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Geotechnical Analysis and Assessment of Soil Properties in Irepodun Local Government Area in Kwara State

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Abstract- This study deals with the geotechnical analysis and assessment of soil samples within some major towns in Irepodun Local government area of Kwara State. The soil under consideration was assessed base on their properties, experimental and laboratory investigations such as particle size analysis test, Alterberg limit test, specific gravity test, and compaction test. The Recommendation and the conclusion drawn provides a final clear verdict for any construction work within the chosen areas in the Local government.

Keywords-Geotechnical Analysis, soil assessment properties, Irepodun local government.

I. INTRODUCTION

It has been observed that not much work of soil Investigation Engineering has been conducted to investigate the geotechnical properties of sub soils in this North Central region of Nigeria, and this has accounted for the reason in increased risks and Collapse of Buildings and other structures in this part of the country. This research work was carried out with the aim of solving geotechnical significant problems in Irepodun Local government Area of Kwara State.

The soil analysis consists of determining the nature of the soils and rocks, as well as the conditions of ground water by using probing drilling and open cut Techniques. The analysis of these soils would allow the design Engineers to define each element to the adaptation of the ground components, especially with a consideration on future construction of Buildings and other similar structures in towns covered in this research.

II. METHODOLOGY

The Geotechnical analysis of soil samples collection was by the use of hand anger and shovel. The soil samples were collected from three different towns, namely Odo-Owa, Oke-Onigbin and Ilofa and transported to the Laboratory of civil Engineering department in Landmark University Omu-Aran for the necessary Test in accordance with BS 1377 of 1975. The Laboratory Tests carried out includes

1. Determination of particle size distribution
2. Alterberg limits
3. Specific gravity
4. Compaction Test

The detailed results for each of the Test carried out is equally Tabulated and assessed.

III. DISCUSSION AND RESULTS

Irepodun is a Local government area in Kwara State. The Headquarter is situated in the town of Omu-Aran. It has an area of 737 square kilometer and a population of 148, 610 according to the last population census conducted in 2006. The local government was created as Igbomina Ekiti division in 1968, which later matarmorphosed into Irepodun in 1976, as a result of the 1976 local government reform. Omu-Arab remains the seat of power with Eleven wards and six area offices for Administrative services.

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It shares boundary with Ifelodun Local government area to the North, Osun State to the South, Ekiti and Offa local government to the East and West respectively. It has a Land mass of 1, 095 square kilometer. It is endowed with savannah and Rain forest vegetation. This area experiences rainy season between April and October of every year and it ceases from the month of November to march. Geologically this study area falls within the basement complex of North central of Nigeria

Tabulation of Laboratory Results

3.1 Specific Gravity

Location:- Odo-Owa

Sample A

Specimen number	1	2	3
WP = Mass of empty, clean pycnometer (grams)	20	18	18
WPS = Mass of empty pycnometer + dry soil (grams)	45	37	38
WB = Mass of pycnometer + dry soil + Water(grams)	85.5	79.5	93
WB = Mass of pycnometer + Water(grams)	73	70	88
Specific Gravity (GS) = $\frac{W2-w1}{(W2-w1)-W3-w14}$	2.00	2.0	4.0
Average Specific Gravity, Gs		2.67	

Sample B

Specimen number	1	2	3
WP = Mass of empty, clean pycnometer (grams)	23	17	17
WPS = Mass of empty pycnometer + dry soil (grams)	46	38	39
WB = Mass of pycnometer + dry soil + Water(grams)	84.5	80	90
WB = Mass of pycnometer + Water(grams)	73	70	88
Specific Gravity (GS) = $\frac{W2-w1}{(W2-w1)-W3-w14}$	2.42	2.10	2.0
Average Specific Gravity, Gs		2.17	

Location: Oke-Onigbin

Sample A

Specimen number	**1**	**2**	**3**
WP = Mass of empty, clean pycnometer (grams)	24.5	15	18
WPS = Mass of empty pycnometer + dry soil (grams)	50.5	37	38
WB = Mass of pycnometer + dry soil + Water(grams)	89	87	80
WB = Mass of pycnometer + Water(grams)	75	77	69
Specific Gravity (GS) = $\frac{W2-w1}{(W2-w1)-W3-w14}$	2.08	2.10	2.22

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Average Specific Gravity, Gs		2.17	

Sample B

Specimen number	1	2	3
WP = Mass of empty, clean pycnometer (grams)	24.5	16	19
WPS = Mass of empty pycnometer + dry soil (grams)	52.5	45	42
WB = Mass of pycnometer + dry soil + Water(grams)	88	87	86
WB = Mass of pycnometer + Water(grams)	73	70	74
Specific Gravity (GS) = $\frac{W2-w1}{(W2-w1)-W3-w14}$	2.15	2.42	2.09
Average Specific Gravity, Gs		2.22	

