

Comparative Effects of Lime and Banana Leaf Ash on Engineering Property of Soil

E. O. Ayoola, G. O. Adunoye, H. I. Alawiye

Department of Civil Engineering, Obafemi Awolowo University, Ile-Ife, Nigeria

ABSTRACT

This study compared the effects of lime and banana leaf ash (BLA) on engineering property of selected soils. This was with a view to identifying the more effective stabiliser. To achieve the aim of the study, soil samples were collected from two identified locations in Ile-Ife. Using standard procedures, the soils were subjected to preliminary and geotechnical tests such as natural moisture content, particle size analysis, specific gravity, Atterberg limit, compaction and California bearing ratio (CBR). Thereafter, the soil samples were separately treated with lime and BLA at 2 %, 4 % and 6 % by weight of dry soils. The stabilized soils were then subjected to CBR tests. Results of preliminary and index property tests showed that the tested soil samples belong to A-2-7 category, according to American Association of State Highway and Transport Officials (AASHTO) classification system.

The CBR values of natural soils indicate that the soils were good subgrade and subbase materials. For both samples, the CBR values increased with increase in lime content and BLA. However, optimum (maximum) value of CBR was obtained at 4 % BLA content. The highest percentage increase in CBR was obtained at the optimum content (4 %) of BLA. The study concluded that BLA (at 4 %) content resulted in a more significant improvement in the engineering property of tested soils than lime.

KEYWORDS: *Banana leaf ash, California bearing ratio, Engineering property, Lime, Stabisation*

INTRODUCTION

The importance of soil improvement for civil engineering applications cannot be over emphasized. Industrial stabilizing agents such as cement and lime have been used variously in stabilizing soils. In a bid to find and use environment friendly and more economic means of improving soils researchers have made attempts to explore the possibility of using some agricultural and industrial wastes in the stabilization of soils.

Banana leaf ash (BLA) has been used as pozzolanic material in civil engineering structures with advantages such as lower costs and the equivalent reduction in adverse environmental impacts resulting from the accumulations of this type of waste in the field. This has geared researchers towards employing the use of BLA (and some other agricultural wastes) in soil stabilization for road works (Amu *et al*, 2011; Ajala *et al*, 2020; Daramola *et al*, 2021; Adunoye *et al*, 2022; Adunoye *et al*, 2023a; Adunoye *et al*, 2023b; Adunoye *et al*, 2024).

Daramola *et al* (2021) studied the effect of BLA on the geotechnical properties of selected lateritic soils, using fine component of the ash. They observed that addition of BLA improved the properties of the soils, that is, with the addition of BLA, reduction was generally noticed in the values of plasticity index for tested soil samples. The optimum values of California bearing ratio (CBR) were obtained at 4 % BLA for the soils. They concluded that BLA can cause significant improvement in the strength of lateritic soils.

Adunoye *et al* (2023a) undertook a study on the stabilisation of lateritic soil for road construction using coarse component of BLA. They observed that, with the addition of BLA plasticity index generally reduced. Increase in BLA content also led to increase

How to cite this paper: E. O. Ayoola | G. O. Adunoye | H. I. Alawiye "Comparative Effects of Lime and Banana Leaf Ash on Engineering Property of Soil" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-8 | Issue-4, August 2024, pp.433-436, URL: www.ijtsrd.com/papers/ijtsrd67155.pdf



IJTSRD67155

Copyright © 2024 by author (s) and International Journal of Trend in Scientific Research and Development Journal. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0) (<http://creativecommons.org/licenses/by/4.0>)



in the CBR, with the optimum values at 4 % BLA content. They concluded that: BLA could be used to improve the properties of lateritic soils for road construction purpose; and the particle size of BLA used does not diminish the quality of BLA as a soil-stabilising agent.

There is increasing need to compare the effects of industrial stabilizing agents and some agricultural wastes on the engineering properties of soils. This study therefore investigated and compared the effects of lime and BLA on the CBR of selected soils.

MATERIALS AND METHODS

Materials and equipment

The materials used for this study were lateritic soils and lime.

