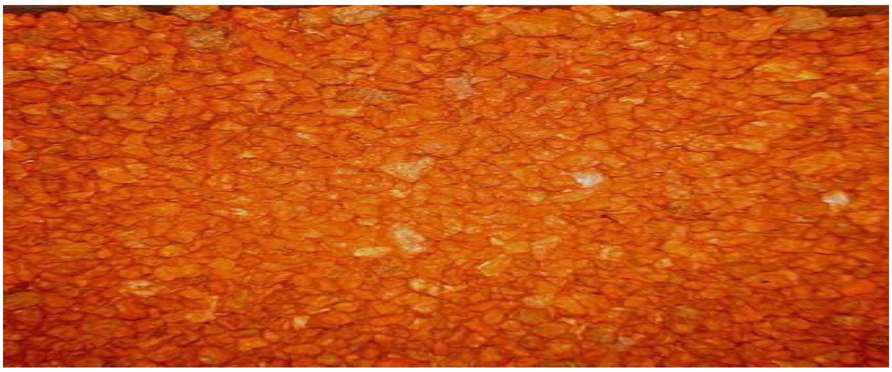

Plate II: Laterite Aggregate

III. MATERIALS AND METHODS

3.1 Material

The materials used for the study are cement, coarse aggregate (granite), fine aggregate (sand), water and Ejule laterite.

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3.1.1 Cement

Dangote brand of Ordinary Portland Cement was used throughout the research work. The cement properties comply with (BS 12 1996) specifications.

3.1.2 Coarse Aggregate (granite)

The coarse aggregate used was normal weight aggregate from an igneous rock source with maximum size of 20mm. It was obtained from a quarry site in Ajaokuta, Kogi state. The physical properties tested includes: particle size distribution, bulk density, aggregate crushing value, aggregate impact value and specific gravity. The tests were conducted in accordance with BS EN 933: part 1 (1997), BS 812: part2 (1975), BS 812: part 110 (1990), BS812: part 112:(1990) and BS EN 1097: part 6 (2000) specifications respectively.

3.1.3 Fine aggregate

The fine aggregate (river-sand) used was obtained from the bank of River Niger flowing through Idah, Kogi state. The tests conducted are specific gravity, particle size distribution, silt content and bulk density. The tests were conducted in accordance with BS EN 1097: part 6 (2000), BS EN 933: part 1 (1997), ASTM C117- 1995& BS812: part 2: (1975) specifications respectively.

3.1.4 Water

The water used was collected from a portable water source (tap water) within the structure's laboratory which is fit for drinking and therefore no test was conducted on the water.

3.1.5 Ejule Laterite

Ejule Laterite (disturbed sample) was collected from a borrow pit site (see Plate I) within Ejule town in Kogi state. The laterite aggregate was sieved using BS standard sieve size 20mm in order to grade the aggregate. The sample retained on the sieve size 20mm was used for the study. The physical properties tests carried out are: particle size distribution, bulk density and specific gravity. The tests were conducted in accordance with BS EN 933: part 1 (1997), BS 812: part 2: (1975) and BS EN 1097: part 6 (2000) specifications respectively. The Mechanical properties test carried out are: Aggregate Crushing Value (ACV) and Aggregate Impact Value (AIV). These tests were conducted in accordance with BS 812; part 110: (1990), BS812; part 112; (1990) specifications respectively. Chemical test was carried out on Ejule laterite to determine its chemical properties. X – Ray Fluorescence analysis was used to conduct the chemical analysis in accordance with BS EN 15309 (2007).

3.2 Experimental Design

The entire study was conducted in two phases; phase one involved the assessment of some engineering properties of fresh and hardened concrete. Slump test was carried out on fresh concrete while Density, water absorption, compressive strength and flexural strength test were carried out on hardened concrete. Phase two part of the study, deals with the statistical analysis of the data obtained from the tests carried out in phase one.

3.2.1 Concrete Mix Design

The grade of concrete used for the study was M-25. The ACI standard 211.1 method of mix design was used and the minimum specified compressive strength is 25N/mm^2. Ten different mixes were used in the study. EL-00 represent mix with 0% EL while EL-10, EL-20, EL-30, EL-40, EL-50, EL-60, EL-70, EL-80, EL-90 and EL-100 represented mix with 10, 20, 30, 40, 50, 60, 70, 80, 90 and 100% EL contents.

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Table 2: Summary of mix proportion for the M – 25 Concrete.

