Investigation of the Index Properties of Lateritic Soil Reworked By Termite for Road Construction

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Abstract - **The determination of the influence of activities of termites on the index properties of termite reworked soils and non-reworked surrounding soils from Ado-Ekiti, Southwestern Nigeria was carried out. Two termite hills from two locations were chosen. Twenty bulk representative soil samples depicting twelve Termite Reworked soils and eight Non-Reworked surrounding lateritic soils samples were collected. Some index parameters such as specific gravity, grain size distribution, consistency limits and linear shrinkage of the soils were determined. The results of these tests showed that the specific gravity of grain of the termite reworked soils are higher than those of the surrounding soils. However, the plasticity indices and linear shrinkage of the termite reworked soils were significantly lower than those of the surrounding soils, while the linear shrinkage test showed that linear shrinkage values are generally lower for the termite reworked soils than that of surrounding soils. All the index tests carried out favoured termite reworked soils as a better engineering soil than the surrounding lateritic soils. Findings from this work indicate that reworking by termites has improved the index properties of the studied termite reworked soils.**

Keywords: **Investigation, Index, Termite, Laterite, Road**

INTRODUCTION

Lateritic soils abound in virtually all parts of the tropical world. They find wide applications not only as foundations for structures but more importantly as construction materials. Although, lateritic soils possess geotechnical, mineralogical and physical characteristics that make them fair to good engineering soils (Ola, 1980), their properties may need to be improved upon. In some cases, soil stabilization, as the process of improvement is called, has over the years gained wide popularity among users of soils.

Quite unknown to many people, however, some social insects and burrowing animals do modify the structure and hence some index properties of soils. Earthworm, for instance, rework alluvial deposits and make them at times more porous and permeable while termites (social insects) rework soils and make them appear stronger. Termitaria, which are edifices built by tropical termites abound in virtually all parts of the tropics.

Construction of termite moulds involves excavation of the soil and mass shifting of the excavated soils to the surface. The soils (mostly of clay and silt size fraction) are then mixed with saliva and faecal materials from the termites and at times some other debris are added to form a tough material referred to as 'carton' with variable compositions (Mando et al, 2000). A termitarium, which, may be up to 7m high, may weigh up to two and a half tons (Atkins 1980). The termitaria which are huge mounds built by these termites allow them to have a great degree of control over the temperature and humidity of the environment in which they live.

Generally, several soils in the tropics in particular are being reworked by the activities of these termites. The determination of the effect of reworking by termites on the index properties of the soil is a major objective of this research.

Materials And Methods

The termite reworked soils and non reworked soil samples used for this study were collected from two different locations in Ado-Ekiti, Nigeria. Twenty samples were taken altogether from two different locations that is, ten samples from each location. In each location, two samples were taken from the upper part of the termitarium after the outer surface has been scrapped off with cutlass, then another two samples were taken from where the queen of the termites was found after the termitarium has been broken and two samples were taken from the bottom of the termitarium. Four different samples were taken from the surrounding of the termitarium and this was done by measuring 4m (four meters) away from the 4-cardinal points of the termitarium (i.e. 4m away from the East, West, North and South of the termitarium). The same process was repeated in the second location.

The samples of soils collected were air dried for several weeks before tested in accordance with BS1377 standards and AASHTO specification.

The tests that were carried out on these soil samples include: specific gravity, grain size distribution, consistency limits and linear shrinkage.

RESULTS AND DISCUSSION

Specify Gravity

This is an important index property of soil that is closely linked with mineralogy/chemical composition. It shows the sesquioxide content and hence the extent of laterisation (Lohnes and Demirel, 1973). The mean specific gravity values of the soils are shown in Table 1.

The table shows that specific gravity value is 2.71 for the surrounding soil in location 1, while the value ranges between 2.76 and 3.02 in the termite reworked soils from the same location. From location 2, the value is between 2.79 and 3.00 for termite reworked soils while the value is 2.75 in the surrounding soil. This result indicates that termite reworked soils from both locations have higher specific gravity than the surrounding soils, thus the termite reworked soils have a higher degree of laterization.

