The Hydro Geotechnical Properties of Clay Occurrences in Afikpo and Unwana E b o n y State,

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Abstract: The aim of this research project is to investigate occurrences of clay around Afikpo and unwana within Ebonyi State with an objective to determine its hydro geotechnical properties. The results of the geotechnical analysis of the clay samples within the study area, suggests an average; moisture content of about 0.9% and 0.72%, liquid limit of about 19.9% and 22.1%, plastic limit of about 14.1% and 16.8%, plasticity index of about 5.8 and 5.3%, and a linear shrinkage limit of about 7.2% and 5.9%, for both Afikpo and unwana respectively. Results of the plasticity classification chart suggest that the soils are composed of inorganic clay of low plasticity. While results from the modified plasticity classification chart revealed three clay minerals; these include montmorillonite (35%), illite (35%) and kaolinite (30%). A simple comparison of sieve analysis results suggest clay from Afikpo to be more coarse-grained within the coarser half of the sieves (i.e. between 5mm to 0.3mm), and also more fine- grained in the finer half of the sieves (i.e. between 0.01mm to 0.075mm) than clay from location Unwana. Their analyses suggest the texture of the soil to be predominantly sandy. The results of the investigation of the- clay deposits suggest that the clay can be utilized in the manufacturing of ceramics hard wares, refractory bricks, paper, fertilizer and paint.
Keywords: Clay, Unwana, Afikpo, Hydro geotechnical properties, Texture of the soil

Introduction

The state is in the South East geo-political zone of Nigeria. It was created out of Abia and Enugu States on 1st October, 1996. It derived its name from the Ebonyi River. The state capital is Abakaliki known for its salt deposits. Other mineral deposits found in the state are zinc, lead, limestone, granite, refractory clay and gypsum. The tourist attractions in the state include the eleven officially gazette forest reserves and the 450 hectares Akanto Game Reserve. The state is refer to as the Salt of the Nation. In the 2006 Population and Housing Census, Ebonyi state is made up of 1,064,156 males and 1,112,791 females

Study Location

The study area is situated in Afikpo north Local Government Area of Ebonyi State, within basin. It lies between longitude E and E and latitude N and 9^0 13^1 N^2. Afikpo and Unwana are among the major towns in the area, while The physical landform of areas is made up of flat-lying to gently rolling plains. The monotony of the landscape is however broken by residual hills, which are either conical or flat-topped. The terrain is mostly covered by lateritic soils and fairly by soil and sandstone as a result of the weathering activities that have depleted the hills and ridges. The area is particularly drained by si many seasonal streams and river which run near Kusogi village and flow in the NE direction of Egbako SW. Manall over the villages and surrounding as tributaries are seasonal and forms a dentritic drainage pattern which strongly suggest that the terrain is composed of lithological, structural and topographic homogeneity base map

Figure 1: Map of an Afikpo showing study area

Research Methodology

Methodology, equipment and materials

The l-16 iron mould and accessories, sliding venier caliper, laboratory oven, laboratory or workshop dryer, desiccators, Enugu fine clay, Unwana clay, Ngodo laterite Some quantities of clay obtained from jaw crusher experiment and that was passed through the 2.35mm sieve was put into a plastic basin and was properly mixed with suitable amounts of water as per damp pressing (or stiff plastic pressing) i.e as it was estimated. The l-16 iron mould was used and produce kidney shaped articles by damp pressing. At the same times, the sample of the damp or moist clay was put in a clean previously weighed stainless iron dish and it was dried in the lab. Or work shop oven for about 24 hours so as to ascertain the working moisture content.

A mark of 50mm was inscribe apart on the centre of the freshly made sample and well to another samples with the aid of sliding venier caliper. The samples are damp pressed and therefore it was put in the dryer immediately they were made and it was dry for about 24 hours (ideally up to 105 or 110o).

The samples were removed from the dryer after they had been properly dried and the distance on the centers of the pieces was measured again .Finally the drying shrinkage of the samples individually (and the means average) drying shrinkage of the samples was calculated.

Method of investigation;

Detailed field mapping was carried out around Afikpo and unwana in order to establish the local geology of the area. The method of investigation involved an intensive fieldwork, which lasted for eight days which now constitute the map of the study area, was enlarged to a scale size of 1:12,500. It covers an area of about 39.88km^2. The area was divided into four equal squares ensure thorough mapping. On the field, the soil exposures were observed and described based on their grain sizes, color, texture, structural elements and mode of occurrence.

Thus, a total of twenty (20) clay samples weighing about 24kg, were randomly taken from both locations. All samples were carefully labeled and arranged in sac bags for the various analyses to be carried out in the laboratory.

Laboratory Analysis

A quantitative determination of the geotechnical properties of the clay samples was determined. The various analyses carried out include the determination Atterberg limit, plastic limit, liquid limit, coefficient of permeability and particle size distribution. These laboratory analyses were carried out according to British Standard Methods of test for soils for civil engineering purposes.

Determination of the Coefficient of Permeability The value of the coefficient of permeability (k) varies widely for different soils. Some typical values of permeability coefficients are given in Table .1

Hazen (1930) proposed an empirical relation for the coefficient of permeability in the form

$$K \ (cm \ / \ sec) = cD^2_{10}.$$

Where c = a constant that varies from 1.0 to 1.5.

D_{10} = the effective size, in millimeters.

Hazen's empirical equation was used to estimate the coefficient of permeability and all results were accurately documented.

Results and Discussion

Result of geotechnical analysis of the clay samples and Moisture content and atterberg limit results.

