Original Article
ISSN (Online): 2454-1907

International Journal of Engineering Technologies and Management Research
June 2022 9(6), 78-87

EFFECTS OF WOOD ASH ON GEOTECHNICAL PROPERTIES OF LATERITIC SOILS

Aboluwarin Tobi [1], Ologun S [2], Esuabanga, W E [3], Osuorji, G.C [4]

[1,2,3,4] Nigerian Building and Road Research Institute, KM 10 Idi Roko Road, Ota, Ogun State, Nigeria

Received 05 May 2022
Accepted 06 June 2022
Published 30 June 2022

Corresponding Author
Ologun S,
sehindeologun@yahoo.com

DOI
10.29121/ijetmr.v9.i6.2022.1164

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Copyright: © 2022 The Author(s). This work is licensed under a Creative Commons Attribution 4.0 International License.

With the license CC-BY, authors retain the copyright, allowing anyone to download, reuse, re-print, modify, distribute, and/or copy their contribution. The work must be properly attributed to its author.

ABSTRACT

Biochar can be derived from pyrolysis of agricultural waste, wood waste (saw dust), logging residues and other biological waste. Biochar can be used to improve the quality of construction and engineering materials. The study deals with the effect of biochar(wood ash)on geotechnical properties of lateritic soils, and it is to investigate the effect of wood ash on the geotechnical properties of lateritic soils. For this purpose, soil samples that were gotten from borrow pit were made use of and blended with available biochar which is used as a stabilizing agent. This was done at different percentages which include (0%, 3%,5%, 10%,15% and 20%,). The biochar was sieved with 125 micrometer sieve and were after blended with the soil samples. The compaction test, consistency limit test, the unconfined compressive strength test were carried out on the samples. It was discovered that the OMC of the blended samples increases as the percentages of the biochar that was used to blend the samples increases, also the MDD on the contrary decreases. The compressive strength test were carried out on all these samples (0%,3%,5%,10%,15% and 20%). It was also discovered that the compressive strength of soil samples increases with increase in the addition of biochar of the samples having its peak at 10%. Then reduction in compressive strength was experienced in between 11% to 20% addition of biochar to the soil sample. Conclusively, the results show that biochar can be use as stabilizing material when added to lateritic soil samples. But more addition of it at a particular stage may lead to the reduction in the compressive strength of the sample in which the sample may be weak and brittle. The size of the biochar if not properly crushed and sieved may not yield a desired result.

Keywords: Biochar, Lateritic Soil, Geotechnical Properties

OPEN ACCESS

1. INTRODUCTION

Biochar is a carbon rich compound that can be gotten from the pyrolysis of some substances which include agricultural, animal, or other organic substance. Majorly it has discovered for the past few years that substances like these can be used for agricultural soil enhancement and for other purpose. There are several ways through which ash can be gotten. But the ash used for this research work was gotten from wood. It has been noticed that biochar can be used to supplement construction materials so that they will be useful for any engineering purpose. They are also melt to solve engineering problems. James et al. (2018). Biochar can be gotten from thermochemical conversion of biomass. Garcia-Perez et al. (2010) Biomass can be referred to as materials that are sourced from waste which are from agriculture, wood, urban or environmental waste. Garcia-Perez et al. (2010) Biochar can also be produced from aerated burning of wood logs. It can also be used in agricultural remediation. The aim of this research work is to know the effect of biochar ash on the geotechnical properties of laterite by conducting; tests that deals with index and strength properties of the biochar blended with laterite with 6 different percentages mix. It has been widely known that the soil whose parent is the rock through the weathering process and also laterite which contain high content of oxides of iron and hydroxides of aluminum. Bello and Adegoke (2013) Most of the soil with weak strength may need to be stabilized so that they can be useful for any engineering purpose. Soil stabilization is melt to increase the strength of the soil. Amu and Adetuberu (2010) It has also been stated in the previous studies that biochar has a stabilizing agent. Smrithi and Soorya (2020)

When lateritic soil consists of high plastic clay, there are several damages in the road pavement due to the plasticity of the soil used for the road construction project. The improvement of strength of soil has become necessary due to the purpose they will be used for. Several stabilizing agents have been made use of to improve the strength of the soil. Lateritic soils have been made to blend with several chemical additives to make it useful for construction. This is to deal with changing the engineering property of laterite. Amu and Adetuberu (2010)