Table 1: Result of Specific Gravity Test

Sample	Location 1	Location 2
Top of Termitarium	2.76	2.79
Queen Surrounding	3.02	3.00
Bottom Termitarium	2.83	2.81
Surrounding Soil	2.71	2.75

Grain Size Distribution

The mean percentage grain size distributions of the studied soils are shown in table2.

From the table, it can be observed that all the soil samples are fairly graded. From location 1, the percentage of sand in the termite-reworked soil is between 29% and 40% but in the surrounding soil from the same location, the percentage of sand is 23%. From the same location, it is observed that the percentage fines is between 41% and 67% in the termite reworked soils while it is 73% in the surrounding soils.

However, silts and clay fractions are lower in the termite reworked soils than the surrounding soils.

The same trend can be observed for both soils samples in location 2.

Table 2: The Result of grain size distribution of the studied soils in percentages

Sample	Location 1					Location 2				
	Gravel	Sand	Silt	Clay	Fines	Gravel	Sand	Silt	Clay	Fines
Top of Termitarium	4	29	18	42	67	12	60	5	23	28
Queen surrounding	8	34	15	44	63	5	58	9	28	37
Bottom of Termitarium	5	40	15	31	41	5	67	8	22	30
surrounding Soil	3	23	25	51	73	3	46	21	41	51

Consistency Limits

This is an important factor in the selection of laterite both as sub-grade and sub-base material. The summary of the consistency limits and plasticity index of the studied soils are presented in Table 3.

From the table, both the liquid limit and plastic limit of the soils from both locations are relatively high. The plasticity index (P.1), which is the difference between the liquid limit and plastic limit is seen to be lower for termite reworked soils (8.0 to 13.3) in location 1, while it is higher for the surrounding soils (23.6) in the same location. It is between 8.0 and 10.0 for termite reworked soils in location 2 and 13.5 for surrounding soils in the same location.

Table 3: Mean values of Consistency Limits of the studied soils

Sample	Location 1			Location 2		
	L.L	**P.L**	**P.I**	**L.L**	**P.L**	**P.I**
Top of Termitarium	32.5	24.5	8.0	28.0	20.0	8.0
Queen Surrounding	40.0	30.0	10.0	32.0	21.3	10.7
Bottom of Termitarium	34.5	21.2	13.3	32.0	22.0	10.0
Surrounding Soil	38.0	13.4	24.6	30.0	16.5	13.5

Linear Shrinkage

Linear shrinkage is a parameter used in the evaluation of soils as highway sub-base material. Gidigasu (2000), suggested that any soil with linear shrinkage below 10% would not pose a field compaction problem. Madedor (1983), also suggested that a linear shrinkage below 8% ($\leq$ 8%) indicates a soil that is good as a sub-base material. Table 4 shows the summary of the linear shrinkage values of the studied soils.

The linear shrinkage is generally high for all the samples in both locations but those of the termite reworked soils are lower than those of the surrounding soil. The termite reworked soils are better road construction materials compared with the surrounding soils.

Table 4: Linear Shrinkage Values of the Studied Soils

Sample	Location 1	Location 2
Top of Termitarium	8.8	9.8
Queen Surrounding	7.6	7.9
Bottom of Termitarium	9.5	9.8
Surrounding Soil	13.6	11.4

CONCLUSION

The results of index properties of lateritic soils reworked by termite and the surrounding lateritic soils have confirmed the following:

The specific gravity of grains of termite reworked soils are significantly higher than those of the surrounding soils. The result of grain size distribution characteristic showed that all the studied soils are fairly graded. The influence of reworking by termites on the grain size distribution of the studied soils is that the amount of coarse (% coarse) of termite reworked soils are higher than that of the surrounding soils. Generally, all the studied soils have high amount of fines.

The liquid limits and plastic limits of the studied soils are generally high in both locations. Termite reworked soils from location 2 have lower plasticity indices (P.I) than those from location one. Generally, the plasticity indices of the surrounding soils are higher than that of the termite reworked soils. This fact makes termite reworked soils better engineering soils.

The linear shrinkage of termite reworked soils are also significantly lower than those of the surrounding soils.

It can therefore be inferred from all the parameters studied that the index properties of termite reworked soils were improved upon by termite activities.

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