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Some Geotechnical Properties of Soils Around Eziobodo, Imo State, Southeastern Nigeria

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Abstract:- Some geotechnical properties of soils around Eziobodo, Southeastern Nigeria was investigated using standard methods. Samples were obtained at three locations, Eziobodo, Ihiagwa and Obinze. The properties determined were particle size analysis, compaction (bulk density, dry density, natural moisture content, maximum dry density and optimum moisture content) and Atterberg limits (liquid limit, plastic limit and plasticity index). The sieve analysis shows that the samples are mainly sandy particles. The liquid limit values for the three locations (Eziobodo, Ihiagwa and Obinze) were 10, 46, and 47% respectively, while the plastic limit were 26, 21, 26.81 % respectively with plasticity index PI of -16, 25, and 20.19 % respectively. The natural moisture content of the samples were 10.3, 9.8 and 7.9% respectively. The bulk density values were 1.76, 1.69, and 1.66 mg/m^3 respectively while the dry density values were 1.40, 1.35, and 1.31 mg/m^3 respectively. The maximum dry density for the locations were 1.54, 1.43, and 1.41 mg/m^3 while the values for the optimum moisture content were 24, 27.5 and 26.5% respectively. Because of their non-plastic behavior, high percentage of sand content, most of the sediments have low swelling potential; have high collapsibility potential, loses strength upon saturation and eventually susceptible to erosion.

Keywords:- *Geotechnical, Atterberg Limits, Plasticity, Bulk Density, Maximum Dry Density, Optimum Moisture Content, Swelling Potential.*

I. INTRODUCTION

Civic structures all over the world such as dams buildings, bridges, roads etc. are designed based on consideration of the properties of soils on which they are constructed.

The determination of engineering properties of a particular soil is one of the ways to confirm the suitability of a particular soil or for a specific structure, whether it can withstand the load or not.

Soils are being used in the construction of roads, highways, airfields, earth dams and as the foundation of structures (AASHTO, 1986). Surface soils are dormant in the tropics where there is rapid and extensive physical and chemical weathering (Disintegration) of rocks to form soils (Amu, Ogunniyi and Oladeji, 2011).

These soils play many roles in the design, maintenance and improvement of urban areas. Apart from design of civil structures, soils engineering properties helps in rural and urban development planning. Most civil structures failure has been attributed to lack of knowledge or inadequate information on the engineering properties of soil. Therefore, the need for soils engineering characteristics is very vital in maintaining a sound and solid structure.

Soil engineering is the branch of engineering science which implies the principles of machines, hydraulics and geology to the solution of engineering in soils. It is the aspect of Earth science known as Geotechnics which comprises soil mechanics, geophysics, hydrogeology and engineering geology.

Briscolland and Chown (2001) explains that many soils can prove problematic in geotechnical engineering because they expand, collapse, disperse, undergo excessive settlement, have a distinct take of strength or are soluble . Such characteristics may be attributed to their composition, the nature of their pore spaces, fluids their minerology and fabric.

According to Rezael et al (2011), there are many problematic soils. Some of the noteworthy are swelling clay, dispersive soils and collapsible soils.

II. MATERIALS AND METHOD

The study commenced with deskwork and reconnaissance survey of the area. Then, sampling was carried out through trial pitting which permitted a close examination of the sampling sites. Soil samples were collected at 3 selected points with the aid of hand auger at a depth of about 30cm. the samples were collected in black airtight sampling bags and sent to the laboratory within 24 hours of collection.

Laboratory tests were conducted on the soil samples and were all performed in accordance with the specified standard procedures (BS, 1975; ASTM 1979).

The study areas (Figure 1) is located in Owerri west Local Government of Imo State and is located between latitude 7^0.00 E to 70^{ll} E and longitude 5023' to 5^0 21' N.