Location: Ilofa

Sample A

Specimen number	1	2	3
WP = Mass of empty, clean pycnometer (grams)	21	19	19
WPS = Mass of empty pycnometer + dry soil (grams)	46	38	39
WB = Mass of pycnometer + dry soil + Water(grams)	86.5	80.5	89
WB = Mass of pycnometer + Water(grams)	74	71	79
Specific Gravity (GS) = $\frac{W2-w1}{(W2-w1)-W3-w14}$	2.00	2.00	2.00
Average Specific Gravity, Gs		2.00	

Sample B

Specimen number	1	2	3
WP = Mass of empty, clean pycnometer (grams)	26	18	20
WPS = Mass of empty pycnometer + dry soil (grams)	51	40	41
WB = Mass of pycnometer + dry soil + Water(grams)	86	84	85
WB = Mass of pycnometer + Water(grams)	74	73	72
Specific Gravity (GS) = $\frac{W2-w1}{(W2-w1)-W3-w14}$	2.08	2.00	2.63
Average Specific Gravity, Gs		2.24	

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3.2Moisture Content

Location:- Odo-Owa

Sample A

Weight of can	30	29.5	29.5
Weight of pan + wet soil	127.5	134.5	140
Weight of pan + Dry soil	120	126	131.5
Moisture content (W%)	8.33	8.81	8.29
Avg Moisture content	8.48		

Sample B

Weight of can	331.5	30	29.5
Weight of pan + wet soil	104.5	111.5	118
Weight of pan + Dry soil	97	103	108.5
Moisture content (W%)	11.48	10.96	12.03
Avg Moisture content	11.48		

Loaction: Oke-Onigbin

Sample A

Weight of can	30	29.5	30
Weight of pan + wet soil	135	117	118.5
Weight of pan + Dry soil	132	111	113
Moisture content (W%)	2.94	7.36	6.63
Avg Moisture content	5.98		

Sample B

Weight of can	31	30	30.5
Weight of pan + wet soil	137	126	127
Weight of pan + Dry soil	132	112	114
Moisture content (W%)	4.95	17.07	15.57
Avg Moisture content	12.53		

Location: Ilofa

Sample A

Weight of can	31	30.5	30.5

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Weight of pan + wet soil	128	131.5	106.5
Weight of pan + Dry soil	119.5	123	100
Moisture content (W%)	9.60	9.19	9.35
Avg Moisture content	9.38		

Sample B

Weight of can	30	29.5	29.5
Weight of pan + wet soil	127	130.5	105.5
Weight of pan + Dry soil	118.5	122	99
Moisture content (W%)	4.94	17.07	15.57
Avg Moisture content	12.53		

3.3 Sieve Analysis

This test was carried out to determine the grain size distribution of the soil. The results obtained are as follows;

Location:- Odo-Owa

Sample A

Sieve no	Diameter (mm)	Mass of empty sieve	Mass of sieve + soil retained	Soil Retained	% Retained	Cumulative frequency	% fine passing
4	4.75	543.5	636.5	93.0	7.37	7.37	92.63
10	2.00	522.0	670.5	148.5	11.77	19.14	80.06
16	1.18	493.5	667.5	174.0	13.79	32.93	67.07
30	0.6	477.0	829.5	352.5	27.93	60.86	39.14
40	0.425	454.0	829.5	171.5	13.59	74.45	25.55
50	0.3	449.5	586.0	136.5	10.82	85.27	14.73
200	0.075	368.0	526.0	158.0	12.52	97.79	2.21
pan		395.5	423.5	28.0	2.21	100	

From the above, a graph is used to determine the particle size of the soil, the coefficient of Uniformity (c_u) and coefficient of Gradation is obtained

The result is as follows

D_{10} = 0.21 mm, D_{30} = 0.48 mm, D_{50} = 0.8mm, D_{60} = 1.0

$C_u = D_{60}/D_0 = 1/0.21 = 4.76$

C_c =D30 / D10*D60 = (0.48) / (1*0.21) = 1.09

Sample B

Sieve no	Diameter (mm)	Mass of empty sieve	Mass of sieve + soil retained	Soil Retained	% Retained	Cumulative frequency	% fine passing
4	4.75	543.5	633.0	89.5	8.35	8.35	91.65
10	2.00	522.0	639.0	117.0	10.93	19.28	80.72
16	1.18	493.5	623.0	129.5	12.08	31.36	68.64
30	0.6	477.0	760.0	283.0	26.41	57.77	42.23
40	0.425	454.0	588.0	134.0	12.51	70.28	29.72
50	0.3	449.5	558.5	109.0	10.17	80.45	19.55
200	0.075	368.0	552.0	184.0	17.17	97.62	2.38
pan		395.5	421.0	25.5	2.38	100	