For several years, several materials have been used for stabilizing soils which include cement and lime and other materials. These materials have rapidly increased in price due to the sharp increase in the cost of energy and high demand for them. It has been shown by Bello et al. (2014) that Co2 that is produced from Portland cement contributes to the depletion of zone layer. These can be avoided by adding materials that can be in replaced proportions to Portland cement. This shows another reason why stabilization is conducted on engineering materials. The common soil that are majorly used are lateritic soils and are majorly used in the country, it has been generally discovered by researchers that laterite have low bearing capacity and low strength due to high content of clay. The strength of the laterite is still low in the presence of moisture. Alhassan and Mustapha (2007) The soil considered in this study is lateritic soil which was mixed in different percentages to the pulverized biochar. This study investigates the changes in the geotechnical properties of lateritic soil treated with biochar. As earlier stated, the test were conducted by using different percentages of biochar at sieze mesh of 125 micrometer.

2. METHODS AND MATERIALS

2.1. MATERIALS

2.1.1. LATERITIC SOIL

The lateritic soil that was used for the work was gotten from a borrow pit. The tests that were carried out include the index property test (consistency limit, compaction,) and strength property(ucs) test. These tests were performed on the soil samples. Prior to the test, the soil was dried and pulverized and crushed into fine powder which was passed through a 2.34 mm mesh. Plate 1, Plate 2, Plate 3 shows the biochar (wood charcoal) before it was added to the soil samples. The Plate 2 shows a big size of locally burnt wood charcoal, which was later pulverized into smaller size and was made to passed through sieve 125 and 100 micrometer

3. TEST PROCEDURE

In the course of this research work, the work is aimed at knowing the of geotechnical effect of lateritic soil in which the samples were mixed with wood ash in several percentages which are (0%,3%,5%, 10%,15%, and 20%). Whereby the atterberg limit, compaction characteristics and unconfined compressive strength are determined.

Plate 1

Plate 1 Shows the pulverized wood ash

Plate 2

Plate 2 Shows the locally burnt wood

Plate 3

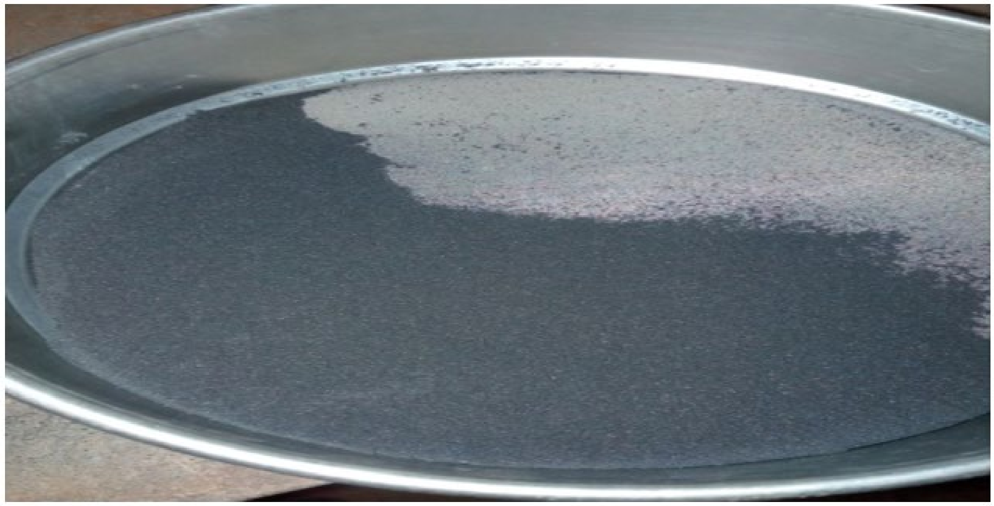

Plate 3 The biochar with the sieve mesh. (125um)

Plate 4

Plate 4 The samples before crushing process

4. RESULT AND DISCUSSIONS

4.1. INDEX PROPERTIES OF SOIL

The index properties of the lateritic soil which include the atterberg limits, liquid limit (LL), plastic limit (PL) and plasticity index (PI) were summarized in Table 1

Table 1

Table 1 Properties of soil sample (lateritic soil	
Natural moisture content	24.7

Plastic limit (%)	12.5
Liquid limit (%)	61
Plasticity index (%)	48.5
UCS(Kg/m3)	91.1
MDD (Kg/m2)	1.24
OMC (%)	19.8
AASHTO Classification	A 7 6
Specific gravity	2.53

4.2. COMPACTION TESTS

Compaction tests were carried out in the lab and whereby proctor mould was used and the result gotten from the test shows that the OMC increases and MDD decreases with the percentage of soil - biochar matrix from.