The following equipment and apparatus were used for field and laboratory works: set of British Standard (BS) sieves and mechanical sieve shaker, for dry sieve analysis; specific gravity apparatus; Atterberg limits apparatus; apparatus for standard compaction; California bearing ratio (CBR) machine, for CBR experiment.

Soil sampling and preparation

Soil samples were collected from two different borrow pits in Ile-Ife, Osun state. The sampling locations were New Market in Obafemi Awolowo University (OAU) campus (7°31'07"N, 4°30'45"E) and Obbafemi Awolowo University Teaching Hospitals Complex (OAUTHC) link road (7°30'53.0", N 4°33'10.4" E). Using disturbed sampling method, soil samples were collected with the aid of hand auger. About 25 kg of each sample was collected in water-proof sacks (which were properly sealed) and immediately transported to the Geotechnical Engineering laboratory of the

Department of Civil Engineering, OAU, Ile-Ife. Representative samples were taken for natural moisture content determination before air-drying the remaining soils for subsequent laboratory analyses.

Preparation of banana leaf ash (BLA)

The banana leaves used were of the plantain specie, scientifically known as *musa paradisiacal*. The leaves were obtained from a plantain farm in Ile-Ife; they were thoroughly cleansed by washing with water before air-drying in the Laboratory. Subsequently, the dried banana leaves were taken to the furnace at the Department of Materials Science and Engineering, OAU, Ile-Ife to burn to ashes at 700°C. The ash was then sieved through BS sieve 75 µm to get the very fine ash to be used for the stabilisation. The fine ash was kept in air-tight container and taken to the Laboratory. for soil stabilisation.

Preliminary and geotechnical tests on soils in their natural state

The following preliminary and geotechnical tests were conducted on the soil samples in their natural state, following standard procedure as outlined in BS 1377 (1990): specific gravity, particle size analysis, Atterberg limits, compaction, and unsoaked CBR.

Geotechnical tests on soils treated with lime

The soil samples were treated with 2 %, 4 % and 6 % (by weight of dry soils) of lim. The following geotechnical tests were then conducted on the stabilized soils, to determine the effect of lime on the tested soils: compaction and unsoaked CBR.

Geotechnical tests on soils treated with BLA

The natural soils were treated with BLA in 2 %, 4 % and 6 % proportions by weight of dry soils. The stabilised soils were then subjected to compaction and unsoaked CBR. tests.

RESULTS AND DISCUSSION

Results of preliminary and geotechnical tests on soils in their natural state

The results of preliminary and classification tests on the natural soils are presented in Table 1. The results showed that the two soil samples belonged to A-2-7 group, using American Association of State Highway and Transport Officials (AASHTO) classification system.

Table 1: Results of preliminary and classification tests on natural soils

Properties	OAUTHC sample	New Market sample
Natural Moisture Content (%)	22.67	14.32
Specific Gravity	2.68	2.77
Liquid Limit (%)	48.45	45
Plastic Limit (%)	41.24	28.01
Plasticity index (%)	7.21	16.99
Percentage passing sieve No. 200 (fines)	1.60	1.40
Percentage passing sieve No. 40	13.60	7.4
AASHTO Classification	A-2-7	A-2-7

Results of compaction and CBR tests on natural soils

The results of compaction and CBR tests on the natural soils are presented in Table 2. The values of the OMC indicate highly plastic clayey soils (Das, 2006). The results of CBR indicate that the soils could be described as good sub grade and sub base materials, for OAUTHC sample and New Market sample, respectively.

Table 2: Results of compaction and CBR tests

Property	OAUTHC Sample	New Market Sample
OMC (%)	16.67	15.25
MDD (kg/m ³)	1654.05	1840.7
CBR (kN/m ²)	20.02	30.97

Effect of lime on CBR of the soils

The results of variations in CBR values with the various proportions of lime is shown in Figure 1. As observed, the values of CBR increased with increase in lime, meaning that the presence of lime led to improvement in the engineering property (CBR) of the soils. For the first sample (OAUTHC), the CBR increased by over 170 %; and for the second sample (NEW MARKET), the CBR increased by over 70 %, at maximum lime content of 6 %.