The result is as follows
D_{10} = 0.15 mm, D_{30} = 0.44 mm, D_{50} = 0.88mm, D_{60} = 1.2mm
$C_u = D_{60}/D_0 = 1.2/0.15 = 8$
$C_c = (D_{30})^2 / D_{16}*D_{10} = (0.44)^2 / 1.2*0.15 = 1.07$

3.4 Location: Oke-Onigbin
Sample A

Sieve no	Diameter (mm)	Mass of empty sieve	Mass of sieve + soil retained	Soil Retained	% Retained	Cumulative frequency	% fine passing
4	4.75	543.5	635.0	91.5	8.5	8.5	91.5
10	2.00	522.0	638.0	116.0	10.78	19.28	80.72
16	1.18	493.5	625.0	131.5	12.22	31.50	68.5
30	0.6	477.0	759.0	282	26.21	57.71	42.29
40	0.425	454.0	586.0	132	12.27	69.98	30.02
50	0.3	449.5	560.0	110.5	10.27	80.25	19.75
200	0.075	368.0	542.0	174	16.17	96.42	3.58
pan		395.5	434.0	38.5	3.58	100	-

From the result obtained
$C_u = D_{60}/D_0 = 0.92/0.4 = 2.3$
$C_c = (D_{30})^2 / D_{16}*D_{10} = (0.44)^2 / 0.92*0.18 = 0.96$

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3.5 Location: Oke-Onigbin

Sample A

Sieve no	Diameter (mm)	Mass of empty sieve	Mass of sieve + soil retained	Soil Retained	% Retained	Cumulative frequency	% fine passing
4	4.75	543.5	640.0	96.5	8.83	8.83	91.17
10	2.00	522.0	642.0	120.0	10.98	19.81	80.19
16	1.18	493.5	630.0	136.5	12.49	32.30	67.70
30	0.6	477.0	740.0	263	24.06	56.36	43.64
40	0.425	454.0	589.0	135	12.35	68.7	31.29
50	0.3	449.5	570.0	120.5	11.02	79.73	20.27
200	0.075	368.0	548.0	180	16.47	96.20	3.580
pan		395.5	437.0	41.5	3.80	100	-

Total weight of soil sample = 1270g
Cu=D60/D10=1/0.21=4.76
Cc=(D30)2/D10*D60=(0.48) 2/1*0.21=1.09

Sample B

Sieve no	Diameter (mm)	Mass of empty sieve	Mass of sieve + soil retained	Soil Retained	% Retained	Cumulative frequency	% fine passing
4	4.75	543.5	634.0	90.5	8. 31	8. 31	91.69
10	2.00	522.0	640.0	118.0	10.84	19.15	80.85
16	1.18	493.5	624.0	1305	11.99	31.14	68.86
30	0.6	477.0	770.0	293	26.92	58.06	41.94
40	0.425	454.0	589.0	135	12.41	70.47	29.53
50	0.3	449.5	559.0	110	10.11	80.58	19.42
200	0.075	368.0	553.0	185	16.99	97.57	2.43
pan		395.5	422.0	26.5	2.43	100	-

TOTAL WEIGHT OF SOIL SAMPLE=1088.5G

3.6 ATTERBERG LIMIT

Atterberg limit test was conducted on the soil sample and the following results were obtained

Odo Owa

3.7 Plastic Limit

SAMPLE A

Average moisture content=39.16

Plastic limit

Number of trial	Mass of empty can + lid (g)	Mass of can, lid + moist soil (g)	Mass can, lid+ dry soil (g)	Mass of soil solids	Mass of pore water (g)	Water content, w%	Wet soil	Number of drops
1	20.4	37.68	31.44	11.04	6.24	36.11111111	17.28	29
2	22.3	28.56	26.02	3.72	2.54	40.57507987	6.26	27
3	23.33	35.63	29.23	5.9	6.4	52.03252033	12.3	21
4	22.07	31.8	29.08	7.01	2.72	27.95477903	9.73	16
				27.67			45.57	

Sample B

Average moisture content =39.17

Number of trial	Mass of empty can + lid (g)	Mass of can, lid + moist soil (g)	Mass can, lid+ dry soil (g)	Mass of soil solids	Mass of pore water (g)	Water content, w%	Wet soil	Number of drops
1	20.4	37.68	31.44	11.04	6.24	36.11111111	17.28	29
2	22.3	28.56	26.02	3.72	2.54	40.57507987	6.26	27
3	23.33	35.63	29.23	5.9	6.4	52.03252033	12.3	21
4	22.07	31.8	29.08	7.01	2.72	27.95477903	9.73	16
				27.67			45.57	

3.8 Location: Oke Onigbin

Plastic limit A

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Average moisture content = 29.49

