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Research Paper

Geotechnical Properties of Lateritic Soils at Adekunle Ajasin University Campus, Akungba Akoko, Nigeria

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Abstract
Un-disturbed soil samples were collected from two trial pits in order to determine the geotechnicalproperties of the soil as well as predict the suitability of this soil for engineering use. These samples were taken from the northwestern part of the permanent site of Adekunle Ajasin University Akungba-Akoko, Nigeria at 0.5 m intervals to a depth of 2.0 m and were tested in order to determine their geotechnical characteristics. The tests carried out on the samples include: grain size analysis, compaction, Atterberg limits, specific gravity and CBR. The results showed that CBR values ranged from 22.85 to 49.46%. The bearing capacityat similardepth in Pit 1 is higher than that of Pit 2. The MDD ranged from 1.65 to 1.90 g/cm3 and OMC from 10.50 to 20.75%, liquid limit from 35.5 to 46.30%, linear shrinkage from 7.1 to 11.4% and specific gravity valuesfrom 2.65 to 2.78. The linear shrinkage values show that Samples 1a, 1b, 2a, 2c and 2d needs to be improved before it can be used for construction purpose. Samples 1b and 2d exhibits poor resistance to shrinkage while samples 1a, 1c, 1d, 2a, 2b and 2c have moderate resistance to shrinkage. All the samples have intermediate plasticity and cohesive. They will therefore display fair support for load when wet. Therefore the soils from these pits requires stabilization to improve their geotechnical properties based on their indices.
Keywords: *California Bearing Ratio, geotechnical properties, lateritic soils,maximum dry density, optimum moisture content.*

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I. INTRODUCTION

InNigeria, civil engineering structures has been constructed without considering the geology of the environment, thus many building collapsed times without number in Nigeria, leading to loss of lives and properties. The significance of this study is to show that the geology of an environment greatly affects the bearing capacity of soils. Therefore the geotechnical properties of the soil must be investigated to determine if the bearing capacity of the soil is suitable for the designed construction purposes.Adekunle Ajasin University Campus is located in Akungba Akoko one of the ancient town in Akoko S.W Local Government of Ondo State. The relocation of the University to its present location has resulted in enormous anthropological activities in this town. This underscores the need to have improved facilities such as buildings and good roads in order to facilitate the associated economic improvement. This study was carried out in order to determine the engineering properties of the soils within the study area due to failure of roads and structures within and around the town particularly along Akungba-Ikare road.Singh [1] defined soil as the upper layer of theground made of unconsolidated material produced dueto weathering agencies from the rocks and generallymodified subsequently by a variety of mechanical,chemical and organic process all operating constantly ina complex manner. Soil types, properties andcharacteristics depend on their parent material fromwhich they were formed. Soil properties determine theusefulness of soils in foundation design, constructionand stability of engineering structures that rest on them [2]. The soils in the study area are thesoil weathered in-situ. The purpose of this study is todetermine the soil properties in the study area and relatethem to their usefulness in supporting engineeringconstructions.

II. LOCATION AND GEOLOGY OF THE STUDY AREA

The studyarea lies between latitudes 07° 26[1]N and 07° 29[1]N and between longitude 5°43[1]E and5° 45[1]E of the Greenwich Meridian (Figure 1).