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The three (3) sampling locations namely.
Eziobodo L: N5^0 23.6' and longitude E 7^0.4'
Ihiagwa: N5^0 26.3' and longitude E7^0 5.1'
Obinze: N50 26.0 and longitude E 7^0 01'

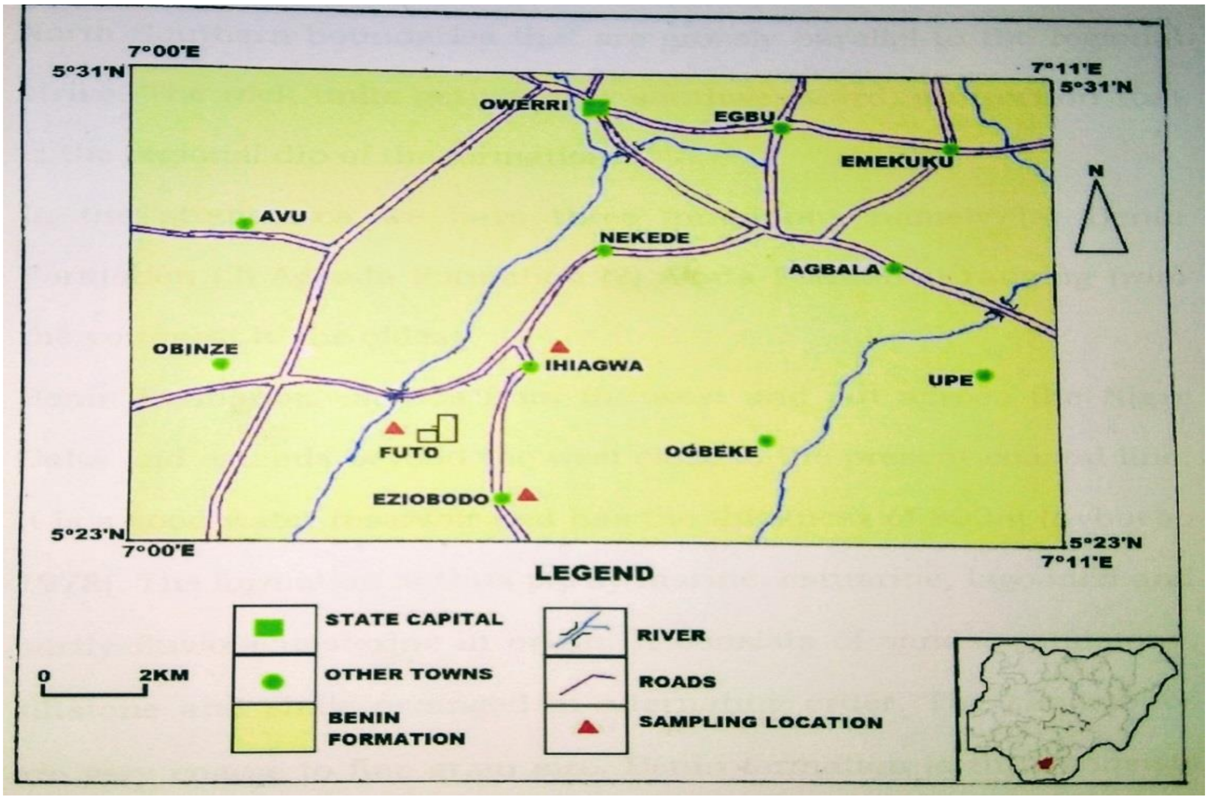

Fig 1:- Location map of the study area

Standard laboratory methods were used to determine moisture content, Atterberg limits, sieve analysis, Bulk and Dry densities of the samples.

III. RESULTS AND DISCUSION

Result of the analysis of the grain size, atterberge limits (liquid and plastic limits) and compaction (bulk and dry densities, maximum dry density and optimum moisture content) are shown in the tables and figures below.