Number of trial	Mass of empty can + lid (g)	Mass of can, lid + moist soil (g)	Mass can, lid+ dry soil (g)	Mass of soil solids	Mass of pore water (g)	Water content, w%	Wet soil	Number of drops
1	20.4	35.63	32.34	11.94	3.29	21.6021 0112	15.23	29
2	22.3	29.57	27.03	4.73	2.54	34.9381 0179	7.27	27
3	23.15	32.24	29.25	6.1	2.99	32.8932 8933	9.09	21
4	22.01	31.9	29.08	7.07	2.82	28.5136 5015	9.89	16
				29.84			41.48	

Plastic limit B

Average moisture content = 41.69

Number of trial	Mass of empty can + lid (g)	Mass of can, lid + moist soil (g)	Mass can, lid+ dry soil (g)	Mass of soil solids	Mass of pore water (g)	Water content, w%	Wet soil	Number of drops
1	20.4	37.67	31.44	11.04	6.23	36.074 11697	17.2 7	29
2	22.3	28.56	26.02	3.72	2.54	40.575 07987	6.26	27
3	23.15	35.24	29.23	6.08	6.01	49.710 50455	12.0 9	21
4	22.05	33.8	29.05	7	4.75	40.425 53191	11.7 5	16
				27.84			47.3 7	

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3.9 ILOFFA
SAMPLE A
Average moisture content = 38.65

Number of trial	Mass of empty can + lid (g)	Mass of can, lid + moist soil (g)	Mass can, lid+ dry soil (g)	Mass of soil solids	Mass of pore water (g)	Water content, w%	Wet soil	Number of drops
1	20.4	36.67	32.44	12.04	4.23	25.998 77074	16.2 7	29
2	22.3	29.57	26.04	3.74	3.53	48.555 70839	7.27	27
3	23.15	34.57	29.23	6.08	4.99	45.076 7841	11.0 7	21
4	22.01	32.9	29.03	7.08	3.81	34.986 2259	10.8 9	16
				28.94			45.5	

SAMPLE B
Average moisture content = 7.401

Number of trial	Mass of empty can + lid (g)	Mass of can, lid + moist soil (g)	Mass can, lid+ dry soil (g)	Mass of soil solids	Mass of pore water (g)	Water content, w%	Wet soil	Number of drops
1	6.8	17.3	16.4	9.6	0.9	8.5714 28571	10.5	29
2	8.7	16.8	13.2	4.5	3.6	44.444 44444	8.1	27
3	14.3	24.6	23.2	8.9	1.4	13.592 23301	10.3	21
4	15.6	23.7	22.4	6.8	1.3	16.049 38272	8.1	16
				29.8		20.664 37219	37	

3.10 ODO-OWA
SAMPLE A

Number of trial	Mass of empty can + lid (g)	Mass of can, lid + moist soil (g)	Mass can, lid+ dry soil (g)	Mass of soil solids	Mass of pore water (g)	Water content, w%	Wet soil	Number of drops

1	19.4	22.8	21.2	1.8	1.6	47.058 82353	3.4	30
2	21.3	26.7	23	2.6	2.8	51.851 85185	5.4	26
3	22.2	28.71	25.2	3	3.51	53.917 05069	6.51	20
4	22.01	25.9	23.9	1.89	2	51.413 88175	3.89	17

Average moisture content = 51.06

SAMPLE B

Numb er of trial	Mass of empty can + lid (g)	Mass of can, lid + moist soil (g)	Mass can, lid+ dry soil (g)	Mass of soil solids	Mass of pore water (g)	Water content, w%	Wet soil	Number of drops
1	20.4	36.06	30.3	9.9	5.78	36.862 2449	15.6 8	29
2	25.3	32.57	25.4	0.1	6.64	98.516 32047	6.74	27
3	23.15	33.83	27.7	4.55	9.13	57.397 00375	10.6 8	21
4	24.02	31.4	28.66	4.64	6.13	37.127 37127	7.38	16
				19.19	2.74		40.4 8	

Average moisture content = 57.47

3.11 OKE ONIGBIN

SAMPLE A

Numb er of trial	Mass of empty can + lid (g)	Mass of can, lid + moist soil (g)	Mass can, lid+ dry soil (g)	Mass of soil solids	Mass of pore water (g)	Water content, w%	Wet soil	Number of drops
1	20.4	38.3	31.3	10.9	7	39.106 14525	17.9	29
2	22.3	29.4	25.38	3.08	4.02	56.619	7.1	27

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						71831		
3	23.2	34.8	29.66	6.46	5.14	44.310 34483	11.6	21
4	21. 1	31.4	28.66	7.56	2.74	26.601 94175	10.3	16
				28			46.9	

Average moisture content = 41.66

SAMPLE B

Average moisture content = 38.67

Number of trial	Mass of empty can + lid (g)	Mass of can, lid + moist soil (g)	Mass can, lid+ dry soil (g)	Mass of soil solids	Mass of pore water (g)	Water content, w%	Wet soil	Number of drops
1	20.4	37.2	29.3	8.9	7.9	47.023 80952	16.8	29
2	22.3	28.04	25.4	3.1	2.64	45.993 03136	5.74	27
3	23.2	32.83	29.7	6.5	3.13	32.502 59605	9.63	21
4	22.01	31.4	28.66	6.65	2.74	29.179 9787	9.39	16
				25.15			41.5 6	

