ISSN 2229-5518

QUANTITATIVE AND QUALITATIVE EVALUATIONS OF RESIDUAL CLAY DEPOSIT ALONG IKERE –IGBARA ODO ROAD IKERE-EKITI, SOUTHWESTERN NIGERIA.

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Abstract

Quantitative and qualitative evaluations of residual clay deposit along Ikere –Igbara Odo Road, Ikere-Ekiti were executed with a view to determining its possible utilities. Geophysical study involving electrical resistivity survey was carried out in order to estimate its reserves. Particle size distribution analysis and consistency limits tests were employed for qualitative evaluation. The results of geophysical survey revealed fairly thick layer (about 1.7m -5.6m) of lateritic clay with depth to the bedrock of about 18m. The amounts of the fine fraction (about 58 – 65 %), clay sized fraction (about 8 -18%) and permeability coefficient (about 3.6 x 10^{-6} cm/s to 8.0 x 10^{-6} cm/s) show that the clay possesses properties of good liner for landfills. The fairly high amount of sand sized fraction (about 31 to 36%) show that the clay can be used for the production of building bricks if appropriately stabilised with lateritic soil.

Index Terms- Residual, Reserves, Evaluation, Geophysical.

1 Introduction

Lateritic clay deposits abound in many parts of the southwestern Nigeria. Clay has found wide application such as ceramic, pharmaceutical and building construction industries. However, most of the clay deposits are yet to be assessed quantitatively and qualitatively. The clay deposit along Igbara Odo road in Ikere-Ekiti developed over porphyritic granite which outcrops in most part of Ikere Ekiti metropolis(Fig.1). Porphyritic granite essentially consists of quartz, feldspar phenocryst, micas (biotite and muscovite) and pyroxene (augite). The rock often undergoes deep weathering to form clayey soils. (Fig. 2). This study attempted to evaluate the clay deposits for its possible utilities.

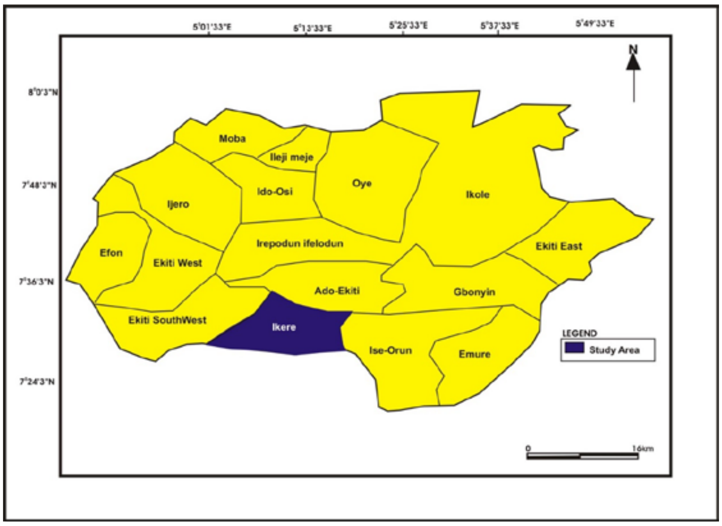

FIG. 1. Map of Ekiti showing the study area [1]

2 Study Area

Ikere-Ekiti is located within Ikere local government area in the southern part of Ado-Ekiti, Ekiti State (Fig. 1). It is located on latitudes 7° 30’N – 7° 35’ N and longitudes 5° 10’ E – 5° 15’ E respectively covering a total area of 346.5 km2. Ikere-Ekiti and its environs are dominated by crystalline rocks which are composed of migmatite-gneiss quartzite complex, charnockites and fine to medium- grained granites [2, 3, 4 and 5].

ISSN 2229-5518

3 Materials and Methods

The surface geophysical technique employed in the study was the electrical resistivity survey. A total of eight vertical electrical sounding (VES) points were carried out with a maximum current electrode spacing of 100 meters. Schlumberger array was employed. The apparent resistivity data obtained from the VES survey were presented as depth sounding curves by plotting the apparent resistivities along the ordinate axis and the half current electrode spacing (AB/2) along the abscissa. The results of the VES curves (Fig. 3) obtained from the partial curve matching were then used to constrain the interpretation by the computer using iteration software known as WINRESIST. This invariably reduces overestimation of depths. For qualitative evaluation of the study, five soil samples were collected and evaluated for geotechnical tests.

