International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

http://ijpsat.ijsht-journals.org
Vol. 15 No. 2 July 2019, pp. 351-354

Assessment of Strength Characteristics of Cement Stabilized Lateritic Soil Using Rice Husk Ash for Road Construction

ABE Omoloye Elijah

Department of Civil Engineering,
Federal Polytechnic, Ado-Ekiti.
E-mail: abeomoloye@yahoo.com
+2348035062943

Abstract - This study investigated the effect of rice husk ash (RHA) on the strength properties of cement stabilized lateritic soil. Geotechnical and chemical tests were used to characterize both the raw and treated laterite. Rice Husk Ash (RHA) was used in the present study as admixture. The compaction test, specific gravity, triaxial compressive strength test and California bearing ratio tests of the samples were carried out with varying proportions of RHA; 2%, 4%, 6%, 8% and 10%. The soil classification test showed that the soil is A-7-6 soil on the AASHTO soil classification system. The specific gravity test result showed that specific gravity of 2.70 was obtained. There was an increase in dry density from 1.325mg/m^3 at 0% to 2.3mg/m^3 at 10% RHA + 6% cement content. The CBR value increased from 11.00% in its natural state to 102.05% at 10% RHA + 6% cement content. The Triaxial compressive strength test showed that the frictional angle increased from 22° at 0% to 28° at 8% RHA and the test maintained a considerable cohesion with the varied percentage of RHA. Therefore, RHA has been proved to be a good admixture on the improvement of the engineering properties of lateritic soil for road construction.

Keywords -Assessment, Strength Characteristics, Cement, Lateritic Soil, Rice Husk Ash, Road Construction.

I. INTRODUCTION

The major part of Nigeria is underlain by basement complex rocks, the weathering of which had produced lateritic materials spread over most part of the area. It is virtually impossible to execute any construction work in Nigeria without the use of lateritic soil because they are virtually non-swelling (Arora, 2008). Agricultural and environmental demands for natural aggregates coupled with frequent increases in the price of cement and other binders have consequently escalated the cost of construction, rehabilitation and maintenance of road works. Soil stabilization with bagasse ash emerges as an attractive option for providing low-cost roads because the soils are locally available and relatively cheap. This would be one way of actualizing the dreams of the Federal government of Nigeria in scouting for readily cheap construction materials. Internationally, the World Bank equally has been spending substantial amounts of money on research aimed at harnessing agricultural waste products for further usage.

Laterite soil at a particular location for highway pavement is usually not of the same strength at other locations along a given road particularly for a lengthy one. Long haulage of laterite soil may as well not be economical and so the nearby material may be stabilized and economically used for subbase or basecourse. Subgrade or highway foundation soil California Bearing Ratio (CBR) value may not be up to 5% and in such situation it has to be stabilized in place by making it suitable subbase before the placement of basecourse material in the construction of a road. Akinwumi (2014) reported that in the tropical regions, laterite soils occupy about 23 percent of the land surface and selecting them for use as highway materials can be economically viable. He further reported that some of the lateritic soils are unsuitable for use as road construction materials because their properties do not comply with existing standard requirements. The reasons given by him are that some of laterite soils exhibit high plasticity, poor workability, low strength, high permeability, tendency to retain moisture and high natural moisture content. Mustapha (2005) claimed that there are instances where laterite soil containing a large amount of clay minerals with weak strength and instability to sustain traffic load especially in the presence of moisture are common in many tropical regions and sourcing for alternative soil may prove uneconomical and hence it may be better to improve the available soil to meet the desired strength. Ali (2012) claimed that soil stabilization is a process to improve the physical and engineering properties of soil to obtain some predetermined targets. Therefore it is necessary to evaluate the strength properties of soil subgrade. It helps to adopt suitable values of strength parameter for design purposes (Khanna and Justo 2011). There are various types of soil available having different properties. Few are having good strength and stability while few having properties of high volume change due to change in moisture content. So it can be accepted that all soils do not possess all the desirable qualities of soil subgrade for pavement. Soil with poor subgrade qualities should be avoided as much as possible. But when it's unavoidable its subgrade performance should be increased. The present study is therefore, carried out to assess the effect of addition of rice husk ash to cement-stabilized lateritic soil with a view to reducing pavement construction cost.

II. Materials And Methods

Soil sample used in this study was collected from a lateritic soil deposit along Ado-Ikere Road in Ekiti State of Nigeria. It was collected at a depth of not less than 150mm using the method of disturbed sampling technique and was air-dried. The rice husk was collected from a rice mill located at Ilumoba Ekiti also in Ekiti State of Nigeria. It was incinerated into ash in a furnace with temperature of up to 500^0C for about 2 hours after which it was allowed to cool and thoroughly ground. It was then sieved through 75µm sieve as required by BS 12 (1991). Preliminary tests on the collected laterite soil sample were carried out in the laboratory of the Department of Civil Engineering, Federal Polytechnic, Ado-Ekiti, Nigeria. The tests were carried out in accordance to the American Association of State and Transportation Officials (AASHTO, 2007). Chemical tests were also carried out on the rice husk ash to determine its pozzolanic properties. Engineering strength tests such as compaction, CBR and triaxial compressive tests were performed on 6% cement stabilized lateritic soil with 2%, 4%, 6%, 8% and 10% rice husk ash contents. The sample was air dried in the laboratory to take advantage of the aggregating potentials of lateritic soils upon exposure to air as claimed by Omotosho and Eze-Uzomaka (2008)

III. Results And Discussion

A. *Results of Preliminary Tests*

Results of preliminary tests on the lateritic soil are shown in Table 1. It shows that the soil is classified as A-7-6 according to AASHTO classification system. This implies that it falls below the recommended standard for use for construction work and would therefore require improvement.

