Effect of Lime-Guinea Corn Husk Ash on the Engineering Properties of Lateritic Soils

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Abstract-The effect of lime-guinea corn husk (GHA) ash on the engineering properties of lateritic soil was assessed. The lateritic soil, which was modified with guinea corn husk ash and lime as stabilizing agents, was obtained from kudenda along Kaduna-Abuja express way Kaduna (lat. 070, long. 100). The Optimum moisture content (OMC) and Maximum dry density (MDD) of the lateritic soil without stabilizing are 15.24% and 1.73g/cm3 respectively. The sample, on stabilizing with lime-GHA ash, the OMC at 2%, 4%,6%,8%, 10% and 12% of the lime - GHA ash were 15.57%, 15.13%, 18.27%, 18.17%, 21.16% and 21.36% respectively with corresponding MDD of 1.72 g/cm3, 1.74 g/cm3, 1.74 g/cm3, 1.66 g/cm3, 1.62 g/cm3,and 1.61 g/cm3. The OMC at every percentage Lime-GHA were used to cast lateritic bricks and air-dried for 7days, 14days and 21days.The compressive strength of the bricks for 7, 14 and 21days were found to be 0.89N/mm2,0.92N/mm2 and 1.10N/mm2for the control; the compressive strength of the cubes at 7, 14 and 21 days were observed to increased with curing age and reach the optimum strength 8, 10 and 10days respectively (corresponding values of 1.14, 1.21 and 1.35 N/mm2).It is therefore deduced that lateritic soil strength can be improved at 10% each for lime and GHA.

Keywords: Compressive strength; Dry density; Guinea corn; Lateritic soil; Lime; Moisture content.

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Introduction

The effects of lime–Guinea corn, Pozzuoli material, have an undisputed role to play in the future of the construction industry. This is so, due to the shortage and escalating price of cement.

From the economical, technological and ecological point of views, this study focuses on the utilization of lime – Guinea corn husk ash (an agricultural residue) as cementation material, [1].

Today the use of lateritic soil for building is highly restricted to rural area and even the sand crete block (which is more expensive) are gradually replacing the use of lateritic soil. This is because the sand crete block acquire it maximum strength within 28 days. This trend is not satisfactory as local materials must be put to better use. A lot of lateritic gravels and pisoliths, which are also good lateritic soil improvement could either by modification or stabilization or both. Lateritic soil modification is the addition of a modifier (cement, lime etc) to the soil to change its index properties, while stabilization is the treatment of soil to enable their strength and durability to be improved such that they become totally suitable for construction beyond their original classification [5]. Over the times, cement and lime are the two main materials used for stabilize soil. These materials have rapidly increased in price due to sharp increase in the cost of energy since 1970. The over dependent of industrially manufactured soil improving addition (cement, lime etc), have kept the cost of construction of stabilized road financially high. These hitherto have continued to deter the underdeveloped poor nations of the world from providing accessible road to their rural dweller who constitute the higher percentage of their population

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and are mostly agricultural dependent. Thus, the use of Guinea corn husk ash will considerably reduce the cost of construction. Lateritic stabilization with a secondary cementitious material like Guinea Corn husk ash will reduce the overall environmental impact of the stabilization process [2], [3].

Guinea corn husk ash is an agricultural waste obtained from milling of Guinea corn. About 10 million tones of Guinea corn husk is generated annually in the world. In Nigeria alone 1.5 million tones of Guinea corn is produced annually, while in Kaduna state, about 92, 000 tones of Guinea corn is produced in 2007, [3]. Meanwhile, the ash has been categorized under Pozzolana with about 60 – 65% Sio_2 and about 29% Al_2O_3 and 3.5% iron oxides, the silica is substantially contained in amorphous form, which can react with the CaOH [4]. Hence this study evaluates the effect of lime – Guinea Corn husk ash (GHA) on the engineering properties of lateritic soil.

Figure 1: Guinea corn husk

Figure 2: Guinea corn husk ash

Methodology

Pretreatment carried out include surfing to remove big stalk, sun drying, hand picking to remove the non–husk materials so as to make it purely shaft husk. At the completion of the whole pretreatment exercise of the guinea corn husk, it was spread to the sun in order to dry it. It was allowed to dry for about two to three days before the burning commenced. Maximum of one day was used to burn the guinea corn husk by burning in the absence of oxygen at temperature of 950^0 C; the collected ash was carbon and white grey in color which was allowed to cool within the oven to 27^0C room temperature.

The lateritic soil sample was collected at Hayin – Rigasa along Kaduna – Abuja express way during the raining season (i.e. July to be precise), from a 1m x 1m x 0.5m trial pit as disturbed sample.