Table 2

Table 2 The result of Maximum dry density (MDD) and Optimum Moisture Content (OMC)

Percentage	(OMC) Optimum moisture content	(MDD) Maximum dry density.
0%	16.7	1.99
3%	18	1.86
5%	21	1.54
10%	28	1.17
15%	29	1.67
20%	27	1.09

Figure 1

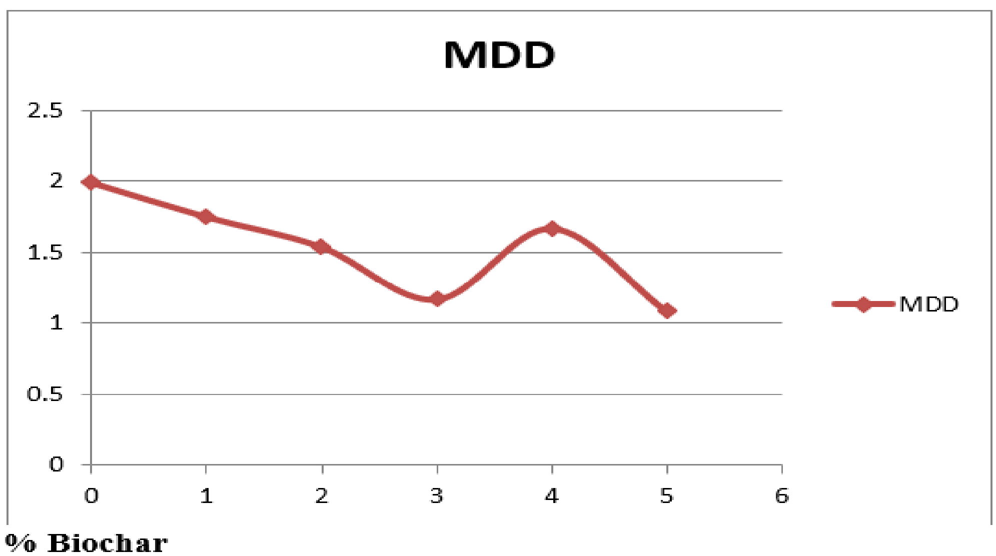

Figure 1 Variation on MDD

Figure 2

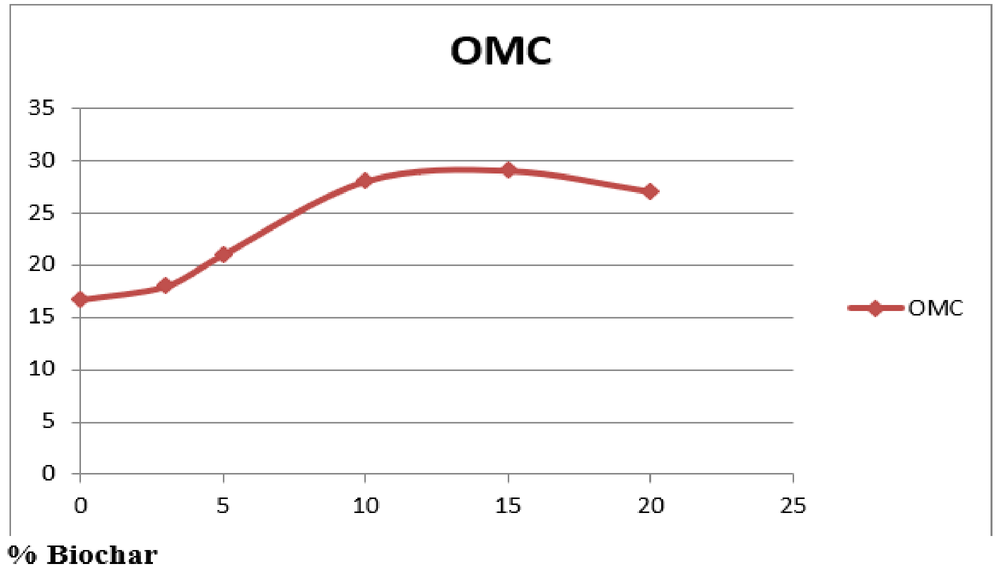

Figure 2 Optimum moisture content graph

The results shows that there was increase in the addition of the biochar percentage in soil biochar mix leads to increase in OMC and MDD got decreased at the process. The addition of the biochar to the soil samples leads to increment in the OMC from one sample to the other except for the last sample which experiences a decrease.