	Cement	Fine aggregate	Coarse	Water
Weight (Kgm^{-3})	323	678.3	1292	180
Ratio	1.0	2.10	4.02	0.56

3.2.2 Concrete Production

The process of concrete production was strictly adhered to which involves the following: batching, mixing, transporting, compaction and curing. All were performed in accordance with (BS1881: part 125:1986, BS1881: part 108:1983, BS1881: part 103: 1993 and BS 1881: part 111:1983) specification. Eleven different mixes were designed and tested for the aforementioned properties by replacing coarse aggregate with Ejule laterite at various replacement levels of 0, 10, 20, 30, 40, 50, 60, 70, 80,90 and 100 percent by weight of Ejule laterite aggregate. The concrete cubes and beams were de-moulded after 24 hours of casting and cured by water immersion for 7, 14, 28, 56 and 90 days. Curing of the concrete cubes and beams were performed in accordance with BS 1881: part 111: 1983 specification. For each test average of three (3) samples were used.

3.4 Tests on Hardened Concrete

3.4.2 Water absorption test on concrete

The water absorption was determined on hardened concrete cubes of 150 x 150 x 150mm, cured for 7, 14, 28, 56 and 90 days. The test was carried out in accordance with BS1881: part 22: (1993). The water absorptions were calculated using equation (1).

$$\text{Water absorption} = \left(\frac{Mass\ after\ curing - Mass\ before\ curing}{Mass\ before\ curing}\right) X\ 100\% \quad (1)$$

3.4.4 Flexural Strength Test of Concrete

Flexural strength test was carried out on the hardened concrete beams of size 100mm x 100mm x 500mm using 0, 10, 20, 30, 40, 50, 60, 70, 80, 90 and 100% EL to replace coarse aggregate by weight and cured for 7, 14, 28, 56 and 90 days respectively. The test was conducted in accordance with BS 1881: part 118 (1983) specification. A total number of one sixty-five (165) beams were tested. The flexural strengths or Modulus of Rupture was determined using equation (2).

$$FSC = PL / BD^2 \quad (2)$$

Where:

P = maximum load in KN

L = span of the beam

D = depth of the beam

B = breath of the beam

FSC = Flexural strength of concrete.

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IV. RESULT AND ANALYSIS

Table 3: Physical Properties of Granite and Ejule Laterites

Physical properties	Granite	Ejule laterite
Specific Gravity	2.64	2.42
Water Absorption (%)	0.92	1.07
Flakiness Index	13.5	6.32
Elongation Index	29.8	4.5
Ten Percent Fine (%)	4.3	6.3

Table 3 shows the physical properties of the materials used for the study. The result shows that the laterite and granite aggregates have slightly different physical properties. The specific gravity value of the laterite aggregates is (2.42), which is lower than that of granite (2.64). Aggregates with higher specific gravity are less porous, and hence, denser (Neville, 2005) than those with lower value. Its shows that Ejule laterite is lower in specific gravity by about 8.33% as compared with aggregate for granite source. The flakiness and elongation index of the laterite aggregates is (6.32 and 4.5) respectively, while that of granite is (13.5 and 29.8). These values are less than the maximum limit specified in BS 882,1992.

Table 4: Mechanical Properties of Granite and Ejule Laterites

Physical properties	Granite	Ejule laterite
Aggregate Crushing Value (%)	20.8	34.6
Aggregate Impact Value (%)	26.2	28.7

Table 4 shows the mechanical properties of the test conducted on coarse aggregate. The aggregate crushing value (ACV) and aggregate impact value (AIV) of laterite was 34.6% and 28.7% respectively while that of granite was 20.8% and 26.2%. These values are below the maximum permissible value specified by BS 882: 1992. The coarse aggregate used was good for concrete work.

Table 5: Chemical Properties of Laterite

Oxide composition	Concentration (%)
SiO_2	50.48
Al_2O_3	13.25
Fe_2O_3	11.98
K_2O	3.46
P_2O_5	2.76
MnO_2	0.86
TiO_2	2.37
ZnO_2	0.13
CaO	8.52
MgO	1.8
SrO	0.06
SO_3	3.87
Cl	0.46

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Sky Ray Explorer 7000 handheld X – ray fluorescence (XRF) device was used in the determination of the various percentages of oxide present in the Ejule Laterite. The Ejule laterite was loaded in to the sample holder and placed in the appropriate sample tray. The test was carried out by bombarding the samples with high energy X – Rays which resulted in to emission of characteristics secondary X – Rays. Using silicon drift detector, the elemental analysis and oxide composition were determined. Major Compounds of the Ejule laterite are Silicon Oxide, SiO_2, 50.48%, Aluminium Oxide, Al_2O_3, 13.25%, Iron Oxide, Fe_2O_3, 11.98%, and Calcium Oxide, CaO, 8.52% as shown in Table 5. This result agrees with the findings of past researchers (Marwa et al., 2013).