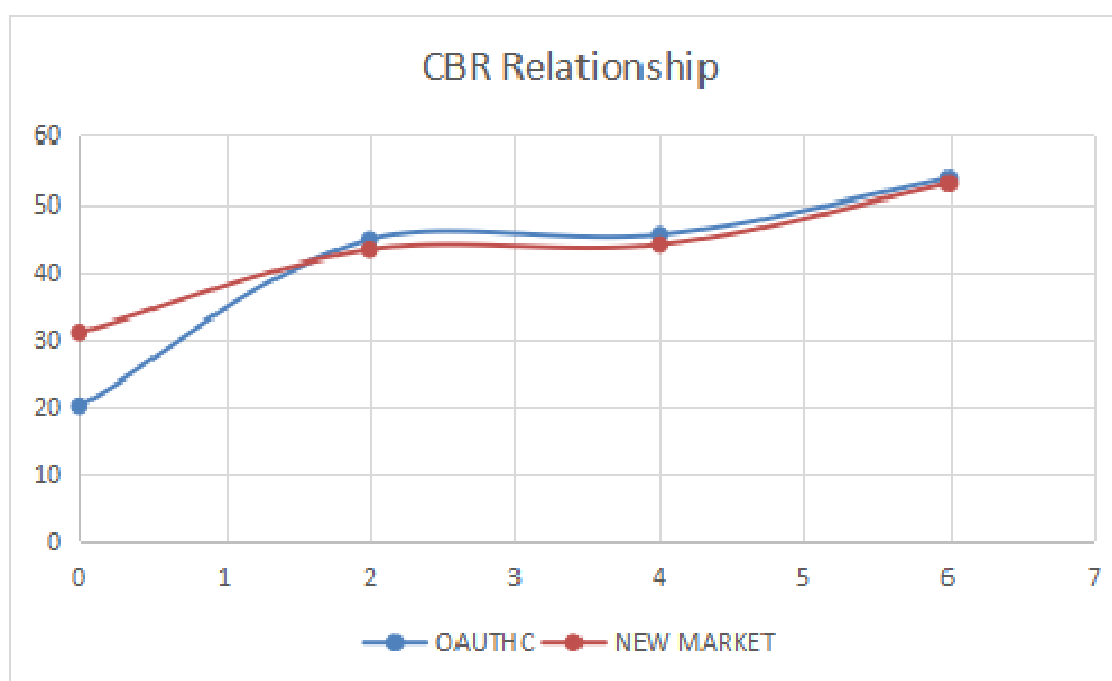


Figure 1: Variation of CBR with lime content (Lime)

Effect of BLA on CBR of the soils

Figure 2 shows the variation of CBR with the addition of BLA proportions to the soils. For both samples, the optimum CBR values were obtained at 4 % BLA content. The increment in the CBR values after the addition of 2 % BLA could be attributed to the gradual formation of cementitious compound between the Silica Oxide of BLA and Calcium Hydroxide ($\text{Ca}(\text{OH})_2$) present in the soils. For the first sample (OAUTHC), the CBR increased by over 190 %; and for the second sample (NEW MARKET), the CBR increased by over 90 %, at optimum BLA content of 4 %. This indicates that BLA proved to be more effective in improving the engineering property (CBR) of the soils,