3.12 ILOFFA

SAMPLE A

Number of trial	Mass of empty can + lid (g)	Mass of can, lid + moist soil (g)	Mass can, lid+ dry soil (g)	Mass of soil solids	Mass of pore water (g)	Water content, w%	Wet soil	Number of drops
1	18.2	23.8	21.2	3	2.6	46.428 57143	5.6	30
2	20.3	25.7	23.93	3.63	1.77	32.777 77778	5.4	26
3	24.2	26.2	25.17	0.97	1.03	51.5	2	20
4	21	25.5	23.9	2.9	1.6	35.555	4.5	17

						55556		
				10.5			17.5	

Average moisture content = 41.56

SAMPLE B

Average moisture content = 44.39

Number of trial	Mass of empty can + lid (g)	Mass of can, lid + moist soil (g)	Mass can, lid+ dry soil (g)	Mass of soil solids	Mass of pore water (g)	Water content, w%	Wet soil	Number of drops
1	20.4	38.80	31.3	10.9	6.78	38.348 41629	17.6 8	29
2	22.3	29.04	25.38	3.08	3.66	54.302 67062	6.74	27
3	23.15	35.82	29.7	6.55	6.12	48.303 07814	12.6 7	21
4	22.03	32.4	28.6	6.57	3.8	36.644 16586	10.3 7	16
				27.1			47.4 6	

IV. GENERAL DISCUSSION ON RESULTS ANALYSIS

ODO OWA

The particle analysis showed that Odo Owa soil is coarse grained material. Percentage of material passing No.200 sieve was 80% while the particle size distribution classified the sample to be sand. From Aterberg limit test, it shoed that the liquid limit was 51.06%, plastic limit to be 39.16% while the plasticity index was 11.9%. the specific gravity was 2.67 while for Sample B, the particle analysis also showed that the soil is a fine grained material. The percentage of material passing a N0 200 sieve is 80.72%. also the Alterberg limit shows that the liquid limit is 57.47%, the plastic limit is 39.17 while the plasticity index is 18.3%. from the result, the specific gravity is normal with a high liquid limit. The result of the plasticity index proved the sample to the medium plastic (according to GRIER & PERRY 1972).

OKE ONIGBIN

The particle size analysis showed that Oke Onigbin is coarse grained material, it has a little content of grave material. It has about 2.3% of grave. From Atterberg limit, it showed the liquid limit was 41.66%, plastic limit is 29.49% while the plasticity index is 12.17%. from the result obtained, the value of the specific grave is 2.17

For sample B, the particle analysis showed is also a fine grained material. The percentage passing through the sieve 200mm is 80.19. also the Atterberg limit shows that, its plastic limit is 41. 69% while the liquid lomit is 48.62%, the value for the plasticity index is 7.07%, the result obtained after the specific gravity test was conducted on it is 2.22

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ILOFFA

The particle size analysis showed that the soil found at Iloffa was also a finr grained soil with a little content of gravel. The percentage passing through the 200mm sieve is 80.83

From the result obtained after Atterberg limit was conducted are; the plastic limit is 38.65%, the liquid limit is 41.56%. The plasticity index is 2.91%

Sample B also show that the percentage passing through the sieve 200mm is 80.85%. Also, from the Atterberg limit, the liquid limit is 44.39%, the plastic limit is 7.40% while the plasticity index is 39.99

V. RECOMMENDATION

It is quite Obvious from the different results obtained that real Engineering and construction works can be carry out in these three towns for Buildings and other related structures. The bearing capacity of the soils in these three locations should also be consider, since it was not captured in the Laboratory Exercise performed in this cause of the study.

VI. CONCLUSION

With the aid of Geotechnical soil analysis and detailed information obtained as a result of various test carried out to check the behavior of soil this Local Government, the host community will hence forth appreciate the use of soil analysis, which will provide them the necessary information needed in order to forestall future collapse of Buildings and other structures within the locality.

