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Research Article

THE GEOTECHNICAL INDEX PROPERTIES OF SOIL IN WARRI, DELTA STATE, NIGERIA

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ABSTRACT

The study of geotechnical index properties of soils in Warri, Delta state was carried out to determine the index properties of soil. The laboratory test carried out included, moisture content, grain size analysis, Atterberg limits and compaction test. As determined, recorded value ranging from 8.1 – 26.9% (moisture content), 22.0 – 38% (liquid limit), 19.5 -22.4% (plastic limit), 2.1 – 17.9% (plasticity index). While the coefficient of uniformity (CU) of the grain size is 4.2 which is less than 6 of the British Standard (BS: 1377). These results indicate that the soil is poorly graded, well drained, it is of intermediate plasticity, medium swelling potential. The results of particle grain size distribution test show that the soil sample is mainly sand that is having an average value of coarse send fraction as 36.6% medium sand fraction as 37.3% and fine sand fraction as 13.6%. This means that they will tend to increase in compressibility and decrease in shear strength. Also, as a result of their poorly graded nature, they will have negative effects such as high effective porosity, large mean pore size, how density and high permeability. The compaction results show that the maximum dry density (MDD) and the optimum moisture content (OMC) of location 1m – 6.5m range for 1832.2 – 1891.3kg/m^3 and 7.1 – 10% respectively.

INTRODUCTION

A whole of laboratory test can performed on soils to measure a wide variety of soil properties. Some soil properties are intrinsic to the composition of the soil matrix and are not affected by sample disturbance, while other properties depend on the structure of the soil as well as its composition, and are tested on relatively disturbed samples. Some soil test measure direct properties of the soil, while other measure "index properties which provide useful information about the soil without directly measuring the property desired. Some of the more commonly performed laboratory test included: Moisture content determination, Atterberg limits, grain size analysis test and compaction test.

There tests are very useful in determining the geotechnical behaviour of soil in Warri of Delta State.

AIM OF THE STUDY

This study is required to determine the geotechnical index properties of soils in Warri area of (Delta State) which is part of the Niger Delta, to access the propriety of the use of the soils for geological and civil engineering purposes. The parameters determined included, moisture content, Atterberg (consistency) limits, grain size analysis and compaction test.

(a) Location of the study Area: The study area is located in Warri South Local Government Area of Delta State. The study area, Warri is on latitude 5^0.33'31N and longitude 5^0.32'35E land which lies between 23 and 40ft above sea level. It is part of the Niger Delta province which occurs at the southern part of Nigeria bordering the Atlantic Ocean.

(b) Literature Review: various scholars have studied various aspects of soil stability and the engineering problems posed by soil of poor geotechnical properties. The engineering and index properties of soils in part of the Niger Delta have also been studied by various scholars.

Previous work done in this area include those of Akpokodje (1986, 1989, 2001 etc), Akpokodje and Arumala (1989). They investigated the soil properties and pavement performance in the Niger Delta; the incidence of pavement failure of various roads in the Niger Delta, and correlated this with various factors uch as rainfall, grain size distribution, etc Etu-Efeotor (1997), carried out work on mineralogy and evaluation of recent clay in the Niger Delta, and concluded that the dominant clay mineral in this area in kaolinite, which makes up 40% clay mineral prent

.**(c) Topography, drainage and geomorphology:** The Niger Delta constitutes an extensive flood plain whose sediments range from Tertiary to Quaternary in age. It is typically a deltaic plain with a predominantly flat topography that is gently sloping towards the Atlantic Ocean.

The Akata formation being rich in organic matter is the source of oil in Niger Delta and its relative thickness is 20,000 ft (about 5,882m) Etu Efeotor (1997)

METHOD OF STUDY

(A) FIELD TECHNIQUES: The samples used for this work are disturbed samples obtained from seven boreholes in basic sites in Delta State, drilled to a depth of 6m (borehole 5), 2.5m (borehole 6) and 1.5m (borehole 7). During sampling, visual examination of each sample was made as well as insitu description based on texture and colour. Sample were put into poythene bags to prevent loss of the natural water content and other alteration that may arise due to exposure to the air.

(B) LABORATORY TECHNIQUES: The even disturbed samples were analyzed in the laboratory for water content, Atterberg limits, grain size distribution and compaction test.

(a) Moisture content determination: This is determination of moisture content of the soil samples

(b) Determination of Atterberg limits: This test enables us to know the moisture content at which a soil sample passes from one stage to the next and is known as consistency limit. The liquid and plastic limits are two of five limits proposed by A. Atterberg.