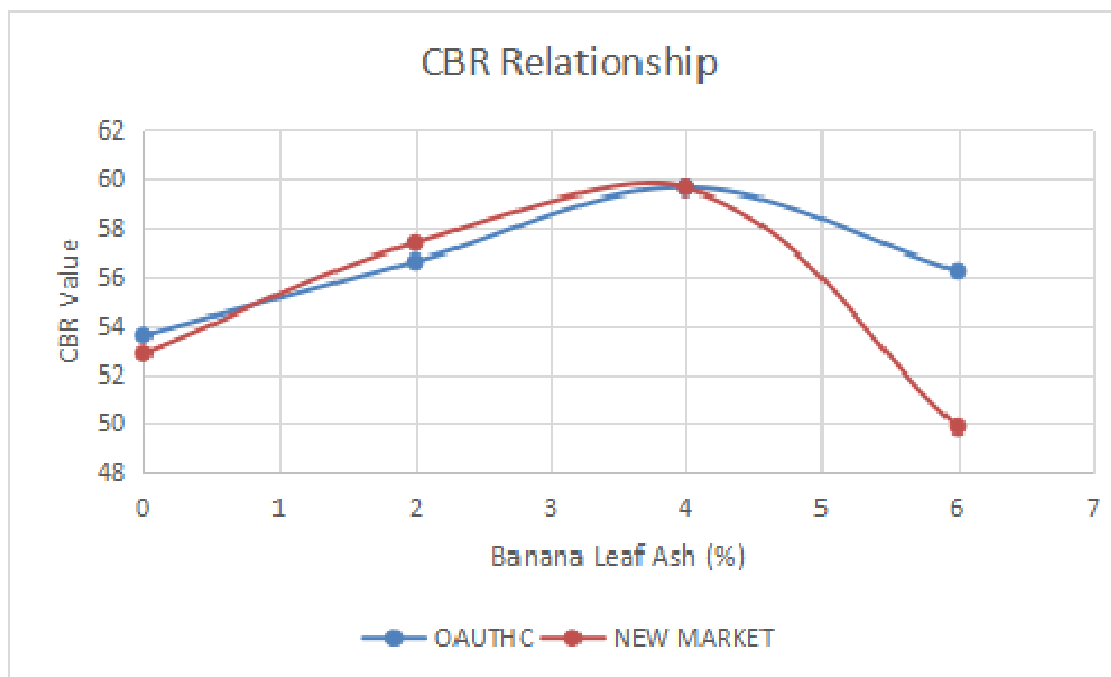


Figure 2:1 Variation of CBR with BLA content

CONCLUSION

Effects of lime and banana leaf ash on engineering property of selected soils have been studied and compared. The natural soils were found to be good subgrade and sub base materials. For the tested soil samples, it was observed that: the CBR values increased with increase in both lime and BLA content; optimum values of CBR were obtained at 4 % BLA; the percentage increase (improvement) in CBR was highest at the optimum content (4 %) BLA.

REFERENCES

- [1] Adunoye, G. O., Osineye, T. O. and Ezeh, H. C. (2022). Investigation of Properties of Soils Stabilised with Groundnut Waste, *International Journal of Physical Research*, 10(1): 33-38.
- [2] Adunoye, G. O., Akanbi, O. T., Oyeniyi, O. M. and Ogunbaku, O. D. (2023a). Stabilisation of Lateritic Soil for Road Construction using Banana Leaf Ash, *International Journal of Civil Engineering, Construction and Estate Management*, 11(1): 14-22.
- [3] Adunoye, G. O., Akanbi, O. T., Odusina, G. H and Faloye, A. S. (2023b). Engineering Characteristics of Soils Reinforced with Shredded Plastic Waste. *International Journal of Mechanical and Civil Engineering*, 6(1), 17-25.
- [4] Adunoye, G. O., Oyelere, A. O., Oladepo, M. T. (2024). Investigation of Soils and Bearing Capacity in Selected Construction Sites. *Archives of Current Research International*, 24(5), 416-426. Germany
- [5] Ajala, M. O., Akinyede, K. J., Adunoye, G. O. and Akintola, I. J., (2020). A Study on the Effects of Groundnut Shell Ash on Strength Characteristics of Soil, *International Journal of Advanced Geosciences*, 8(1): 41 – 46. UAE
- [6] Amu, O.O., Ogunniyi, S.A. and Oladeji, O.O. (2011). Geotechnical properties of lateritic soil stabilized with sugarcane straw ash. *American Journal of Scientific and Industrial Research*. 2(1), 323-331
- [7] British Standard 1377 (1990). *Methods of Test for Soils for Civil Engineering Properties*. British Standard Institution, London.
- [8] Daramola, T. S., Olaniregun, E. O. and Adunoye, G.O., (2021). Experimental Study on the Geotechnical Properties of Soils Treated with Banana Leaf Ash, *New York Science Journal*, 14(1): 32-37.