Fig. 2. The Plate showing the Project Site along

Ikere-Igbara Odo Road, Ikere Ekiti, Ekiti State

4 Results and Discussions

4.1 Electrical resistivity data

Table 1 shows that four layers were encountered in each of the VES points. These are from top to bottom. Top soil is characterized by generally low resistivity which is an indication of loose nature of the soil. Its thickness varies from about 0.8 m to 2.7 m. Lateritic clay has layer thickness varies from 1.7m to 5.6 m. the relatively high resistivity is indicative of stiff to hard soil. The weathered zone has a thickness that varies from about 4.6m to 18.7m. The relatively low resistivity may be indicative of loose and / or wet soil. For the fresh bedrock, the depth to the bedrock varies from about 7.5 m to 26.8m

4.2 Qualitative evaluation of the lateritic clay

The two index geotechnical tests, grain size distribution and consistency limits performed on samples of the clay were used to generate data that were compared with some standard specifications

4.2.1 Particle size distribution

The grading curves for the soil samples in this study are presented in Figure 6 while Table 2 was produced from the curve. The generally high amounts of fine fraction (about 58.3% to 65.4%) are typical of fine grained soils. Rowe et al (1995) stipulated amount of fines of at least 30 % for good liners for landfills. The amounts of clay sized fraction (about 12% to 18%) are not too different from the minimum figure of 15% recommended in ONORMS 2074 cited in Ogunsanwo 1999. Table 3 shows the permeability coefficient estimated from grain size parameter. The values range from about 3.6 x 10^{-6} cm/s to 8.0 x 10^{-6} cm/s. the figures are close to less than 10^{-6} to 10^{-8} stipulated by Allen (2000) for geological barriers which are clay rich soils that are alternating layer which permit show infiltration of leachates.

4.2.2 Consistency limits

Table 4 is the summary of the values of the consistency limits while Figure 7 shows the Casagrande chart classification of the soil. The plasticity index varies from 16.1% to 17.7%. Benson et al., (1994) and Rowe et al., (1995) recommended a plasticity index of at least 7%. The clay is therefore suitable as landfill liner or seal.