Sieve Size (mm)	Mass Retained (g)	Mass Passing (g)	Percentage Passing (%)
4.0	0.0	52.5	100
2.0	0.6	51.9	98.85
1.18	3.0	48.9	93.14
0.85	9.8	39.1	74.47
0.600	8.3	30.8	58.66
0.425	22.1	8.7	16.57
0.300	6.4	2.3	4.38
0.150	1.8	0.5	0.95
0.063	0.5	0	0

Table 1:- Sieve Analysis Eziobodo Soil (52.5g)

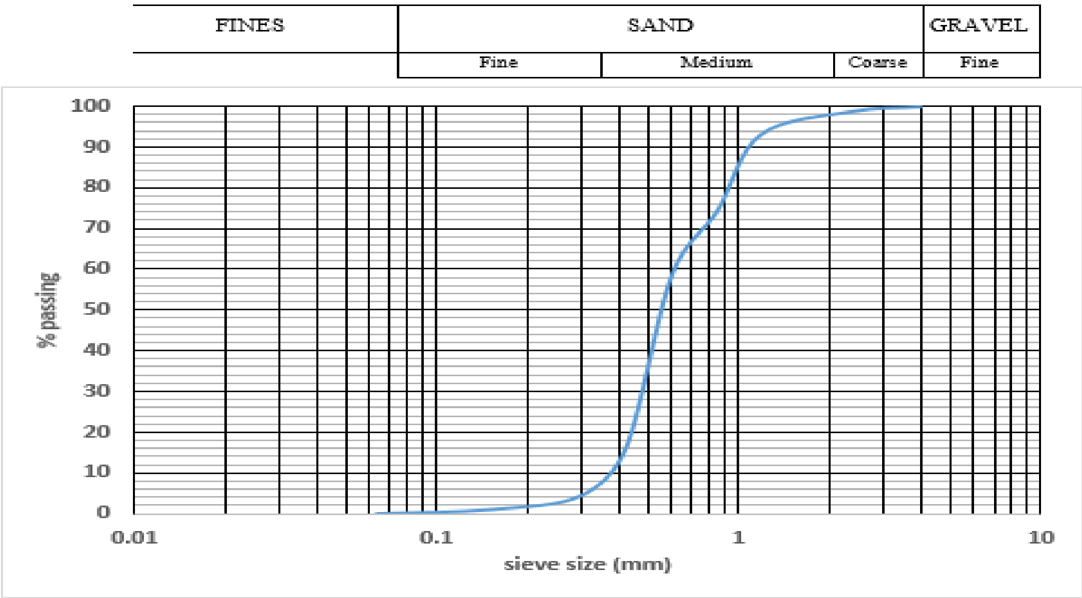

Fig 2:- Particle Size Distribution Curve for Eziobodo Soil

Sieve Size (mm)	Mass Retained (g)	Mass Passing (g)	Percentage Passing (%)
2	0.1	49.2	99.79
1.18	0.6	48.6	98.58
0.850	3.8	44.8	90.87
0.600	7.9	36.9	74.84
0.425	8.6	28.3	57.40
0.300	17.5	10.8	21.90
0.15	8.2	2.6	5.27
0.063	1.8	0.8	1.62
Pan	0.800	0	0

Table 2:- Sieve analysis of Ihiagwa Soil (49.3g)