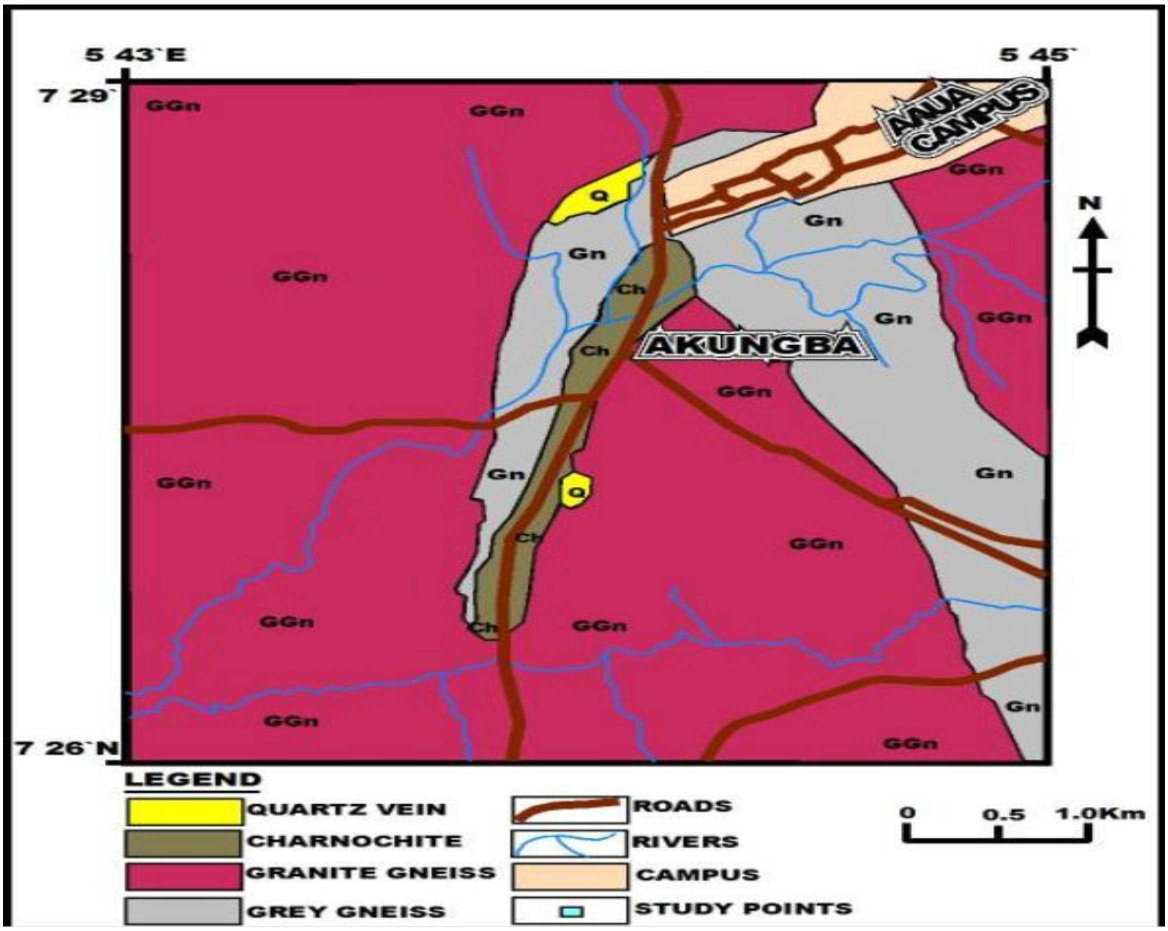

Figure 1: Geological map of the study area

The area belongs to tropical climate, which ischaracterized by alternating wet and dry season. Wetseason start from April and end in October, while thedry season starts from November to March. Thedrainage pattern is dendritic.The area is underlain by rocks of the basementcomplex of South Western Nigeria [3], [4].

The dominant rock types are: granite-gneiss, greygneiss and charnockite. The predominant minerals ofthe rocks are the alumino silicate minerals (feldsparsand micas). The natures of the fracture system withinthe humid tropics have favoured the development ofdeep weathering [2].

III. MATERIALS AND METHODS

Disturbed soil samples were collected from twotrial pits to a depth of 2.0 m below the surface at 0.5 mintervals from two locations. The soil samples collectedwere analyzed at the materials testing/geotechnicallaboratory of Ondo State Ministry of Works, Nigeriafor the following geotechnical properties: naturalmoisture content, linear shrinkage, particle sizeanalyses, CBR (California Bearing Ratio). Atterberglimits and compaction were done based on standardmethods and procedures of BS [5]

IV. RESULTS AND DISCUSSION

The summary of the engineering properties of soil are presented in Table 1 and 2.

Table 1: Engineering properties of the soil from the study area

Location	**1a**	**b**	**c**	**d**	**2a**	**b**	**c**	**d**
Linear shrinkage	10.0	10.7	7.9	7.1	10.0	7.9	8.6	11.4
Specific gravity (SG)	2.78	2.75	2.69	2.67	2.75	2.72	2.65	2.65
Maximum dry density g/cm^3	1.65	1.73	1.78	1.73	1.65	1.90	1.75	1.88
Optimum moisture content	17.0	14.2	16.5	17.5	20.75	14.0	10.5	15.25
Natural moisture content	16.3	13.6	15.6	15.7	21.7	13.6	11.4	14.9

Plastic limit	20.40	21.10	22.15	24.35	17.95	18.70	23.75	25.10
Plasticity index	25.10	25.20	18.85	15.15	22.05	17.60	14.75	17.10
Liquid limit	45.50	46.30	41.00	39.50	40.00	36.30	38.50	42.20
CBR	30.22	42.29	43.08	49.46	25.51	22.85	31.33	40.22