Table 6: Flexural Strength of Concrete

Mix ID	Flexural Strength (N/mm^2)				
	7 days	14 days	28 days	56 days	90 days
EL - 00	3.64	3.90	4.82	5.12	5.41
EL - 10	3.40	3.61	4.33	4.82	5.10
EL - 20	3.21	3.41	4.01	4.52	4.83
EL - 30	3.04	3.29	3.71	4.02	4.52
EL - 40	2.74	2.98	3.31	3.71	4.22
EL - 50	1.94	2.20	2.40	2.70	3.24
EL - 60	1.21	1.54	1.72	1.95	2.67
EL - 70	0.81	1.00	1.30	1.52	2.30
EL - 80	0.50	0.80	1.10	1.32	1.98
EL - 90	0.33	0.55	0.77	1.21	1.56
EL - 100	0.23	0.44	0.76	0.99	1.20

Table 6 shows the result of the flexural strength of concrete while the variation of flexural strength with percentage replacement of coarse aggregate with Ejule laterite is presented in figure 1. And the variation of flexural strength versus curing period is presented in Figure 2. It can be seen from the figures that; the flexural strength decreases with increase in Ejule laterite content. For instance, at EL – 10 coarse aggregate replacement level, there was a flexural strength decrease of 8.60%, 10.26%, 13.05%, 16.17% and 7.39% when compared to the flexural strength of control specimen (EL – 00) at 7, 14, 28, 56 and 90 days of curing periods respectively. Similarly, EL – 20 exhibited flexural strength decrease of 11.02%, 12.56%, 15.46%, 17.84% and 10.72% at 7, 14, 28, 56 and 90 days of curing period respectively. All the remaining coarse aggregate replacement levels, exhibited similar pattern of flexural strength loss when compared to the strength of the control sample.

The decrease in flexural strength is probably due to the characteristics of laterite aggregate which has lower stiffness and more pores compared to granite aggregate (Kamaruzaman *et al,* 2013). This factor causes lower bonding strength between aggregate and cement as well as increase water requirement for workable concrete which in turn reduce the ability of concrete to sustain larger load. Since flexural strength of concrete is about 10 - 20% of compressive strength depending on the type, size and the volume of aggregate used (Neville *et al,* 1997) the value obtained in the testing is within the range. On overall, performance of concrete specimens produced using 10 – 50% of Ejule laterite exhibit good flexural strength. The results of regression analysis from the flexural strength of concrete are shown in Table 7. The results show the relationship between the flexural strengths of the concrete (FSC), EL contents and CP. The regression equation obtained from the analysis is:

$$FSC = 4.08876 - 0.0431673EL + 0.0166145CP \quad (3)$$

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The standard deviation of error in the model, S = 0.291861. The T – statistics are 45.8622, – 34.6865 and 12.8885 for constant, EL and CP terms respectively. These values are greater than T – critical ($T_{54,\ 0.05} =$ 1.6736) at 5% level of significance. The probability of the t – statistic, P = 0.0000 for the constant, EL and CP terms which is less than the P – value (0.005). All these shows there is an excellent linear relationship between the FSC, EL and CP. Therefore, EL and CP are useful predictors of the regression model.

Table 8 shows the results of ANOVA for the flexural strength test of concrete at 5% level of significance. The F – statistics are 684.63, 1203.15 and 166.11 for the constant, EL and CP terms. The values are greater than the F – critical (F1, 53, 0.05 = 4.023). The probability of the F – statistic for the constant, EL and CP terms are less than the P – value (0.05). These show that the EL content and CP have significant effect in variation of Fsc of the concrete.