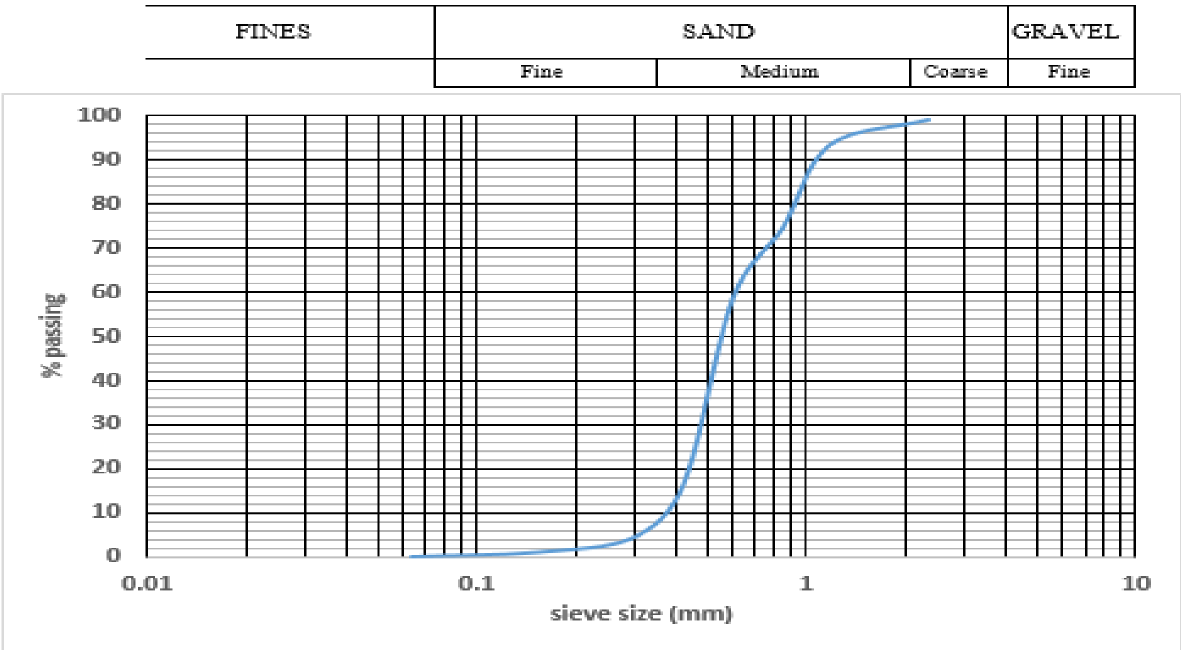

Fig 3:- Particle Size Distribution Curve for Ihiagwa Soil

Sieve Size (mm)	Mass Retained (g)	Mass Passing(g)	Percentage Passing (%)
2	0.0	51.0	100
1.18	0.4	50.6	99.21
0.850	2.9	47.7	93.52
0.600	7.1	40.6	79.60
0.425	8.3	32.3	63.33
0.300	22.5	9.8	19.21
0.150	7.6	2.2	4.31
0.063	1.9	0.3	0.58
Pan	0.2	0	0

Table 3:- Obinze (51.0g)