Compressive Strength Test

Various cubes of the homogenous lime-guinea corn husk ash and lateritic soil mix were produced with varying lime-GHA percentage. The percentage ranged between 0% and 12% with 2% increment. The water content requirement was as the result of the optimum moisture content obtained for every percentage of lime-GHA added. Three cubes were produced each for 7, 14 and 21 days, air dried and tested for various compressive strengths. The strength of concrete in terms of N/mm^2 is computed as the crushing load (load that will cause the immediate failure of concrete when subjected to compressive stress by a compressive testing machine) divided by the area. The area of concrete cubes for this study is $10000mm^2$.

$$Compressive\ strength\ (N/mm^2) = \frac{Load(KN)}{Area\,(mm^2)} x1000$$

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Presentation of Results

Table 1: Summary of Compaction test results with varying lime - GHA contents

Laterite content (%)	GHA content (%)	Lime content (%)	Maximum dry density(MDD)g/cm	Optimum moisture content(OMC)%
100	0	0	1.73	15.24
96	2	2	1.72	15.57
92	4	4	1.74	15.13
88	6	6	1.74	18.27
84	8	8	1.66	18.17
80	10	10	1.62	21.16
76	12	12	1.61	21.36

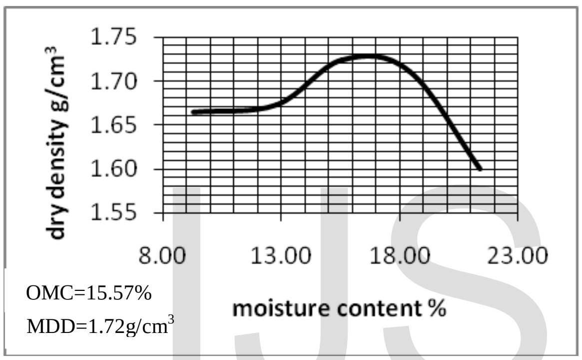

Figure 3: Graph of MC and DD for 2% Lime-

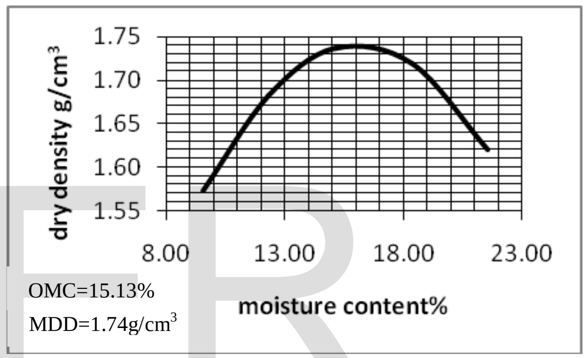

Figure 4: Graph of MC and DD for 4% Lime-

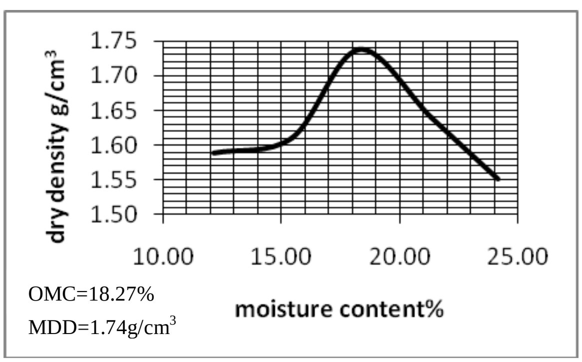

Figure 5: Graph of MC and DD for 6% Lime-

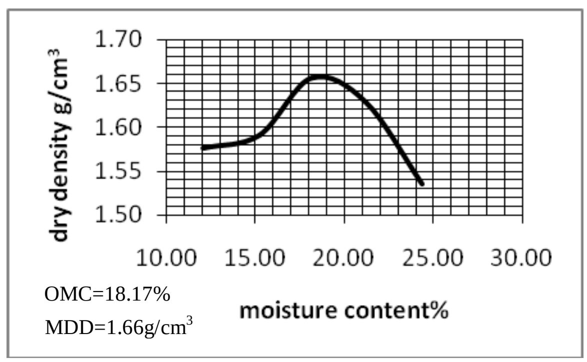

Figure 6: Graph of MC and DD for 8% Lime-

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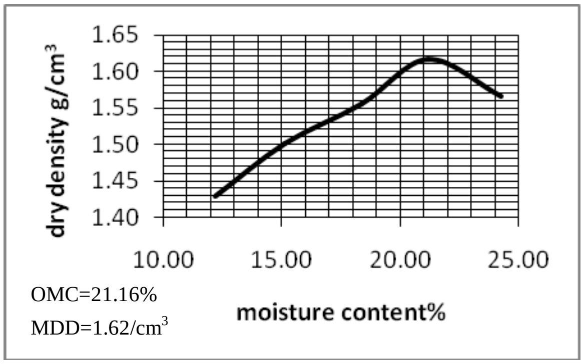