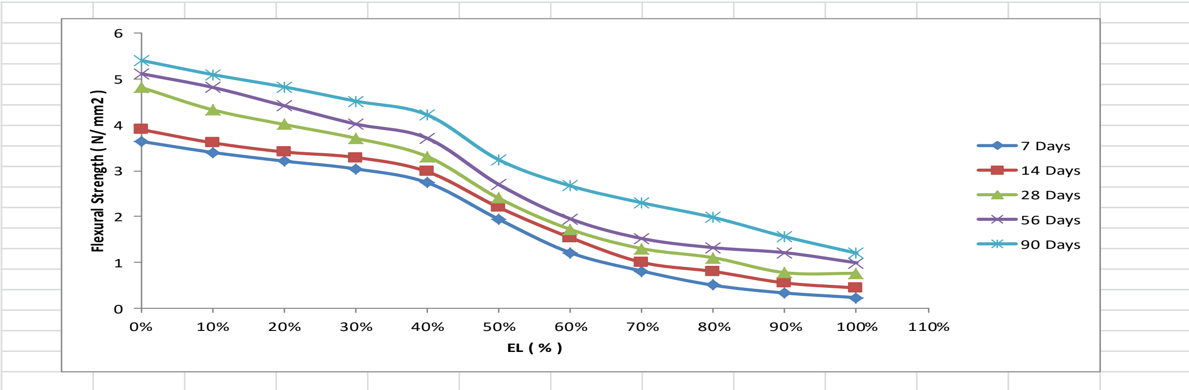

Fig 1: Plot of flexural strength versus Ejule laterite

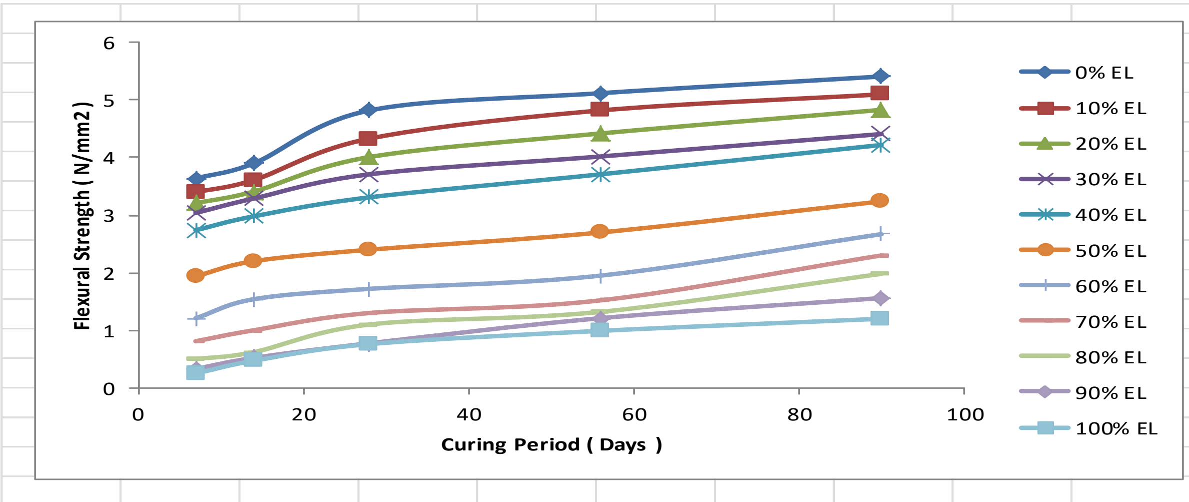

Fig 2 Plot of flexural strength versus curing age

Table 7: Regression Analysis for Flexural Strength of Concrete

Term	Coefficient	SE Coefficient	T	P	Relationship
Constant	4.08876	0.0891531	45.8622	0.000	Significant
EL	-0.043167	0.0012445	-34.6865	0.000	Significant
CP	0.016615	0.0012891	12.8885	0.000	Significant
S = 0.291861					

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Table 8: ANOVA for the Flexural Strength of Concrete at 5% Level of Significance

Source	DF	Seq SS	Adj SS	Adj MS	F	P	Effect
Regression	2	116.638	116.638	58.319	684.63	0.00	Significant
EL	1	102.488	102.488	102.488	1203.15	0.00	Significant
CP	1	14.150	14.150	14.150	166.11	0.00	Significant
Error	52	4.429	4.429	0.085	_	0.00	Significant
Total	54	121.067	_	_	_	_	