Table 2: Particle Size Analyses

Location	**1a**	**1b**	**1c**	**1d**	**2a**	**2b**	**2c**	**2d**
Depth of sampling	0.5	1.0	1.5	2.0	0.5	1.0	1.5	2.0
Sieve size (mm)	% Total passing	% Total passing	% Total passing	% Total passing	% Total passing	% Total passing	% Total passing	% Total passing
4.75	92.87	97.87	98.43	97.75	93.67	98.12	99.08	98.79
2.36	84.95	93.66	92.72	91.98	85.46	92.08	91.80	96.79
1.18	74.72	79.17	85.70	84.84	70.10	79.96	78.60	83.67
0.850	70.30	68.98	81.32	79.93	60.72	74.58	73.59	79.95
0.425	57.09	50.35	60.20	60.65	47.33	54.89	54.31	61.62
0.212	40.30	29.12	40.91	41.19	34.59	36.61	38.38	44.41
0.150	30.02	24.96	33.33	36.45	27.83	32.09	32.19	36.68
0.075	24.20	21.73	28.36	32.94	22.08	29.61	27.57	34.32
Pan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Based on the moisture content shown in Table 3soils from 1a, b, c, d, 2b, c and d are very good forengineering purposes. But soil from location 2a withmoisture content of 20.75% is averagely good forengineering purposes.

Table 3: Soil moisture content and suitability for engineering purposes

Moisture Content %	**Suitability For Engineering Purposes**
10 – 20	Very good
21 – 30	Averagely good
31 – 40	Fairly good
41 and above	Poor

Adapted from Akpah et al. [2].

Linear shrinkage: Silts and sands are not particularlysusceptible to shrinkage and will produce a fairlyshrinkage curve [6]. The shrinkage limit isdetermined as the moisture content below which thevolume ceases to decrease. Comparing the linearshrinkage result of the samples with the standard shownin Table 4 [7], it can beshown that soil in location 1c, 1d and 2b can be used assub-grade, sub-base and base-course materials.

Table 4: Soil classification based on degree of shrinkage.

Degree Of Shrinkage	**Quality of Soil**
%	Resistance to shrinkage
<5	Good
5 – 10	Medium
10 – 15	Poor
>15	Very poor

After Schedig, [8]

Othersoil in locations 1a, 1b, 2a, 2c and 2d needs to beimproved before they can be used as sub-grade, sub -baseand base-course material.Soil in location 1a, 1c, 1d, 2a, 2b and 2c with linearshrinkage between 7.1 and 8.6 have moderate resistanceto shrinkage and can be classified as medium soil.These soils will crack or swell moderately due toseasonal moisture content changes; they have medium resistance.

Soils at locations 1b and 2d have poorresistance to shrinkage (10.7 and 11.4 %), these soils maycrack and may cause differential settlement infoundations and pavement, this may lead to foundation failures of building and formation of pot holes if roadare constructed on them.

Specific gravity: Specific gravity is a reflection of thedensities of constituent materials in each Sampleexcluding the permeable voids they may contain Okogbue and Ene [9]. The specific gravity of thesoil in the study area ranges between 2.65 and 2.78,indicating that the soil in the study area are good forengineering construction purposes.

Atterberg limits: The liquid and plastic limits can beused to obtain plasticity index, which is a measure ofthe plasticity of the soil [10], (shown in Table 5).

Table 5: Standard Range of Plasticity Limits of Soil

Plasticity limit of soil %	**Plasticity**
0 – 10	Non – plastic
10 – 35	Low plasticity
35 – 50	Intermediate plasticity
50 – 70	High plasticity
70 – 90	Very high plasticity

90 – 120	Extremely high

Source: Barnes [6].

The soils do not indicate any non-cohesion. Theplasticity of samples 1a, 1b, 1c, 1d, 2a, 2b, 2c and 2dfall within the range of intermediate plasticity and allthe soil have low plasticity index and is between 14.75and 25.20. At low moisture content because of lowplasticity, it may be difficult to produce a 3 mm threadwithout premature crumbling. It is possible these soilsbecome friable in dry weather. Soils in the study arearange from low to intermediate plasticity. These soilswill have fair support for loads when wet, this is line with Ogunribido [11], [12] submission.

California Bearing Ratio (CBR): The CBR oflocation 2a and 2b are 25.51 and 22.85%, respectively;they are good for sub-grade, while location 1a, 1b, 1c,1d, 2c and 2d meet up with the sub-base specification.

V. CONCLUSION

The soil in the study area is fairly good for engineeringpurposes based on their index and geotechnical properties.

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