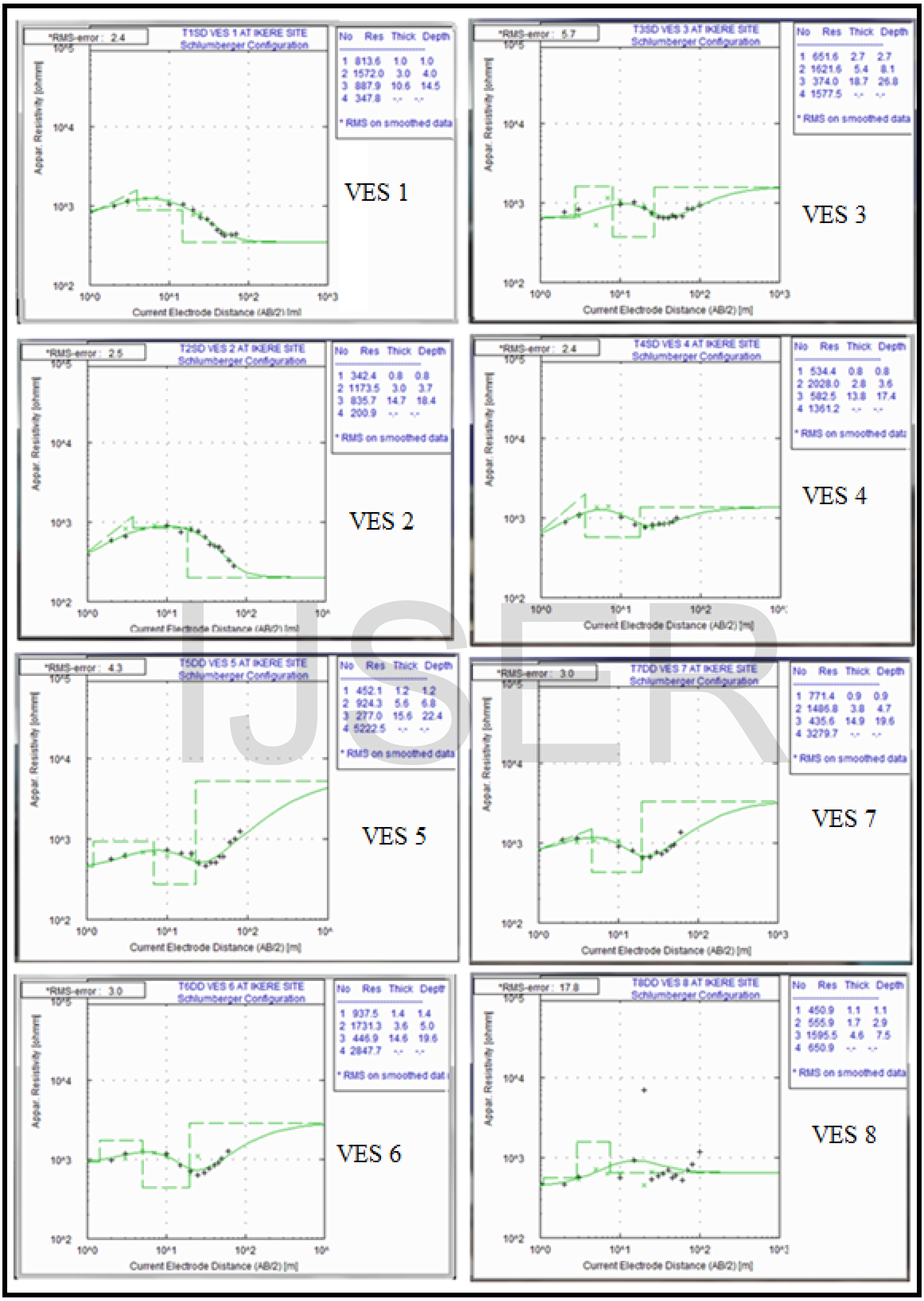

Fig. 3. Depth Sounding Curves (VES 1 – VES 8)

TABLE 1: Summary of layer model interpretation of VES points

Station	Layer	Resistivity (ohm-m)	Thickness(m)	Depth(m)	Probable Lithology
	1	813.6	1.0	1.0	Topsoil
	2	1572.0	3.0	4.0	Lateritic Clay
	3	887.9	10.6	14.5	Weathered Rock
VES 1	4	347.8	infinite	infinite	Fresh Basement
	1	342.4	0.8	0.8	Topsoil
	2	1173.5	3.0	3.8	Lateritic Clay
	3	835.7	18.4	22.2	Weathered Rock
VES 2	4	200.9	infinite	Infinite	Fresh Basement
	1	651.6	2.7	2.7	Topsoil
	2	1621.6	5.4	8.1	Lateritic Clay
	3	374.0	18.7	26.8	Weathered Rock
VES 3	4	1577.5	infinite	Infinite	Fresh Basement
	1	534.4	0.8	0.8	Topsoil
	2	2028.0	2.8	3.6	Lateritic Clay
	3	582.5	13.8	17.4	Weathered Rock
VES 4	4	1361.2	infinite	Infinite	Fresh Basement
	1	452.1	1.2	1.2	Topsoil
	2	924.3	5.6	6.8	Lateritic Clay
	3	277.0	15.6	22.4	Weathered Rock
VES5	4	5222.5	infinite	Infinite	Fresh Basement
	1	937.5	1.4	1.4	Topsoil
	2	1731.1	3.6	5.0	Lateritic Clay
	3	446.9	14.6	19.6	Weathered Rock
VES 6	4	2847.7	infinite	Infinite	Fresh Basement
	1	771.4	0.9	0.9	Topsoil
	2	1486.8	3.8	4.7	Lateritic Clay
	3	435.6	14.9	19.6	Weathered Rock
VES 7	4	3279.7	infinite	Infinite	Fresh Basement
	1	450.9	` 1.1	1.1	Topsoil
	2	555.9	1.7	2.9	Lateritic Clay
	3	1595.5	4.6	7.5	Weathered Rock
VES 8	4	650.9	infinite	infinite	Fresh Basement