5. ATTERBERG LIMIT TEST

Figure 3

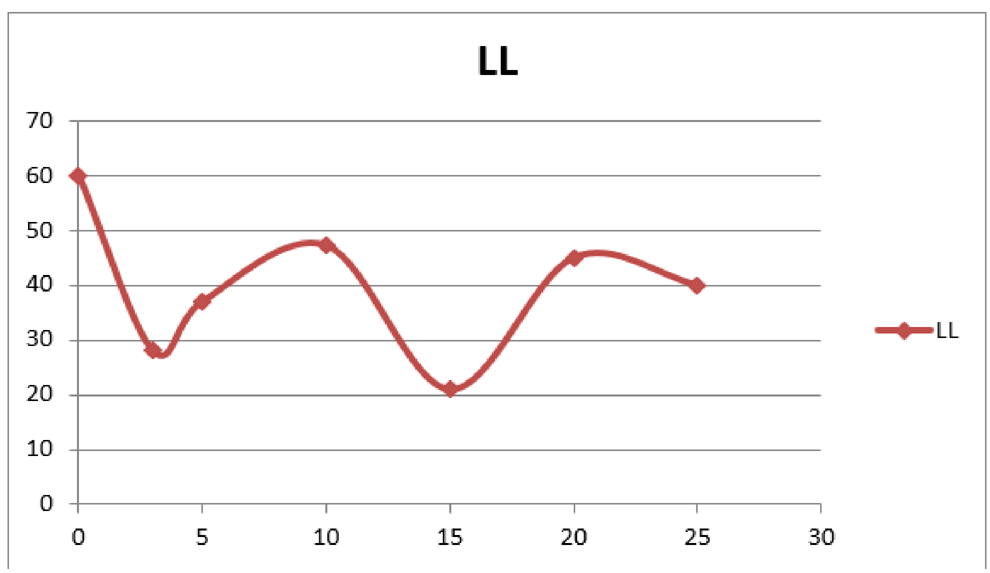

Figure 3 The liquid limit graph

The result of the test shows that the liquid limit of the soil samples from sample 1 to the last sample experience a decrease with the addition of the wood charcoal in the soil sample. If the first sample is compared to the last sample.

Figure 4

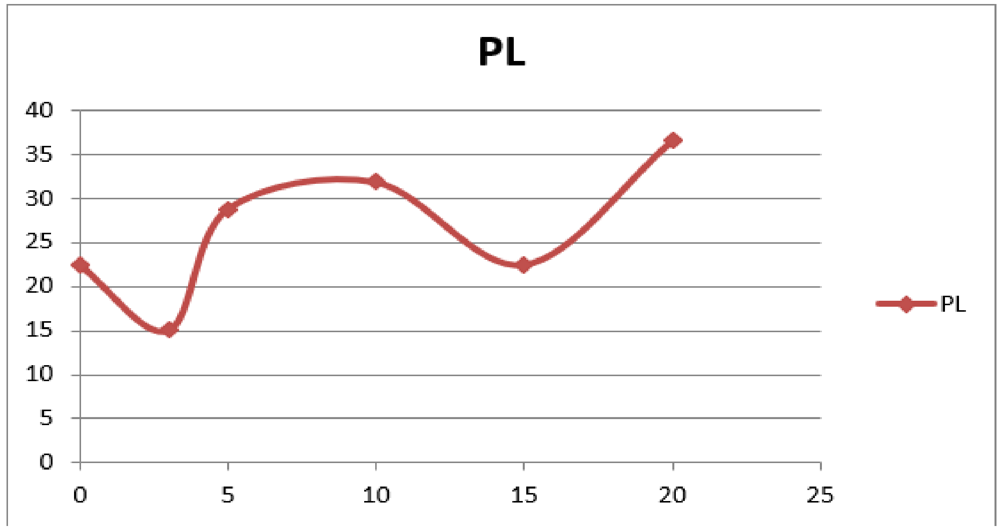

Figure 4 The plastic limit graph

The plastic limit increases with increase in the addition of the biochar to the soil samples. Except for the 3% dosage that is lower to the control sample.