The results of the moisture contents and Atterberg limits of the geotechnical analysis of Afikpo and Unwana clay deposits are presented in Table 2.

The moisture content results show that deposit of clay in location Afikpo have a higher moisture content value than those in location Unwana. The moisture content of clays in location A is about 0.9%, while that of location B is about 0.72%. On the whole, the average moisture content of the clays yields very low result of about 0.81%. The Atterberg limit (which comprises the liquid limit (LL), plastic limit (PL), Plasticity index (PI), and linear shrinkage limits (LSL)) Results of the geotechnical analysis of the clay vary in values for both locations. For locations Afikpo and Unwana, the f o l l o w i n g physical parameters were observed of about 1about 7.2% and 5.9%. A simple comparison of Atterberg limit results of location A to those of location B, clearly show that location A have a lower liquid limit value with about 2.2%, a lower plastic limit value with about 2.7%, a higher plasticity index value with about 0.5% and a higher linear shrinkage limit value with about 1.3%. On the whole, the results revealed a mean liquid limit of about 21%, plastic limit of about 15.45%, plasticity index of about 5.55% and a linear shrinkage limit of about 6.55% which are all below average. The plasticity classification chart shows that the soils are composed of inorganic clay of low plasticity. They are montmorillonite, illite and kaolinite. Chlorite and halloysites are totally absent. The result indicated montmorillonite to constitute about 35% of the plots, illite constitute about 35% of the plots whereas kaolinite constitutes about 30%. Result of Estimated Coefficients of Permeability. The results of the estimated coefficients of permeability of Afikpo and Unwana clay using Hazen equation and their classifications according to soil types The result of the estimated coefficients of permeability of the clay deposits indicated that clays in Afikpo, are more coarse grained than those in Unwana. Coarse-grained soils have higher coefficients of permeability. Hence, Afikpo has higher coefficients of permeability than those of Uwana

Table 1; Typical Values of Permeability Coefficients (after Hazen, 1930)

Soil type	K	
	(Cm/sec)	**(Ft/min)**
Clean gravel	1.0 – 100	2.0 – 200
Coarse sand Fine sand	1.0 – 0.01	2.0 – 0.02
Silty	0.01 – 0.001	0.01 – 0.002
Clay	0.001 – 0.00001	0.002 – 0.00002
	Less than 0.000001	Less than 0.000002

Geotechnical investigation of the clay revealed a very low moisture content value of about 0.9% for location Afikpo and about 0.72% for Uwana. The Atterberg limit results of the soils suggest the following physical parameters respectively. An average; liquid limit of about 19.9% and 22.1%, plastic limit of about 14.1% and 16.8%, plasticity index of about 5.8% and 5.3%, and a linear shrinkage limit of about 7.2% and 5.9%. On the whole the soils revealed a mean liquid limit of about 21%, plastic limit of about 15.45%, plasticity index of about 5.55% and linear shrinkage limit of about 6.55% which are all below average

Table 2: Summary of results from laboratory analysis for Afikpo Clay

Sample No.	Moisture content (%)	Atterberg limit			
		LL (%)	PL (%)	PI (%)	Linear shrinkage limit (LSL) (%)
Afikpo/ 1	1.4	15	9	6	11
AFIKPO/2	0.51	16	10	6	7
AFIKPO/3	1.1	29	21	8	2
AFIKPO/4	0.22	20	16	4	8
AFIKPO/5	1.31	30	26	4	11
AFIKPO/6	0.94	21	15	6	3
AFIKPO/7	0.75	17	9	8	6
AFIKPO/8	0.73	10	7	3	9
AFIKPO/9	0.76	19	9	10	6
AFIKPO/10	1.32	22	19	3	9
Arithmetic Mean	0.9	19.9	14.1	5.8	7.2
Range	0.22 to 1.4	10 to 30	7 to 26	3 to 10	2 to 11
UNWANA/11	0.37	19	15	4	6
UNWANA/12	0.52	23	20	3	16
UNWANA/13	0.58	23	17	6	9
UNWANA/14	0.57	22	18	4	4
UNWANA/15	0.56	21	15	6	2
UNWANA/16	0.72	21	17	4	4
UNWANA/17	0.99	35	25	10	1
UNWANA/18	0.88	17	13	4	3
UNWANA/19	0.9	20	16	4	6
UNWANA/20	1.08	20	12	8	8
Arithmetic Mean	0.72	22.1	16.8	5.3	5.9
`Range	0.37 to 1.08	17 to 35	12 to 25	3 to 10	1 to 16

LL = Liquid Limit
PL + Plastic Limit
PI = Plasticity Index

Conclusion and Recommendation

On the basis of the results from the geological mapping, and geotechnical investigations, it can be deduced that the afikpo clay occurred as immature, inorganic residual clay due to the weathering of feldspar from feldspathic sandstone, and it is predominantly kaolinitic in nature. The colour of the clay, which varies from white to dirty-white, is attributed to stains from the lateritic overburden. A low percentage value recorded for Afikpo kaolin (43.64%) compared to higher percentage values recorded for some well- known kaolin deposit, in terms of their mineralogical composition are attributed to its high percentage of quartz. The results of the mineralogical and geotechnical investigation of the Afikpo clay deposits carried out in this study

and the geochemical analysis of; suggest that they can be utilized in ceramic and pharmactical industries.

Recommendations grade and also exploit and identify the markets for the products. It is hoped that when these are done not only will the internal revenue of Niger State improve, but she will be able to provide jobs in the various local industries for her many unemployed citizens

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