Table 1: Results of Preliminary tests

Characteristics	**Description**
Natural moisture content (%)	21.30
Percent passing B.S Sieve NO 200	76.50
Liquid Limit (%)	48.20
Plastic Limit (%)	23.20
Plasticity Index (%)	25.00
Group Index	19.00
AASHTO Classification	A-7-6
Maximum Dry Density (Mg/m^3)	1.325

Optimum Moisture Content (%)	16.80
Unconfined Compressive Strength (KN/m^2)	280.00
California Bearing Ratio (%)	11.00
Specific Gravity	2.70

B. Results of Oxide Composition of Rice Husk Ash

Results of the oxide composition of Rice Husk Ash are shown in Table 2. The result shows that rice husk ash contains the main chemical constituents of cement which are CaO, SiO_2, Al_2O_3, MgO etc. This shows that rice husk ash is a good pozzolana that could help further promote the formation of cementitious compounds with cement hydration reaction products.

Table 2: Results of chemical composition of the rice husk ash.

Property	Composition (%)
SiO_2	60.40
Al2O3	5.60
Fe2O3	0.93
CaO	2.18
MgO	1.91
K_2O	0.32
P_2O_5	0.24
Na_2O	1.20
Loss On Ignition (LOI)	18.20

C. Compaction Characteristics

Table 3 shows the variations between Optimum Moisture Content (OMC) and Maximum Dry Density (MDD) with addition of rice husk ash. The MDD increased with increase in rice husk ash content. The values range from 1.325mg/m^3 at 0% to 2.3mg/m^3 at 10% rice husk ash content. Also, OMC decreases from 16.80% at 0% to 12.25% at 10% RHA.

Table 3: Results of Compaction test at 6% cement content

Rice husk ash	MDD (mgm^3)	OMC (%)
0	1.325	16.80
2	1.500	15.90
4	1.680	15.45
6	1.890	14.02
8	2.100	13.80
10	23.00	12.25

D. California Bearing Ratio (CBR)

Results of CBR test is shown in Table 4. The results showed that CBR values increased from 11.00% at natural soil level to 102.05% at 10% rice husk ash +6% cement content.

Table 4: Results of CBR test

Rice Husk Ash	CBR (%)
0	11.00
2	58.45
4	75.66
6	84.20
8	92.40
10	102.05

E. Triaxial Compressive Strength

The result of triaxial compressive strength test is shown in Table 5. It shows that the cohesion of the stabilized sample was low at the highest angle of internal friction 28^0 which makes soil very plastic. At 0%, 2%, 4%, 6% and 10%, the cohesion of the soil was recorded as 18, 10, 10, 15 and 19kN/m^2.

Table 5: Results of triaxial compressive strength tests

Rice Husk Ash	Cohesion (kN/m^2)	Angle of internal friction (^{0})
0	18	22
2	10	25
4	10	27
6	15	20
8	09	28
10	19	26

IV. CONCLUSION

The following conclusions were made on the basis of the investigations:

- Classification test revealed that the lateritic soil was classified as A-7-6 soil.
- At 6% cement content, the investigation showed a general increase in MDD with increase in RHA content. OMC also decreased with increase in RHA content.
- It was observed that CBR and triaxial compressive strength increased with RHA content for the 6% cement content.

Therefore, rice husk ash is confirmed to be a good admixture in lateritic soil stabilization using 6% cement as control.

REFERENCES

[1] AASHTO (2007). "Standard Specifications for Transportation Materials and Methods of Sampling and Testing", American Association of State Highway and Transportation Officials, 27th ed., Washington D.C

[2] Akinwumi, I. (2014). "Plasticity, Strength and Permeability of Reclaimed Asphalt Pavement and Lateritic Soil Blends", *International Journal of Scientific & Engineering Research*, 5(6), 631–636

[3] Ali, F. (2012). "Stabilization of Residual Soils Using Liquid Chemical". *The Electronic Journal of Geotechnical Engineering Science and Technology*, 2(1), 102-110.

[4] Arora, K.R. (2008). "Soil Mechanics and Foundation Engineering" Seventh Edition, Standard Publishers Distributors, Delhi, India.

[5] BS 12 (1991). "Specification for Portland Cement" British Standard Institute London.

[6] Khanna, S.K. and Justo, C.E.G. (2011). "Highway Engineering", Roorkee, Uttarakhand, India: Nem Chand and Bros..

Mustapha, M.A. (2005). "Effect of Bagasse Ash on Cement Stabilized Laterite", Seminar Paper Presented at the Department of Civil Engineering, Ahmadu Bello University, Zaria, Nigeria.

[7] Omotosho, O. and Eze-Uzomaka, O.J. (2008). "Optimal Stabilization of Deltaic Laterite". Journal of the South African Institution of Civil Engineering, 50(2), 10–17.