Figure 5

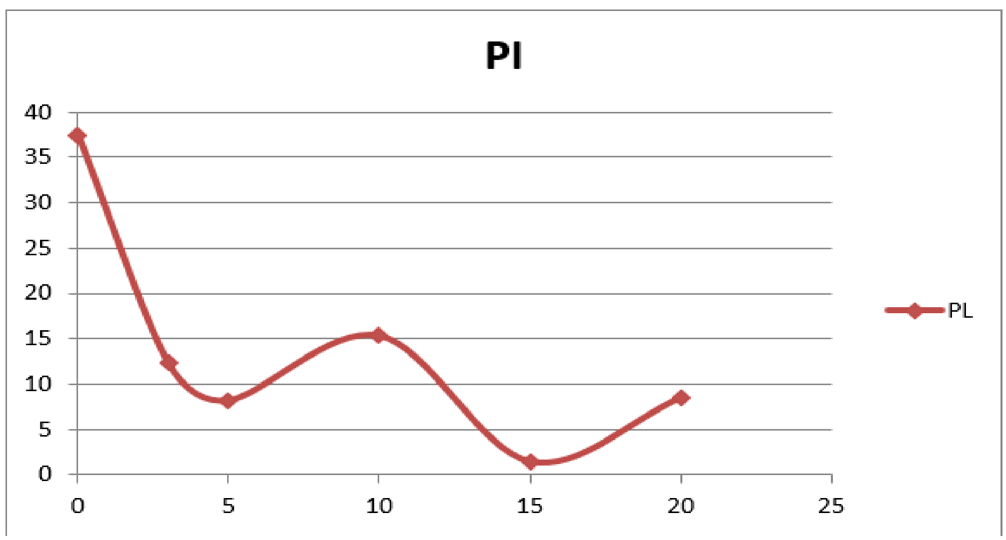

Figure 5 The plasticity index graph

The plasticity index decreases with increase in the addition of the biochar to the soil samples. The sample at 0% has higher plasticity compared to that of the sample at 20%.

Table 3

Table 3 Result of Atterberg limit with different percentages of biochar		
Percentage	**PL (Plastic limit)**	**Liquid limit (LL)**
0	22.5	60
3	15.06	28
5	28.77	37
10	31.84	47.2
15	22.5	21
20	36.5	45

6. EFFECT OF UNCONFINED COMPRESSIVE STRENGTH TEST (UCS) ON SOIL MIXTURES

The soil samples were blended together with the biochar and the compressive strength test were conducted on the samples. It was discovered that compressive strength increases with increase in the addition of the biochar to the soil sample until a decrease was experienced at 10% of the soil biochar mixture. The result(s) of the blended and unblended soil sample(s) were shown in the Table 4 The result were shown below at 0% is at 100kN/m2, at 3%, the UCS is 130.00kN/m2, at 5%, the UCS is 140.00 kN/m2, at 10%, the UCS is 155KN/m2, at 15%, the UCS value is 90kN/m2 and at 20%, 75Kn/m2 respectively. The unconfined compressive strength increased considerably with the addition of BCA (Wood ash), having its peak at 10%. These results further confirmed the stabilizing potentials of BCA (Wood ash) on the lateritic soil if added at the optimum level which is in line with the submission of Bello et al. (2014)

Table 4

Table 4 Results of UCS (Unconfined Compressive strength value)	
Percentage (%)	**UCS (KN/m2)**
0	100
3	130
5	140
10	155
15	90
20	75

