COMPARATIVE EVALUATION OF THE GEOTECHNIC PROPERTIES OF ANTHILL AND LATERITE SOIL FOR CONSTRUCTION WORK

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Abstract

Goal 9 of the SDGs, which emphasizes the development of quality, reliable, sustainable, and resilient infrastructure, can be used by engineering professionals. One such endeavor is to rid the environment of anthill soils and use them for engineering purposes. Lateritic soils have been discovered to be useful in engineering works, and replacing them entirely or partially with anthill soil will be an exciting innovation in the pursuit of economically and resilient infrastructure. The purpose of this paper is to evaluate the geotechnical properties of anthill and laterite soil for construction purposes. Lateritic and anthill soil samples were collected and tested using Sieve Analysis Tests, Atterberg Limit Tests, Compaction Tests, and the California Bearing Ratio Test. Laterite has a maximum dry density of 27.5kN/m3 and a CBR value of 52.91 percent. This is greater than 30% minimum suitable for a road pavement sub-base, whereas the anthills ranges fall within maximum dry density of 15.5kN/m3 and CBR value of 41.80%, respectively. The investigation revealed that the higher the clay content, the lower the values of both the C.B.R and M.D.D, indicating that anthill soil compared favorably with laterite and is suitable for various embankment formation such as footpath, lawn tennis court, ramp, sub-base and base course in road construction work due to their C.B.R values. Because of its clay content, anthill soil can also be used as a water retaining reservoir.

Keywords: Anthill, Geotechnical, Infrastructure, Lateritic, Sustainable

Introduction

It is essential for construction works to be sustainable and these can only be possible by aligning with the Sustainable Development Goals, collections of 17 interlinked global goals designed to be a "blueprint to achieve a better and more sustainable future for all". The SDGs were set up in 2015 by the United Nations General Assembly and are intended to be achieved by 2030. Engineering professionals can use goal 9 of the SDGs which emphasize on Development of quality, reliable, sustainable and resilient infrastructure. One of such endeavors is to rid the environment of the nuisance of anthill soils and use same for engineering purposes. Lateritic soils have been found to be usefulness to engineering works and the replacement of such wholly or partially with anthill soil will be an exciting innovation in quest for economic and resilient infrastructure

Climate, relief (elevation, orientation, and slope of the terrain), biotic activity (organisms), and parent materials (initial minerals) acting over time all have an impact on soil (Gilluly, Waters, Woodford,1975). Numerous physical, chemical, and biological processes, such as weathering and the ensuing erosion, constantly create soil. The functions of soil include engineering, habitat for soil creatures, and nutrient and organic waste recycling. Physical weathering (disintegrating), chemical weathering (decomposition), and chemical transformation are all examples of how parent material weathers. The formation of laterites is the result of extensive and protracted tropical rock weathering, which is accelerated by heavy precipitation and high temperatures.

Due to its low energy consumption and widespread use in construction projects, laterite is regarded as a sustainable building material in many sectors of civil and building construction projects. Dams, airport runways, township roads, intercity link roads, highway roads, and rural feeder roads have all been built using laterite. A material that is economically advantageous, simple to deal with, often abundant, and inexpensive is laterite.

The majority of the genetic diversity on earth is found in soil since it has such a wide variety of niches and environments that are available. Millions of different species of organisms can be found in a small amount of soil. Anthills are a typical natural resource that can be found in many localities. Some are feared, though, because they are home to weird species like ants, snakes, and other deadly ones. Worker ants create anthills as a byproduct of

constructing covert tunnel systems. These worker ants, which belong to the Macrotermes genus and are also known as termites, play a significant role in soil formation by promoting soil turnover and establishing small pockets of better-aerated soils that are more fruitful (Olowofoyeku et al, 2016). These termites create anthills that are extremely durable and resistant to weathering and erosion (Adeyemi & Salami, 2004). Engineers are interested in the engineering value of anthills since it is necessary to remove their habitats due to the environmental annoyances they are producing. Anthills are made of various types of soil (Adegbesan O.O, Ayegbusi O.A. and Omisande L.A 2020).

With the hope that they might be able to replace laterite for construction purposes due to their ability to withstand prolonged adverse weather, it was necessary to determine their characteristics and compare them to laterite. This claim will be supported by the findings of the various tests conducted on the two samples, lateritic and anthill soils.

