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Characterisation Of Lateritic Soils In Ede As Foundation Material For Road Construction

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***Abstract*—This study investigated selected soils in Ede area, Osun state, southwestern Nigeria, wlth a view to assessing their suitability for subgrade, sub base course and base course in road construction. To achieve the aim of the study, soil samples were collected from selected borrow pits within the study area. Preliminary and geotechnical tests were conducted on the selected soil samples, using standard procedure. Results showed that: percentage passing No 200-sieve ranged between 1 and 4;the specific gravity values ranged from 2.52 to 2.80; the liquid limit, plastic limit and plasticity index ranged from 25.98 % to 47.57 %, 10.93 % to 27.20 % and 3.52 % to 20.96 % respectively; the soils belonged to A-2-4 and A-2-7 groups, using American Association of State Highway and Transportation Offficials (AASHTO); the optimum moisture content and maximum dry density ranged from 15 % to 24 % and 1.45 kg/m^3 to1.99 kg/m^3 respectively; unsoaked California bearing ratio (CBR) values ranged between 5.26 % and 41.33 %. The study concluded that soils from the selected locations are suitable for subgrade/fill and sub-base course in road construction.**

Keywords—Foundation, Road construction, Soil, Sub-base, Subgrade

INTRODUCTION

Lateritic soils have wider applications in the Nigerian construction industry, especially in road construction projects where they are utilised as fill materials and flexible pavement foundation. Their usage as foundation materials is mainly because they are easy to manipulate on road surface and have natural stable grading with a suitable proportion to act as binders. (Nwankwoala *et al.,* 2014). The relative abundance and ease of acquisition of lateritic soil in Nigeria has made its application as foundation soil common in engineering construction works especially roadways. The construction of foundations of most engineering structurs requires that adequate information about the engineering properties of the soil and sub-soil condition of the area are known (Habeeb *et al*., 2012).

One of the major causes of road accident is bad road which is usually caused by wrong application of construction materials, especially laterite, as sub-base and base material by construction companies. (Oke *et al*., 2009). Therefore, investigation of geotechnical properties/parameter of the pr oposed highway construction materials (laterite) is necessary for the engineering planning, design and construction of the foundations.

Researchers and civil engineers have always embarked on the investigation of geotechnical properties of lateritic soils for the purpose of road construction (Abubakar, 2006; Ishola *et al*, 2023). Adunoye *et al* (2018) investigated the geotechnical properties of lateritic soils in parts of Ife Central Local Government Area of Osun state, southwestern Nigeria. They found that the investigated soils were good subgrade/fill material for r.

They found that the tested soil samples were good for fill/subgrade in in road construction.

Materials and equipment

The main material used for this study is lateritic soil. The soil samples were collected from selected borrow pits in Ede Area of Osun state, Southwestern Nigeria. The equipment and apparatus used included those used for moisture content determination, particle size analysis, specific gravity determination, Atterberg limits determination, compaction test and California bearing ratio (CBR) test.

Soil sampling and preparation

Ten lateritic soil samples were collected from ten (10) different borrow pits in Ede Area of Osun state, southwestern Nigeria, using disturbed sampling method. About 25 kg of each sample was collected using a hand auger and shovel, kept in water proof sack, properly sealed, labelled and transported to the Geotechnical Engineering Laboratory (the Laboratory), Department of Civil Engineering, Obafemi Awolowo University (OAU), Ile-Ife, Nigeria. At the Laboratory, representative samples were immediately taken for the determination of natural moisture content. The remaining portions were then air-dried in preparation for subsequent laboratory analyses.

Geotechnical tests on soil samp;les

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

RESULTS AND DISCUSSION

Description of sampling points

The geographic positioning system (GPS) description of the sampling points are presented in Table 1.

Table 1: Description of the sampling points

Sample ID	Longitude (E)	Latitude (N)
A	4°27'08.6"	7°41'03.2"
B	4° 27'09.0"	7° 41'52.6"
C	4° 27'20.2"	7° 41'25.7"
D	4° 30'13.8"	7° 43'38.4"
E	4° 31'46.0"	7°45'26.6"
F	4° 30'47.2"	7°43'32.7"
G	4° 25'24.8"	7°42'17.0"
H	4° 30'16.2"	7°43'47.6"
I	4° 29'52.3"	7°43'10.0"
J	4° 31'56.9"	7°45'20.1"

Results of preliminary and geotechnical tests

The results of preliminary and geotechnical tests on the soil samples are presented in Table 2. The natural moisture content of any soil changes with the seasons, being higher during rainy season and lower during dry season. Emesiobi (2000), stated that natural moisture content in soil can vary from less than 5 % to 50 % in gravel and sand. The natural moisture content of the tested soil samples varied from 6 % to 22 %. (Table 2). Sample I had the lowest value of natural moisture content (6.03 %) because of the dry weather condition when the sample was collected. Sample J had the highest value of natural moisture content (21.88 %.