Table 3: Estimated Permeability Coefficient of the Soil Samples

Sample Code	D_{50}	K (cm/s)
L1	0.12	5.14×10^{-6}
L2	0.15	8.03×10^{-6}
L3	0.14	7.00×10^{-6}
L4	0.13	6.03×10^{-6}
L5	0.10	3.57×10^{-6}

$K = 0.00357\ D_{50}^2$ and $K \leq 1 \times 10^{-6}$

Table 2: Particle Size Distribution of the Studied Soil Samples

Sample Code	% Clay fraction	% Silt	Amount of fines	% Sand	% Gravel
L1	13	54	65.4	31	2
L2	16	46	60.3	32	8
L3	8	50.3	58.3	35	7
L4	12	49	61.0	36	3
L5	17.5	47.2	64.7	33	2.5

5 CONCLUSIONS

The studied clay deposit with thicknesses that vary from 1.7m to 5.6 m is large enough for commercial exploitation. The clay also has physical / geotechnical properties such as particle size distribution, plasticity and permeability coefficient that it suitable as liner (seal) for sanitary landfill. This means that huge borrow pit that may result from exploitation of the clay deposit can be used as a landfill site. The clay can also be transported to serve as liner for landfill in any other location. If stabilised with lateritic soil of good quality, the clay can also be used for production of both sun –cured and burnt bricks of adequate strength for building construction.

ISSN 2229-5518

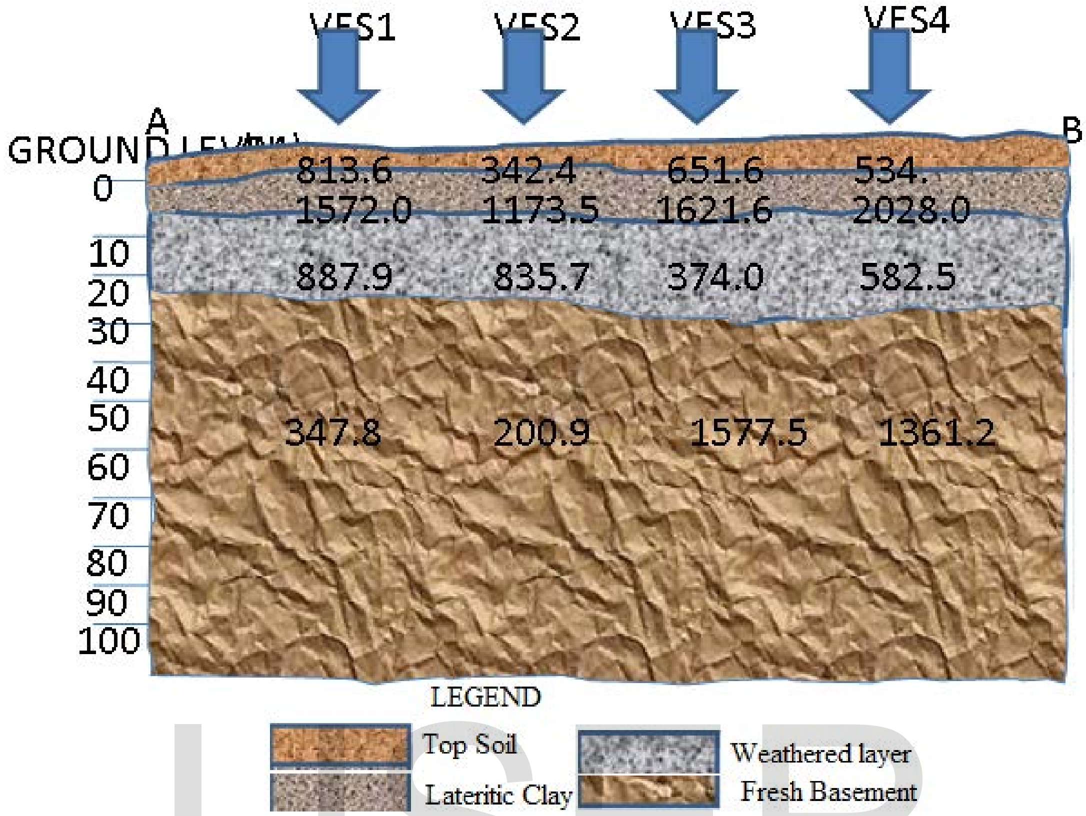

Fig. 4. Geoelectric Section Showing Variation of Resistivity with Depth along VES 4, VES 1 and VES 5.