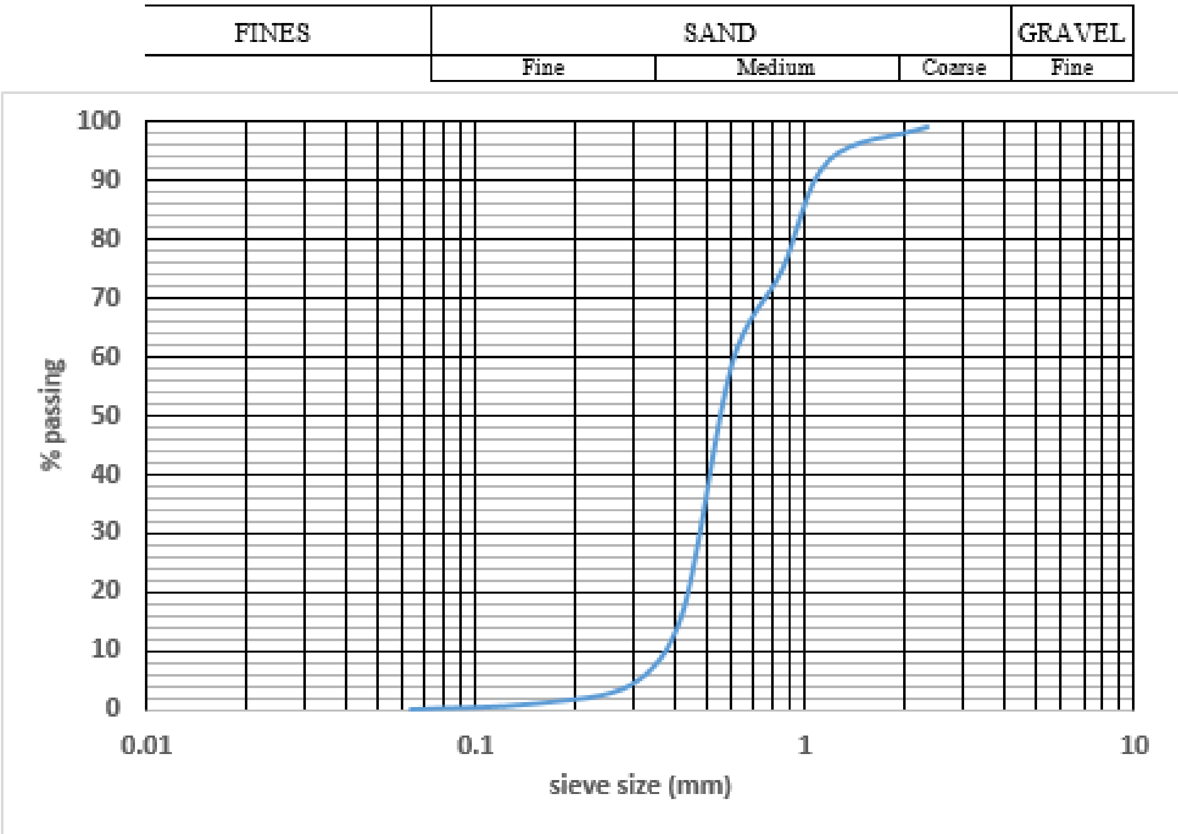

Fig 4:- Particle Size Distribution Curve for Obinze Soil

➢ *Atterberg Limits*

SAMPLE	Eziobodo			Ihiagwa			Obinze		
CAN ID	A	B	C	A	B	C	A	B	C
WT of can + wet soil	44.7	38	38.3	39.2	36.5	37.6	37.5	32.7	40.2
Wt. of can + dry soil (g)	42.1	36.3	35.4	31.2	30.8	31.5	30.7	28.3	29.6
Wt. of can (g)	16.9	17.5	18.5	19.5	17.2	19.6	19.5	17.2	19.6
Wt. of dry soil	25.2	18.8	16.9	11.7	13.6	11.9	9.6	12.0	8.5
Wt. of moisture (g)	2.6	1.7	2.9	8.0	5.7	6.1	9.5	6.3	4.9
WATER CONTENT%	10.3	9	17.2	68.36	41.91	51.26	69.50	41.91	51.26
NO OF BLOW	16	23	35	11	29	49	11	29	49
Liquid Limit	10			46			47		

Table 4:- Liquid Limit Determination

SAMPLE LOCATION	Eziobodo		Ihiagwa		Obinze	
Determination No	A	B	A	B	A	B
Wt. of can (g) M_1	22.5	19	19	21.5	22.5	19
Wt. of can + wet soil (g) M_2	33.8	33.6	29.7	35.6	33.8	33.6
Wt. of can + dry soil (g) M_3	31.2	30.8	27.1	31.8	31.2	30.8
Calculation						
Wt. of water (g) $W_w = M_2 - M_3$	2.6	2.8	2.6	1.1	2.6	2.8
Wt. of dry soil $W_s = M_3 - M_1$	8.7	11.8	8.1	10.3	8.7	11.8
Moisture content $W = \frac{W_w}{W_s} \times 100$	29.89	23.73	32.1	10.87	29.89	23.73
Average PL (%) = $\frac{WP_1 + WP_2}{2}$	26.81		21.49		26.81	

Table 5:- Plastic Limit Determination

Sample)	Eziobodo	Ihiagwa	Obinze
Can identification	B	14	C
Wt. of wet soil + can (g)	16.1	42.7	53.5
Wt. of dry soil + can (g)	14.9	40.6	51.0
Wt. of can (g)	3.3	19.1	19.4
Wt. of dry soil (g)	11.6	21.5	31.6
Wt. of water (g)	1.2	2.1	2.5
Moisture content, w, (%)	10.3	9.8	7.9

Table 6:- Natural Moisture Content Determination

- *Compaction Test*

SAMPLE		Eziobodo			Ihiagwa			Obinze		
MEASUREMENT NO		1	2	1	2	3	3	1	2	3
Weight of mould + compacted Soil	(A)	248.2	286.6	256.0	278.9	265.0	294.4	256.0	278.9	265.0
Weight of mould (g)	(B)	103.5	103.5	103.5	103.5	103.5	103.5	103.5	103.5	103.5
Weight of compacted soil (g)	(A – B)	144.7	182.5	152.5	175.4	161.5	190.7	152.5	175.4	161.5
Volume of mould (cm^3)	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2
Bulk Density, (τ)	$\frac{Wt.\ of\ soil}{volume\ of\ soil}$	1.47	1.86	1.55	1.79	1.64	1.94	1.55	1.79	1.64
Average bulk density(mg/m^3)		1.76			1.69			1.66		