REFERENCES

[1] karafiath and edward; soil mechanics for off road vehicle engineering, first edition trans tech publication
[2] ijaiye a.s. “study of engineering properties of soil” july 1985
[3] head k.h “manual of soil laboratory testing” volume i and ii published by rentech press limited london plymouth 1982
[4] owen g.ingles “soil stabilization principle and practice” butterworth’s property limited 1972
[5] smith g.n “elements of soil mechanics for civil and mining engineers” third edition grosby lockwood staples london 1968
[6] steele “classification of highway subgrade materials”
[7] spangler and handy “soil engineering” fourth edition harper and row publishers new york 1992.
[8] olumide ogundipe “transportation and highway systems design” 2014
[9] geotechnical laboratory manual 2014-2009
[10] das b.m (2008). advance soil mechanics. madison, new york: taylor & francis
[11] vitton, s. (2006). introduction to soil stabilization. (s. vitton,ed.)
[12] wikipedia 2014
[13] the united republic of tanzania ministry of works.(2000). laboratory testing manual
[14] oborie, h.n (2014). geotechnical investigation and characterization of sub soil in yenagoa beyelsa state, central niger delta
[15] das b.m.(2013). fundamentals of geotechnical engineering (fourth edition.) stamfrord, usa
[16] atkinson, j.(2007). the mechanics of soils. new york: taylor & francis group
[17] nwankwoala, p.y.(2013). suitability of soils as bearing media at a fresh water swamp terrain in the niger delta
[18] standard test methods of characteristics of soil using modified effort
[19] zumrawi, m.(2014). effects of inadequate geotechnical investigation on civil engineering projects