Table 9: Durability Test by Water Absorption of Concrete

Mix ID	Water Absorption (%)				
	7 days	14 days	28 days	56 days	90 days
EL - 00	0.98	0.91	0.84	0.81	0.78
EL - 10	1.10	0.98	0.93	0.91	0.88
EL - 20	1.32	1.21	1.10	0.95	0.93
EL - 30	1.48	1.33	1.21	1.02	0.97
EL - 40	1.80	1.51	1.34	1.24	1.18
EL - 50	2.25	1.85	1.62	1.45	1.25
EL - 60	2.55	2.15	1.92	1.74	1.46
EL - 70	2.73	2.51	2.13	1.99	1.63
EL - 80	3.10	2.84	2.46	2.20	1.85
EL - 90	3.95	3.72	3.42	2.81	2.53
EL - 100	4.62	4.30	4.12	3.67	3.14

Table 9 shows the results of water absorption of the concrete. Figure 3 is the graph of variation of water absorption with EL content. The water absorption increased with increase in EL content. This occurs mainly owing to the specific gravity of the laterite aggregates, which is lower than that of granite. The lower specific gravity of Ejule laterite brings about higher water absorption of the concrete. However, the highest water absorption of the concrete mix produced using laterite aggregates of up to 100% replacement is less than 4.62%. Concrete with maximum water absorption of 10% is classified as high quality (Nevill, 2005). Laterised concretes produced in this study can be categorized as high-quality concrete.

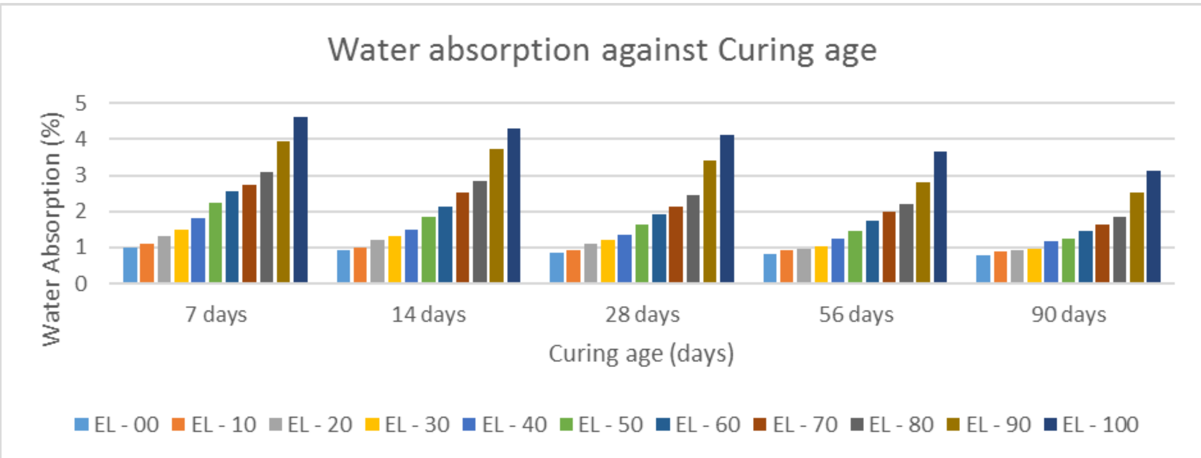

Fig 3; Variation of water absorption of concrete with curing age.

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Table 10: Regression Analysis for Water Absorption of Concrete

Term	Coefficient	SE Coefficient	T	P	Relationship
Constant	0.850452	0.110217	7.7162	0.000	Significant
EL	0.028673	0.001539	18.6365	0.000	Significant
CP	-0.009303	0.001594	-5.8375	0.000	Significant
S = 0.360817					

Table 11: ANOVA for the Water Absorption of Concrete at 5% Level of Significance

Source	DF	Seq SS	Adj SS	Adj MS	F	P	Effect
Regression	2	49.6532	49.6532	24.827	190.697	0.00	Significant
EL	1	45.2169	45.2169	45.2169	347.318	0.00	Significant
CP	1	4.4363	4.4363	4.4363	34.076	0.00	Significant
Error	52	6.7698	6.7698	0.1302	_	0.00	Significant
Total	54	56.4230	_	_	_	_	

Table 10 shows the regression analysis of water absorption test results. The regression analysis results show the relationship between water absorption of the concrete (Wab), EL contents and curing period (CP). The regression equation obtained from the analysis is:

WAB = 0.850452 + 0.028727EL - 0.00930297CP………………………………………..(4)

The standard deviation of error in the model, S = 0.360817. The T – statistics are 7.7162, 18.6365 and -5.8375 for constant, EL and CP terms respectively. These values are greater than the T – critical ($T_{54,0.05} = 2.71$) at 5% level of significance indicates whether the effect for that term is significant. The probability of the t – statistics, P = 0.000 for the constant, EL and CP terms which is less than the P – Value (0.05). All these shows there is an excellent linear relationship between the Wab, EL and CP. Therefore, EL and CP are useful predictors of the regression model.