By gathering anthill soils from three LGAs in Ogun State, Adegbesan O.O, Ayegbusi O.A, and Omisande L.A. (2020) studied the geotechnical features of anthill soil. The Atterberg limits data showed that the soil around the anthills and the anthills themselves was primarily intermediately plastic, with an OMC (optimum moisture content) range of 7.14 to 18.60 percent and an MDD (maximum dry density) range of 1.054 to 2.40 Mg/m3. The geotechnical assessment of anthill soils was the subject of investigations conducted by Andre-Obayanju, O., and Imarhiagbe, O. J. in 2019. In order to determine the characteristics of the soils, samples of anthill soil from several locations in the state of Edo were gathered and submitted to various geotechnical tests, including the Atterberg, compaction, CBR, and particle size tests. The soils' homogeneity coefficient and coefficient of curvature showed that they make excellent subgrade materials for constructing roads. Using a standard soil analysis procedure, Eneji, I. S., Sha'Ato, & Ejembi, S. E. studied variations in the properties of termitaria and the soil properties around them in 2015, the texture (clay content), pH level, AP, and TN within the mound and in the surroundings were all clearly different, according to their findings. Different varieties of clay were subjected to particle size analysis by Aluvihara, S., and Kalpage, C. S. in 2020. They gathered samples of anthill clay, brick clay, and roof tile clay from various parts of Sri Lanka. Every sample that was obtained was dried in an oven at 1100C for around 24 hours until the mass became consistent. Results for the moisture contents were found for anthill clay at 15.49 percent, brick clay at 21.45 percent, and roof tile clay at 25.97 percent.

2.0 Methodology

Sample Collection

Samples of lateritic soil and anthill soil were collected and subjected to various tests. The sample of laterite was collected from the Ajegunle borrow pit along Papalanto- Ilaro Road. The samples of Anthill soil were collected from different locations which are all within Yewa South Local Government Area of Ogun State. They are as listed below:

i. Egbado college site

ii. Ibeshe site I close to Dangote factory

iii. Site along Papalanto road (By Deeper life Church camp ground).

iv. Federal polytechnic, Ilaro West Campus (By Engineering high rise building).

After the samples collected were brought to the laboratory and spread out in order to air dry them.

Experiments carried out on the soil sample included:

i. Sieve Analysis Tests

ii. Atterberg Limit Tests

iii. Compaction Test in accordance with BS 1377-2: 2022

iv. California Bearing Ratio Test in accordance with BS 1377-2: 2022

Sieve Analysis

The proportion by weights of the particles within the various size ranges are calculated during the particles sieve examination of a soil. In order to properly describe, classify, and name the soil in accordance with standards like the unified, AASHTO, and British soil classification systems, it is necessary to calculate the proportion by weight of particles falling within the various size categories.

Atterberg Limit Test

The Atterberg limit test can be used to measure the plasticity of fine-grained soil. The liquid limit (LL), plastic limit (PL), and shrinkage limit are the three components of the Atterberg limit test, respectively.

The maximum and lower limits of the range of water content across which a soil exhibits plastic behavior are known as the liquid limit and plastic limit, respectively.

It is worth noting that P.L. > 35 (low plasticity) P.L between 35 and 50 (moderate plasticity) P.L. > 50 (high plasticity)

Shrinkage Limit Test

In order to determine the moisture content stated in percentage at which volume change ends and to obtain a quantitative indication of the amount of potential volume change, the test was conducted in line with British standards.

Compaction Test

Compaction is the process of densifying soil by squeezing soil particles closer together while reducing the amount of air present. The densities obtained during compaction are always stated as dry densities, often in mg/m3, though occasionally kg/m3 is used. The optimal moisture content is the level of moisture at which a given quantity of compaction results in the highest dry density. To ascertain the ideal moisture content (O.M.C.) and maximum dry density (M.D.D.) of the soil sample, a compaction test was performed.

California Bearing Ratio (C.B.R) Test

Bearing Ratio of California (C.B.R) A soil's California Bearing Ratio (C.B.R.) indicates how resistant it is to being penetrated by a conventional plunger. It aids in determining whether a soil is suitable for use as sub-grade, sub-base, and base materials.

3.0 Results and Discussion

Sieve Analysis

Table 1

SITE		SOIL SAMPLE	D10	D30	D60	CU	CC	CLAY CONTENT	CLASS
1	EGBADO	ANTHILL	0.18	0.28	0.47	2.61	0.93	26	SP/SC
	COLLEGE	LATERITE	0.16	0.28	0.38	2.38	1.29	23.5	WG
2	IBESHE	ANTHILL	0.15	0.24	0.44	2.93	0.87	47.5	SP/SC
		LATERITE	0.17	0.25	0.34	2.00	1.08	22.6	WG
3	FPI	ANTHILL	0.19	0.29	0.35	1.84	1.27	35.4	WG/SC
		LATERITE	O.21	0.29	0.49	2.33	0.82	25	SP
4	ALONG	ANTHILL	0.18	0.31	0.48	2.67	1.11	57.5	WG/SM
	PAPALANTO ROAD	LATERITE	0.19	0.29	0.54	2.84	0.82	30.9	SP
	CONTROL	LATERITE	1.00	0.62	0.50	4.50	1.53	16.4	WG