APPENDIX

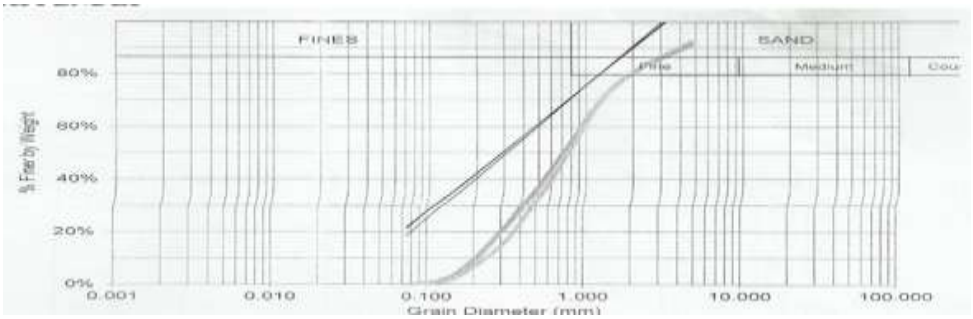

FIG 1: SIEVE ANALYSIS GRAPH

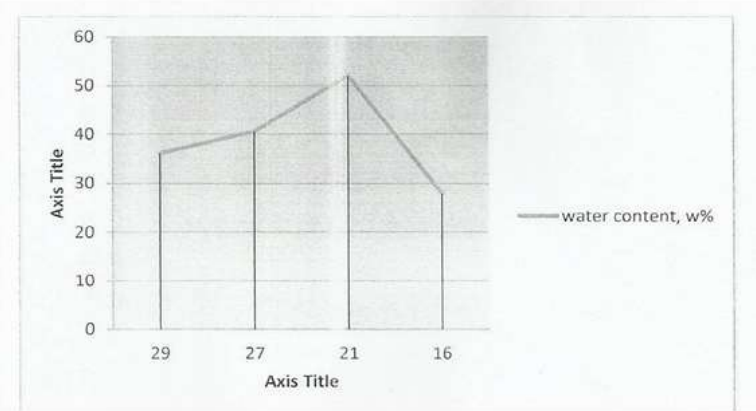

FIG II: GRAPH OF PLASTIC LIMIT OF SOIL SAMPLES IN ODO OWA

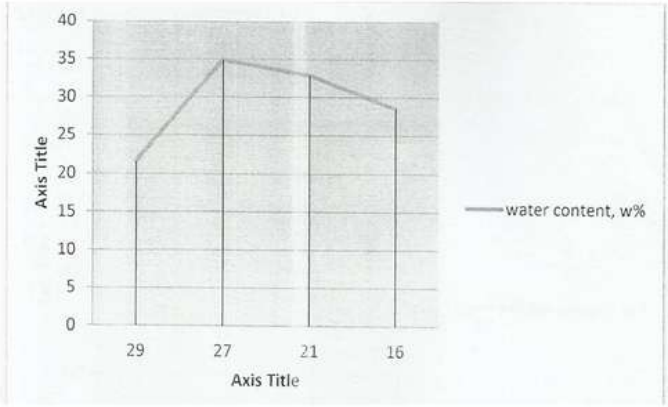

FIG III: **GRAPH SHOWING THE PLASTIC LIMIT OF SOIL SAMPLES IN OKE ONIGBIN**

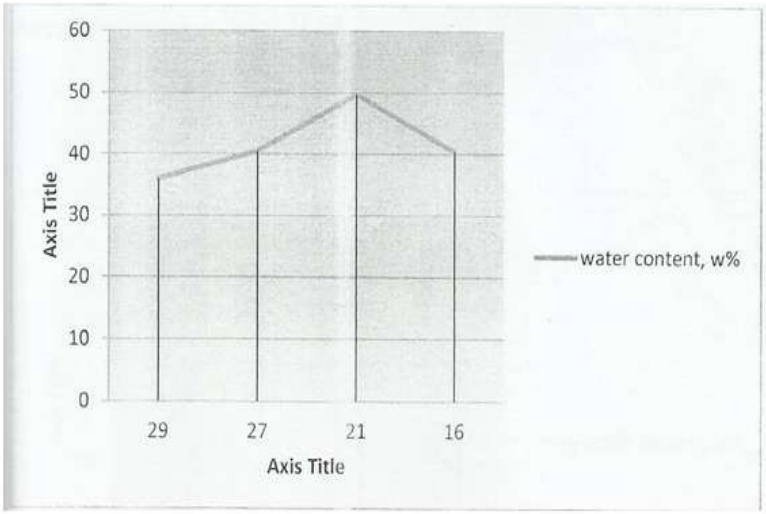

FIG IV: GRAPH SHOWING SOIL SAMPLES IN OKE ONIGBIN

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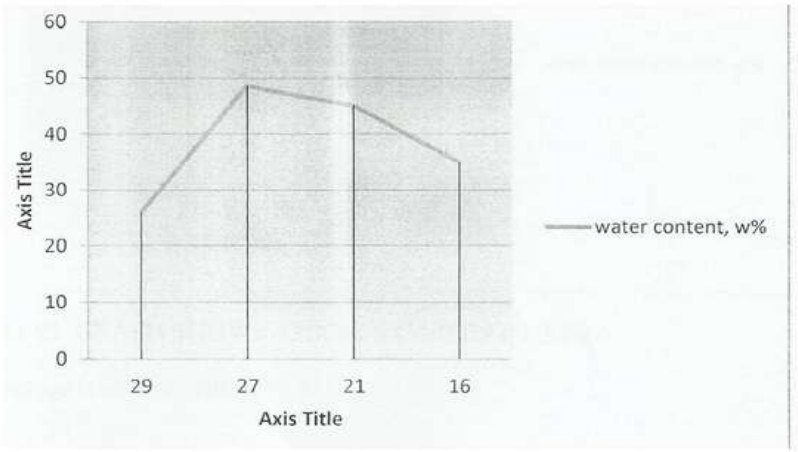