Specific gravity values of the samples ranged from 2.52 to 2.80 (Table 2). Wright (1986) reported that the normal range of specific gravity values for soils is between 2.52 and 2.80. Thus, the specific gravity values obtained for the tested soils are typical. Que *et al.* (2008) demonstrated that specific gravity is related to the mineralogy or the chemical composition of soil. It can be concluded that sample E (with the highest specific gravity value) is the most lateritised sample; while sample I (with the lowest value) is the least lateritised sample (De GraffJohnson, 1972). Also, higher specific gravity values indicate a fine-grained soil, while lower values indicate a coarse soil (Wright, 1986). Therefore, sample E is the finest, while sample I is least fine.

Table 2: Results of preliminary and geotechnical tests

Sample ID	Natural moisture content (%)	Specific gravity	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	MDD (kg/m^3)	OMC (%)	CBR (%)
A	16.94	2.70	27.26	22.37	4.89	1.53	24.00	5.26
B	17.08	2.57	29.64	26.12	3.52	1.68	16.25	10.52
C	18.14	2.68	38.74	18.66	20.08	1.56	22.00	17.37
D	15.4	2.65	38.86	26.08	12.78	1.54	21.00	41.33
E	14.56	2.80	40.5	25.43	15.07	1.99	15.00	20.20
F	10.7	2.7	35.14	24.44	10.70	1.45	21.80	32.44
G	11.33	2.59	47.57	27.20	20.37	1.87	15.00	23.80
H	15.54	2.73	36.37	21.41	14.96	1.83	20.50	25.30
I	6.03	2.52	25.98	10.93	15.05	1.72	16.00	5.85
J	21.88	2.70	38.85	16.84	20.96	1.56	24.00	25.43

According to clause 6201 of Federal Ministry of Works and Housing (FMW & H) Specification (1997) requirement, for a sample to be used as subgrade/fill and base, the percentage by weight passing the No.200 sieve (75μm) should be less than 35 %; and if the percentage passing sieve No. 200 for a lateritic base course is more than 35 %, the material is rejected without further tests. It could therefore be said that the lateritic samples under investigation are suitable or subgrade/fill and base, since each o hem has percentages by weight passing sieve No. 200 35 % o.

The liquid limit of the soil samples varies from 25.98 % to 47.57 % while the plastic limit varies from 10.93 % to 27.20 % (Table 2). Clay soils usually have liquid limits of 40 % - 60 % or higher while silty soils usually have liquid limits of 25 % - 50 % (BS 1377, 1990). Soils with liquid limits less than30 % are considered to have low plasticity and compressibility, while soils with liquid limits between 30 % and 50 % have medium plasticity, and those with liquid limits higher than 50 % have high plasticity and compressibility. It follows that, samples A, B and I have low plasticity while the remaining samples have medium plasticity. The Federal Ministry of Works and Housing Specifications (1997) are: liquid limits of 30 % maximum, plastic limit of 30 % maximum and plasticity index of 13 % maximum for sub-base and base materials. Samples A, B and I are the only samples that satisfy this specification.

Table 2 shows the values of maximum dry density (MDD) and optimum moisture content (OMC) of the soil samples. The OMC of the soil samples varies from 15 % to 24 % while the MDD ranges between 1.45 mg/m^3 and 1.9`^{3}. According to O“Flaherty (1988) the expected values for the standard proctor test methods are: for clay, OMC may be between 1.44 %

and1.685 %; for silty-clay, OMC may range from 15 % to 25 %, and MDD may range from 1.6 mg/m^3 to 1.845mg/m^3; for sandy clay, OMC is between 8 % and 15 %, and MDD is between 1.76 mg/m^3 and 165 mg/m^3. It could therefore be said that the investigated soil samples ranged between clay and silty-clay.

The results of unsoaked California bearing ratio (CBR) are presented in Table 2.The CBR values vary from 5.26 % to 41.33 %. The Federal Ministry of Works and Housing Specifications (1997) suggest that unsoaked CBR for subgrade, subbase, and base soils should not be less than 10 %, 30 %, and 80 %, respectively. This implies that all tested samples except sample D and sample F (with values below 30 %) are excellent sub-base materials. The results also showed that none of the samples is a good base course material for road construction.

CONCLUSION

Selected lateritic soil in Ede area of Osun state. Nigeria were investigated to assess their suitability as foundation material for road construction. The soils were generally found to range between clay and silty clay that can be easily compacted and have good drainage properties. The soils also showed a general cohesive nature with low moisture content, high granular material, which make them suitable for road construction. Specifically, majority of the soils were found to be excellen materials for subgrade and subbase in road construction.

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