Table 11 shows the results of ANOVA for the water absorption test of concrete at 5% level significance. The F – statistics are 190.697, 347.318 and 34.076 for the constant EL and CP terms. These values are greater than the F – critical ($F_{1, 53, 0.05} = 3.17163$). The probability of the F – statistic; P = 0.0000 for the constant, EL and CP terms which is less than the P – value (0.05). These show that the EL constant and CP have significant effect in variation of Wab of the concrete.

V. CONCLUSION

Based on the results of this research work, the following conclusions were drawn:

1. The flexural strength increases with increase in curing period and decrease with increase in Ejule laterite content. However, Ejule laterites satisfied requirement of BS EN 206: part 1 (2000) for normal weight aggregates.
2. The flexural strength decreased with increase in EL content at early age and at curing periods beyond 28 days there were gain in strength at (10% and 20%EL) due to reaction between products of hydration of OPC and EL. The optimum blend was obtained at 20% EL and 80% granite content.
3. Use of Ejule laterite as partial replacement of coarse aggregates in concretes production would reduce the high dependency of concrete industry on the granite aggregate supply and thereby prolonging the granite aggregate reserved for future generation.

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4. The statistical models developed provide good prediction for the flexural strength and water absorption of concrete. This implies that there is no statistical significant difference between the experimental and predicted strength values at 5% level of significance

VI. RECOMMENDATION

Based on the results obtained from this study, Ejule Laterite (EL) is recommended for use as coarse aggregate replacement in concrete. With respect to strength, not more than 20% EL content is recommended as coarse aggregate replacement in concrete.

REFERENCES

1. Adoga, E.A. (2008). Durability and fire resistance of laterite rock concrete. Unpublished M.Tech Thesis. Department of civil Engineering, Rivers State University of Science and Technology, Portharcourt, Nigeria
2. Aginam, C.H. (2016). Quarry Dust as a partial replacement of coarse aggregates in concrete production. Journal of Mechanical and Civil Engineering. 13:65-73
3. Biju, M., Benny, J. and Freeda, C.C. (2013). Strength performance of concrete using laterite as sand replacement. International journal of civil engineering research and applications (IJCERA). 1: 122-136.
4. Dalvi, A. D., Bacon, W. G. and Osborne, R. C. (2004). The Past and Future of Nickel Laterites. *PDAC International Convention, Trade Show & Investors Exchange*. (Report). Retrieved November 7, 2016.
5. Ettu, L.O., Arimanwa, J.I., Njoku, F.C., Amanze, A.P.C., and Eziefula, U.G. (2013). Strength of Blended Cement Sandcrete & Soilcrete block containing sawdust ash and pawpaw leaf ash. International journal of inventions. 2: 35-40.
6. Hill, I. G., Worden, R. H. & Meighan, I. G. (2000). "*Geotechnical Evolution of Palaeolaterite: The Interbasaltic Formation, Northern Ireland*" Chemica Geology, 166(1-2), pp 65. Doi: 10.1016/S0009-2541(99)00179-5, Retrieved April, 2017.
7. Olugbenga, A., Kolapo, O., Oludare, O. and Abiodun, O. (2007). A study of compressive strength characteristics of laterite / sand hollow blocks. Civil Engineering Dimension. 9: 26 – 29.
8. Schellmann, W. (2008). An Introduction in Laterite Available Online: Retrieved November 10, 2016. From: http://en.wikipedia.org/wiki/laterite.
9. Steven, S.Z. (2005). Chemical Principle. Houghton Mifflin Company, USA.
10. Whittington, B. I. and Munir, D. (2000). Pressure Acid Leaching of Nickel Laterite. A Review, Mineral Processing and Extractive Metallurgy. 21:527-599.
11. Yamaguchi, K. E. (2010). Iron Isotope Compositions of Fe-Oxide as a Measure of Water-Rock Interaction: An Example from Precambrian Tropical Laterite in Botswana. (Report). Retrieved November 7, 2016.

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