Table 7:- Bulk Density

SAMPLE	Eziobodo			Ihiagwa			Obinze		
Can Identification	1	2	3	1	2	3	1	2	3
Mass of mould + Wet Soil	88.50	66.00	63.40	65.35	74.00	58.90	46.20	62.50	54.70
Mass of mould + Dry Soil	77.40	57.50	52.50	58.20	62.50	49.30	41.70	53.40	45.40
Mass of mould	18.90	19.40	19.40	17.60	18.90	19.20	18.90	19.30	17.60
Weight of Water	11.10	8.50	10.90	7.15	11.50	9.60	4.50	9.10	9.30
Weight of Dry Soil	58.50	38.10	33.10	40.60	43.60	30.10	22.80	34.10	27.80
Moisture Content (W %)	18.97	22.31	32.93	17.40	26.30	32.00	19.70	26.80	33.40
Dry Density(τd) (mg/m^3)	1.24	1.52	1.46	1.26	1.42	1.37	1.29	1.41	1.24
Average Dry Density(mg/m^3)	1.40			1.35			1.31		
Maximum Dry Density (MDD) mg/m^3	1.54			1.43			1.41		
Optimum Moisture Content (OMC) %	24			27.5			26.5		

Table 8:- Dry Density the Soil Samples

The percentage of the soil samples passing BS Sieves 4mm, 2mm, 1.18mm, 0.85mm, 0.6mm, 425µm, 300µm, 150µm, and 63µm are shown in Table 1.The percentage passing through No. 200 (63µm) BS sieve ranges between 10.5% and 24.7% showing that the soil samples are fine to coarse sandy materials according to Unified soil classification system (USCS). The soil samples can be basically suitable for subgrade construction as their percentage by weight finer than No. 200 BS sieve is less than 35%, according to (Holtz R. D. and Kovacs W. D., 1981) specification.

The sieve analysis (Tables 1 to 3 and Figure 2 to 4 above) shows that the samples are poorly graded as they are mainly sandy particles. The Atterberg limits of soils are important factors in understanding and determining the consistency of fine soils. The liquid limit values (Table 4) for the three locations (Eziobodo, Ihiagwa and Obinze) were 10, 46, and 47% respectively, while the plastic limit (Table 5) were 26, 21, 26.81 % respectively with plasticity index PI of -16, 25, and 20.19 % respectively. The natural moisture content (Table 6 above) of the samples were 10.3, 9.8 and 7.9% respectively. Soil compaction is one of the ground improvement techniques of soils (Surendra and Sanjeev, 2017). The bulk density (Table 7) values were 1.76, 1.69, and 1.66 mg/m^3 respectively while the dry density (Table 8) values were 1.40, 1.35, and 1.31 mg/m^3 respectively. The maximum dry density for the locations were 1.54, 1.43, and 1.41 mg/m^3 while the values for the optimum moisture content were 24, 27.5 and 26.5% respectively.

IV. CONCLUSION AND RECOMMENDATIONS

Some geotechnical properties of three (3) soil samples from Eziobodo, Ihiagwa and Obinze all in the Benin Formation was investigated. The properties determined include particle size analysis, Atterberg limits (liquid limit, plastic limit, plasticity index), natural moisture content, compaction (bulk density, dry density, maximum dry density and optimum moisture content). The soils are generally well graded sandy soils with low plasticity.

Because of their non-plastic behavior, high percentage of sand content, most of the sediments have low swelling potential; have high collapsibility potential, loses strength upon saturation and eventually susceptible to erosion. It is recommended that further tests should be carried out on the soils in the area to ascertain the suitability of the soil for engineering/civil construction.

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