FIG V: GRAPH SHOWING SOIL SAMPLES IN ILOFA

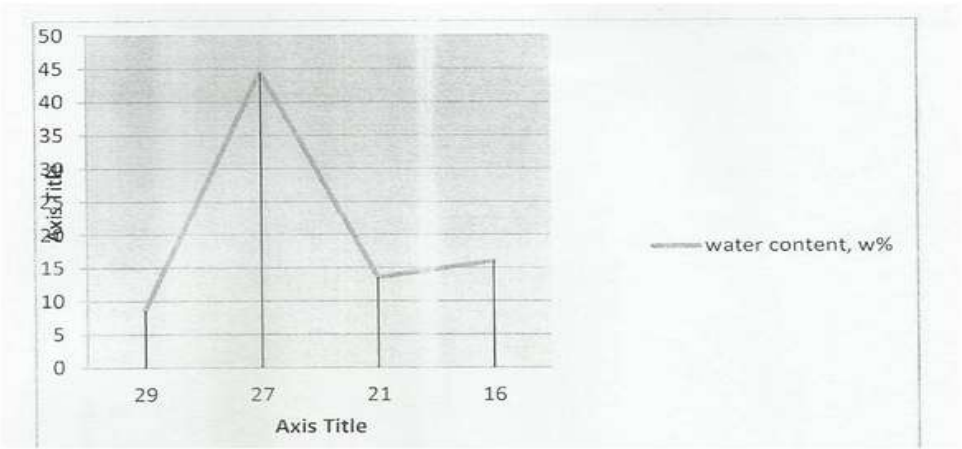

FIG VI: GRAPH SHOWING SOIL SAMPLES IN ILOFA

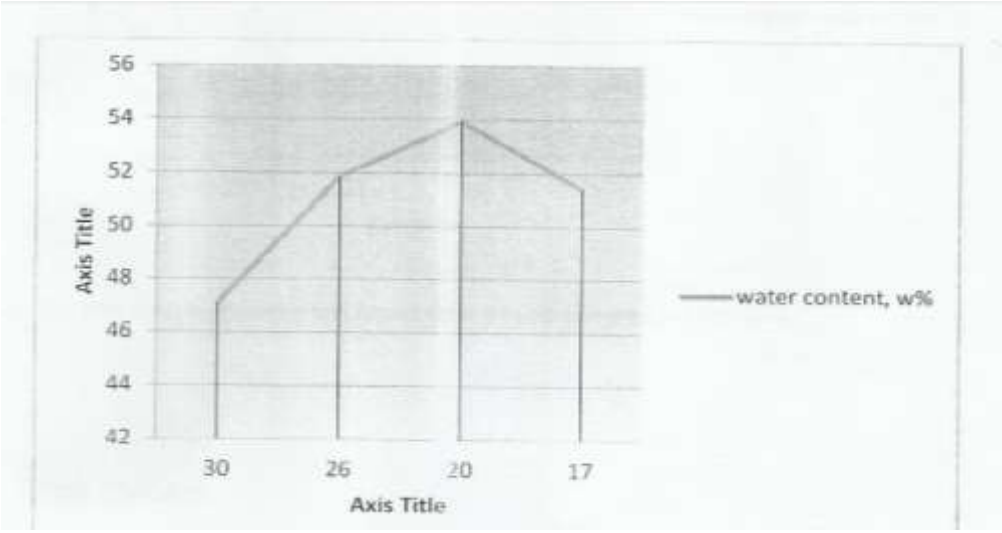

FIG VII: GRAPH SHOWING LIQUID LIMIT OF SOIL SAMPLES IN ODO OWA

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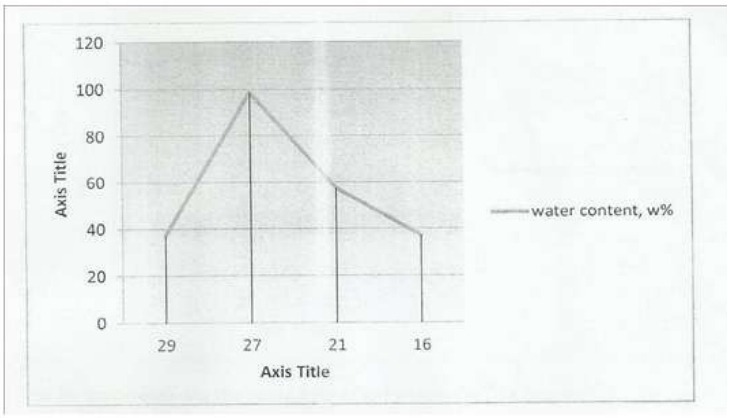

FIG VIII: GRAPH SHOWING LIQUID LIMIT OF SOIL SAMPLES IN ODO OWA

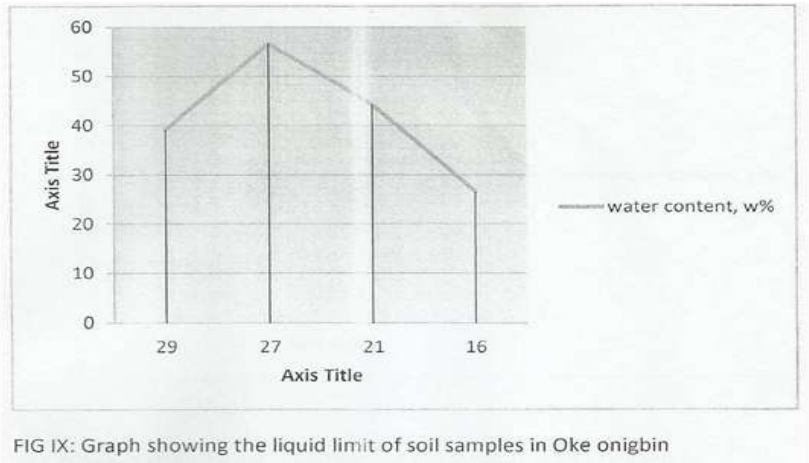

FIG IX: GRAPH SHOWING LIQUID LIMIT OF SOIL SAMPLES IN OKE ONIGBIN

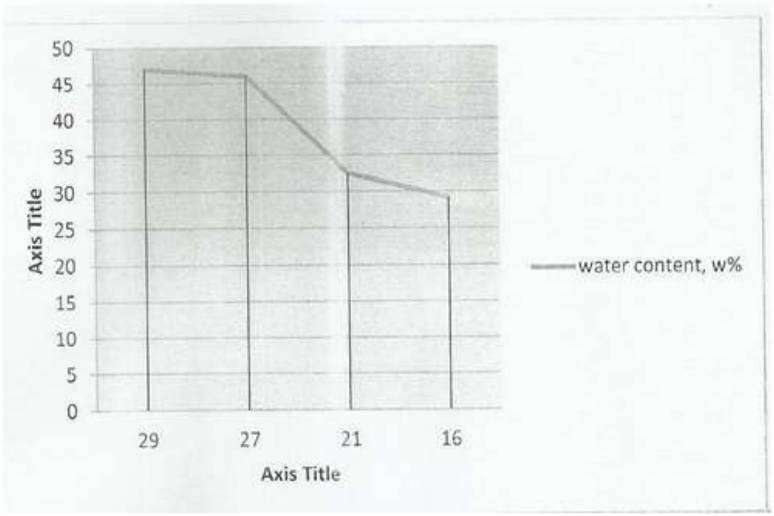

FIG X: GRAPH SHOWING LIQUID LIMIT OF SOIL SAMPLES IN OKE ONIGBIN