Figure 6

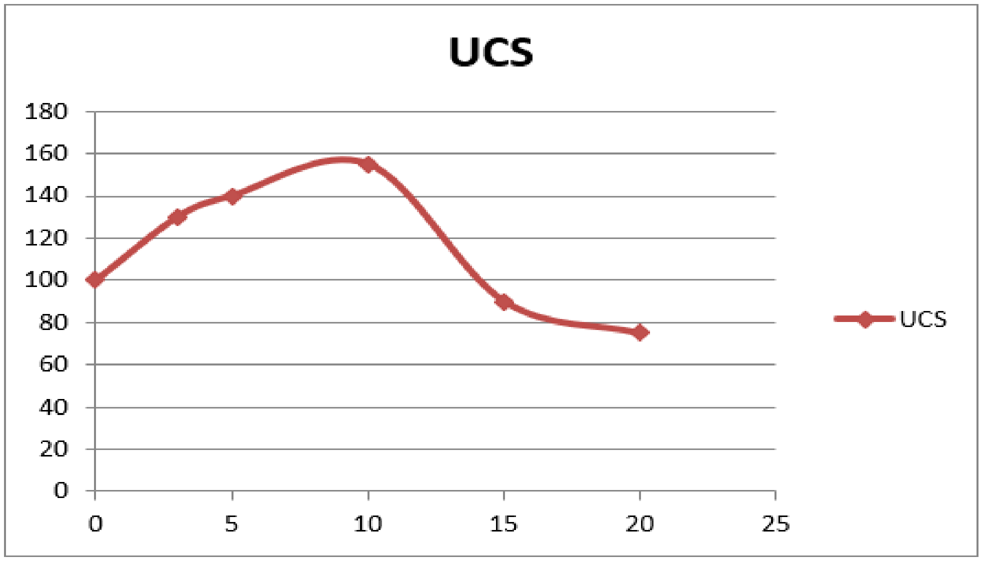

Figure 6 Compressive strength test graph

It was discovered that there was an increase in the strength of soil samples until 10% soil biochar admixture was reached. This shows that the addition of the wood ash have a stabilizing effect on the soil sample.

7. CONCLUSION

Addition of the biochar resulted in water absorption and decrease in pores between clay particles resulting in a decrease in the maximum dry unit weight and in OMC of the soil. The liquid limit decreases and plastic limit increases. The plasticity index decreases. The PI at 0% is 37.5% and at 20% is 8.5 It was discovered that UCS value of the stabilized sample at 10% was at the peak and then reduced. Addition of more of the biochar will lead to the reduction in compressive strength at 20% and 30% more. It was noted in the lab during the test (Atterberg), that there was an increase also in the elastic behaviour of the sample when 10% was of biochar was added. There was an increase in the strength of the soil samples until 10% soil biochar admixture was reached. To achieve a desired result, the 125 micrometer of sieve size (biochar) should be used which can easily serve as stabilizing agent when blended to the soil sample.

CONFLICT OF INTERESTS

None.

ACKNOWLEDGMENTS

None.

REFERENCES

Alhassan, M. and Mustapha, A. M. (2007). Effect of Rice Husk Ash on Cement Stabilized Laterite, Leonardo Electronic Journal of Practices and Technologies, 71(4), 246-250.

Amu OO, Ogunniyi SA, Oladeji OO. (2011). Geotechnical properties of lateritic soil stabilized with sugarcane straw ash. American Journal of Scientific and industrial Research. 2(2), 323-331. https://doi.org/10.5251/ajsir.2011.2.2.323.331

Amu, O. Bamisaye, O. F. Komolafe, I. A. (2011). The Suitability and Lime Stabilization requirement of Some Lateritic Soil Samples as Pavement. Int. Journal of PureApplied Science and Technology. 2(1), 29-46.

Amu, O. O. Adetuberu, A. A. (2010). Characteristics of bamboo leaf ash stabilization on lateritic soil in highway construction. International Journal of Engineering and Technology. 2(4), 212-219.

Amu, O. O. Adetuberu, A. A. (2010). Characteristics of bamboo leaf ash stabilization on lateritic soil in highway construction. International Journal of Engineering and Technology. 2(4), 212-219.

Bello, A. A. Adegoke, C. W. (2013). Geotechnical characterization of abandoned dumpsite soil. ARPN Journal of Earth Sciences, ISSN 2505-403X, Asian Research Publishing Network. 2(3), 90-100.

Bello, A. A. Awogboro, O. S. Oriaje, A. T. (2014). Influence of Compactive Efforts on Lateritic soil stabilized with Rice Hush Ash. International Journal of Applied Engineering. 9(21), 9639-9653.

Bello, A. A. Ige, J. A. Ibitoye, G. I. (2014). Geotechnical properties of lateritic soil stabilized with cement-bamboo leaf ash admixtures.International Journal of Applied Engineering Research. 9(21), 9639- 9653.

Garcia-Perez, M. Lewis, T. and Kruger, C. E. (2010). Methods for Producing Biochar and Advanced Biofuels in Washington State. Part 1 ; Literature Review of Pyrolysis Reactors. First Project Report. Department of Biological Systems Engineering and the Center for Sustaining Agriculture and Natural Resources. 137.

Gupta, S. and Kua, H. W. (2017). Factors Determining the Potential of Biochar As a Carbon Capturing and Sequestering Construction Materials ; Critical Review. Journal of Materials in Civil Engineering, 29(9). https://doi.org/10.1061/(ASCE)MT.1943-5533.0001924

Smrithi, U. B. and Soorya, S. R. (2020). Study of the Geotechnical Properties of Biochar Stabilized Soil, 3(3).