The unified soil classification system classifies the Egbado anthill soil, which has more than 50% of grain that is greater than 200mm US sieve sieve or 63 am BS or 0.075mm BS, as clayey SC sand because C_u<6 and P.I>7as shown in the graph, while its laterite sample, which has more than 50% of coarse grain, has 23.5 percent of clay based on the sieve analysis carried out, has 23.5 percent of clay. According to the unified soil classification system, it is categorized as silty sand because C_u<6 and P.I>7

The anthill soil at Ibese was found to contain 47.5 percent clay according to the sieve analysis, which had more than 50% of coarse fraction of sand size with C_u<6 and P.I>7. As a result, it was categorized as clayey sand (SC) according to the unified soil classification system, whereas its laterite contained 22.6 percent clay according to the sieve analysis, which had more than 50% of coarse fraction of sand size with C_u<6 and P.I>7. In accordance with the unified soil classification, it is categorized as silty sand.

Due to the fact that the anthill soil at Federal Polytechnic Ilaro contained 35.4 percent clay based on the sieve analysis performed, which has more than 50% of coarse fraction of sand size, and that its lateritic soil contained 25.0 percent clay based on the sieve analysis performed, which has more than 50% of coarse fraction of sand size, the unified soil classification for these two types of soil is clayey sand. Both have a C_u<6 and P.I>7.

According to the sieve analysis performed, which has more than 50% of coarse fraction of sand size with C_u<6 and P.I>4, the anthill soil obtained along the Papalanto road contained 57.5 percent clay and is categorized as silty (SM) sand according to the unified soil classification system. In contrast, the lateritic soil contained 30.9 percent clay and has more than 50% of coarse fraction of sand size with C_u<6 and P.I>7. According to the unified soil classification, it is categorized as clayey sand.

Atterberg Limits, Compaction and CBR Test

Table 2

	SOIL	SL %	LL	PL	PI	M.D.D kN/M^3 Mg/M^3	O.M.C (%)	CBR VALUE (%)	Remark
EGBADO	ANTHILL	7.36	29	20.81	8.19	18.8	14.40	40.77	GOOD FOR BASE/SUB-BASE
	LATERITE	8.62	20	14.49	5.51	19.60	11.87	36.51	
IBESHE	ANTHILL	12	39.5	30.16	9.34	19.8	14.7	24.18	GOOD FOR BASE/SUB-BASE
	LATERITE	9.26	19.0	15.40	3.96	17.20	9.81	33.33	
FPI	ANTHILL	7	27.1	18.87	18.4	24.4	7.00	34	GOOD FOR BASE/SUB-BASE
	LATERITE	4.76	34.2	31.35	2.85	19.9	10.40	41.80	
ALONG PAPALANTO	ANTHILL	14	44.2	33.5	10.7	15.2	12.8	19.67	FAIR FOR SUB-BASE
	LATERITE	7.99	33	9.47	23.26	20.8	1.10	32.39	
CONTROL	LATERITE	6	20	10.51	9.49	27.5	10.4	52.91	EXCELLENT FOR BASE

Maximum dry density and CBR for laterite are 27.5 kN/m3 and 52.91 percent, respectively. This is more than the required minimum of 30 percent for a road pavement's sub-base. Maximum dry density and CBR values for the Egbado anthill are 18.8 kN/m3 and 40.77 percent, respectively. This has a CBR value of 36.51 percent and a maximum dry density of 19.60 KN/m3, making it more than 30 percent suitable for the sub-base of a road surface.

The maximum dry density of the Ibeshe anthill is 19.80 kN/m3, and its CBR value is 24.18 percent, whereas the maximum dry density of the laterite sample is 17.20 kN/m3, and its CBR value is 33.33 percent. This exceeds the minimum threshold of 30.5 needed for a road sub-base.

The maximum dry density and CBR value of the anthill located within the grounds of Federal Polytechnic Ilaro are 24.0kN/m3 and 34%, respectively. The laterite recovered nearby also has a maximum dry density of 19.9 KN/m3 and a CBR value of 41.80 percent, above the minimum necessary for road sub-base.

The anthill soil sample got along Papalanto road by Deeper Life Church Camp ground has a maximum dry density of 15.5kN/m^3 and CBR value 19.67% respectively while laterite collected within the same axis too has a maximum dry density of 20.8KN/m3 and CBR value of 32.39%.

4.0 Conclusion

According to the investigation, anthill soil compared favorably to laterite and is suitable for various embankment formation, such as footpaths, lawn tennis courts, ramps, sub-base and base course in road construction work because of their C.B.R values. This is because the higher the clay content, the lower the values of both the C.B.R and M.D.D. Additionally, because anthill soil contains clay, it can be used to serve as a water reservoir.

5.0 References

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