Figure 7: Graph of MC and DD for 10% Lime-

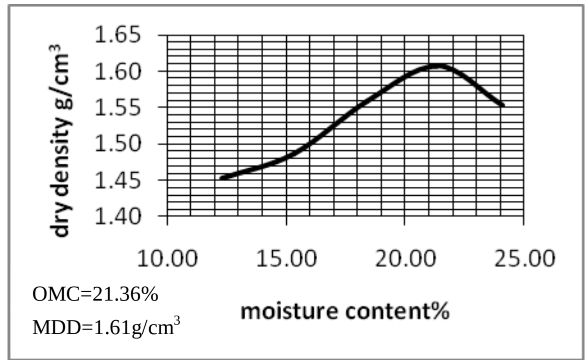

Figure 8: Graph of MC and DD for 12% Lime-

Table 2: Compressive Strength results with varying lime - GHA contents

Laterite (%)	G.H.A (%)	Lime (%)	Age of bricks (Days)	Av. compressive strength (N/mm^2)
100	0	0	7	0.89
			14	0.92
			21	1.1
96	2	2	7	0.92
			14	0.94
			21	1.14
92	4	4	7	1.1
			14	1.15
			21	1.17
88	6	6	7	1.12
			14	1.17
			21	1.19
84	8	8	7	1.14
			14	1.19
			21	1.21
80	10	10	7	1.11
			14	1.21
			21	1.35
76	12	12	7	1.10
			14	1.18
			21	1.26

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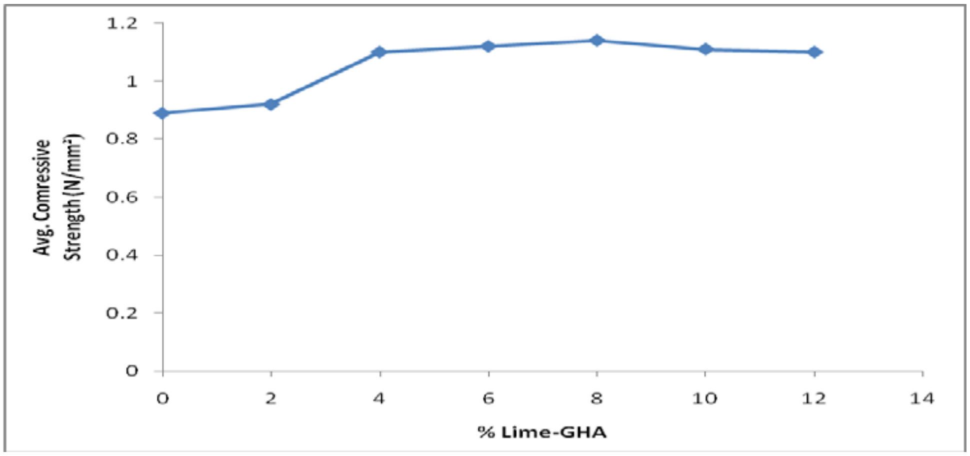