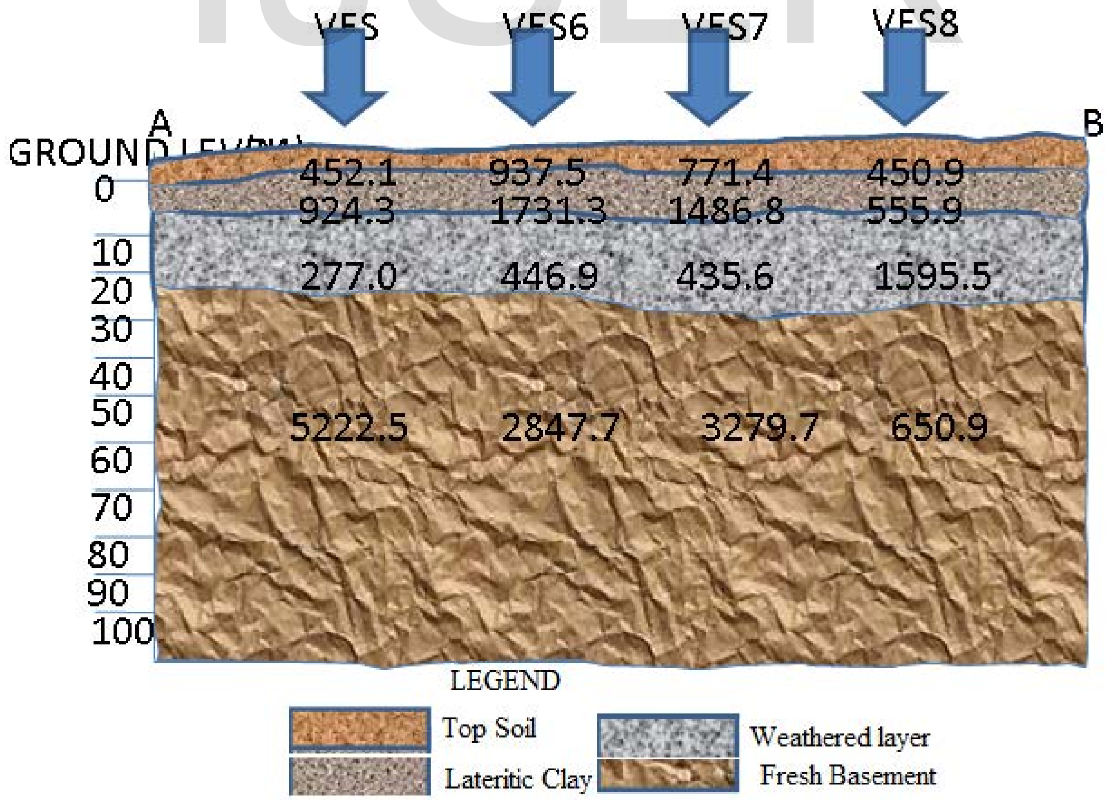

Fig. 5: Geoelectric Section Showing Variation of Resistivity with Depth along VES 4, VES 1 and VES 5

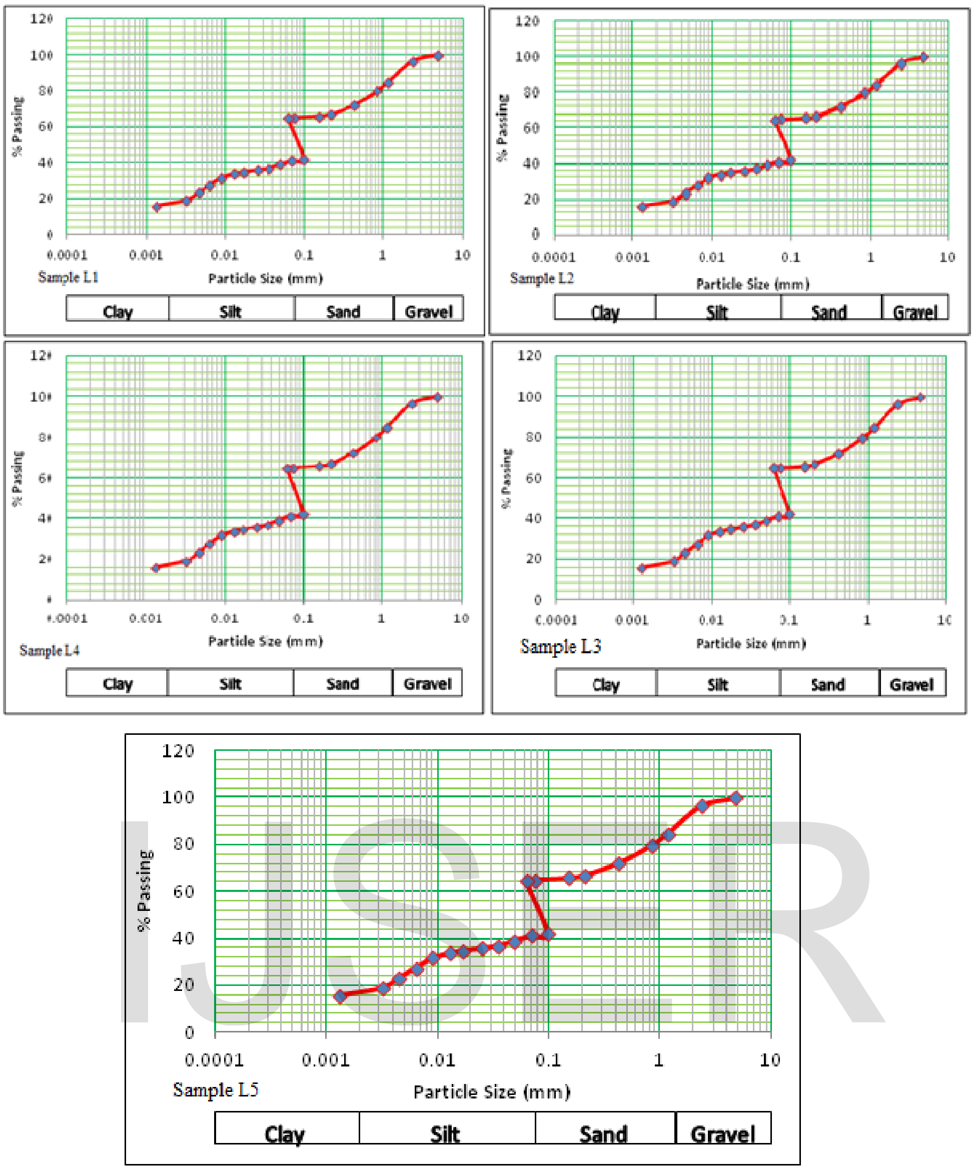

Fig. 6. Grading Curve for Soil Samples in the study area (Samples L1 – L5).

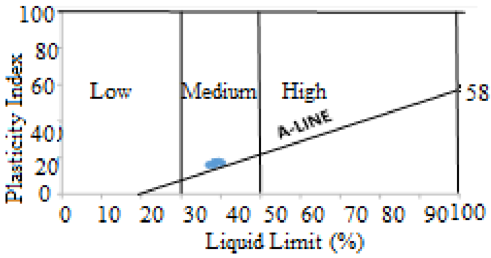

Fig. 7. Casagrande chart classification of the soil samples

Table 4: Plasticity Characteristic of the Soil Samples

Sample Code	Liquid Limit	Plastic Limit	Plasticity Index	Casagrande chart classification
L1	39.4	21.7	17.7	Medium plasticity
L2	38.2	20.8	16.1	Medium plasticity
L3	37.0	20.9	16.1	Medium plasticity
L4	40.2	22.9	17.3	Medium plasticity
L5	38.4	20.8	17.6	Medium plasticity

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