Figure 9: Graph of Lime-GHA and Compressive strength for 7 Days

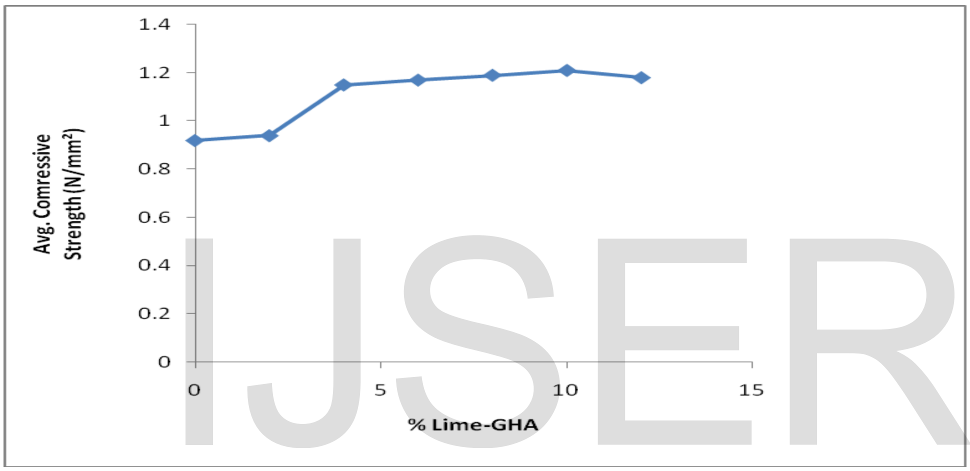

Figure 10: Graph of Lime-GHA and Compressive strength for 14 Days

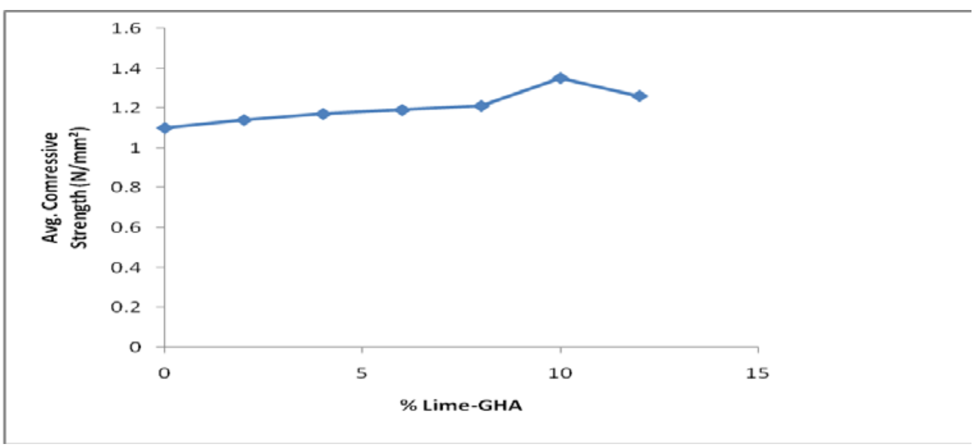

Figure 11: Graph of Lime-GHA and Compressive strength for 21 Days

Discussion of results

The results of the compaction test revealed the maximum dry densities and optimum moisture contents of the stabilized lateric soil; percentage Lime-GHA at 2%, 4%, 6%, 8%, 10% and 12% while the control lateritic soil, 0%, are presented in table 1. Table 2 presents the compressive strengths at 7days, 14days and 21days.

The compaction test on the control lateritic soil has its MDD as 1.73g/cm^3 with the OMC of 15.24% while that of at 2%, 4%, 6%, 8%, 10% and 12% lime-GHA have MDD of 1.72 g/cm^3, 1.74 g/cm^3, 1.74 g/cm^3, 1.66 g/cm^3, 1.62 g/cm^3,and 1.61 g/cm^3 with corresponding OMC of 15.57%, 15.13%, 18.27%, 18.17%, 21.16% and 21.36% respectively. The highest MDD obtained was at 4% and 6% of Lime-GHA.

The compressive strength of the cubes at 7, 14 and 21 days were observed , figures 9, 10 and 11, to increase with curing age and reach its optimum strength at 8, 10 and 10 Lime-GHA percentage respectively (corresponding values of 1.14, 1.21 and 1.35 N/mm^2). The implication is that the compressive strength is increasing with increase in the Lime-GHA as compared to the control 0.89, 0.92 and 1.10 N/mm^2, while there was decrease in strength as the content of Lime-GHA got beyond its optimum. More so, in terms of percentage increase in strength, it was observed that, the percentage increase in maximum strength attained rose from 28% at 7days to 32% at 14days and fell to 23% at 21days.

Conclusion

Results of percentage of Lime-GHA on Lateritic soil as modifier at 0%, 2%, 4%, 6%, 8%, 10% and 12% were established at various curing ages of 7days, 14days and 21days.

Studying these results, there are variations in the compressive strengths of all bricks produced under these stabilizing conditions indicating an increase in strengths at 7days, 14days and 21days, 1.14, 1.21 and 1.35 N/mm^2 respectively, when compared with the control test results curing ages with strengths of 0.89, 0.92 and 1.10 N/mm^2. Hence, the percentage increase in maximum strength attained rose from 28% at 7days to 32% at 14days and fell to 23% at 21days.

Finally, the maximum strength attained at the end of the curing age was 1.35 N/mm^2 at 10% Lime-GHA. This implies 23% increase in strength when compared to the control.

Recommendation

Lateritic bricks produced under this condition, 10% Lime-GHA, and within this location (lat. 07^0, long. 10^0) can be utilized for low cost construction purposes where concrete is required.

More so, since strengths of lateritic soils vary from one location to the other, this process is recommended to ascertain the require Lime-GHA percentage.

Finally, further study should be conducted by keeping the percentage of lime to be constant and vary GHA percentages since guinea corn husk is an agricultural waste.

Acknowledgment

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