(c) Liquid limit determination: This is the minimum moisture content at which the soil will flow under its own weight. In order words, it is a soil – water mixture with no measureable shear strength..

(d) Plastic limit determination: Plastic limit is the maximum water content as which the soil can be rolled into a thread of 3mm an diameter without breaking.

(e) Compaction test: Compaction of densification is the process whereby soil particles are mechanically forced to pack more closely together by expelling air from the voids. The test involves the determination of mass of the dry soil per unit volume when the soil is compacted in a specific manner over a range of moisture content.

The strength of any earth material is related to its density, and the objectives of densification is simply to improve the engineering properties of the soil mass.

The laboratory compaction test also reveals optimum moisture content at which the compaction should be carried out to achieve the maximum dry density possible for the earth material (soil). In this work, the modified proctor test method was used. Some advantages of compaction include the reduction of subsidence, reduction in shrinkage (decrease in volume) and increase in soil strength (shear strength).

(f) G**rain size analysis:** The particles size distribution (texture) of a soil refers to the sizes and the relative proportions of various size groups of the solid particles that make up a given soil materials. The various particle size groups and their limits that are commonly used in Engineering Geology were adapted from MIT (Massachusetts's Institute of Technology) textural classification.

The laboratory determination of the particle size distribution of soils is usually accomplished by sieving and sedimentation analysis. The former method is used for the coarse fraction (i.e. sizes?0.075mm) while the latter is for fine fraction (<0.7mm). The full description of the laboratory procedure of these methods are given in the American Society for Testing of Material (ASTM 479) and the British Standard (BS 1377).

RESULT AND DISCUSSOIN

(i) Moisture content determination: The moisture contents of the soil samples varied from 8.1% at Cinema site to 26,9% at Okumagba Avenue off Total filling station. The high value of water content contained in the sample is as a result of the type of clay mineral preset. The large range of water content in the soil sample that the soil will be prone to expansion, and shrinkage when water is expelled from its pore spaces. (See Table 1)

SAMPLE NO: A1

Mass of cup + wet soil, M2	26.7
Mass of cup + dry soil, M3	24.1
Mass of cup, M1	5.0
Mass of dry soil, Ms	19.1
Mass of water, Mw	2.6
Water content W%	13.6

SAMPLE NO: A2

Mass of cup + wet soil, M2	23.4
Mass of cup + dry soil, M3	20.8
Mass of cup, M1	4.6
Mass of dry soil, Ms	16.2
Mass of water, Mw	2.6
Water content W%	16.0

Table 1: Moisture content determination

(ii) Atterberge limits: It is observed that the highest value of liquid limit (38.0%) was recorded in Giwamu road and the lowest values (22.05) in Ighorue street. On the other hand, the highest value of plastic limit (22.4%) was recorded in Giwamu Road while the lowest value (19.5%) was recorded in Okumagba Avenue off Total filling station. Further more, the highest plasticity index value (17.9%) was recorded in Akemu street while the lowest value (2.1%) in Ighorue street. These values indicate that the soils are of intermediate plasticity as well as of low to medium swelling potential and they denote increase in compressibility and decrease in shear strength. It will easily promote early failure of roads due to their ability to expand when they absorb water and contractors when they loss it. This could account for failures that show as cracks on our roads in Delta State.(See Table 2,3 and figure 1)

Test No.	1	2	3	4
Can No.	X	Y	Z	W
Mass of wet soil + can(g)M2	19.4	23.0	29.9	25.1
Mass of dry soil + can (g) M3	15.8	17.8	18.7	19.1
Mass of can(g) M1	5.4	5.7	5.8	5.9
Mass of wet soil (g)	14.0	17.3	18.1	19.2

Table 2: Liquid limit Determination

Test No.	1	2	3	4
Can No.	AB	E	G	H
Mass of wet soil + can(g)M2	12.2	16.3	17.1	18.5
Mass of dry soil + can (g) M3	5.2	5.5	5.8	6.3
Mass of can(g) M1	10.0	10.8	11.2	12.2
Mass of wet soil (g)	7.2	8.9	9.7	10.7
Mass of dry soil (g)	2.8	1.9	1.5	1.5
Mass of moisture	38.9	21.3	15.5	14.0
Water content, W%	22.43%			

Table 3: Plastic Limit Determination

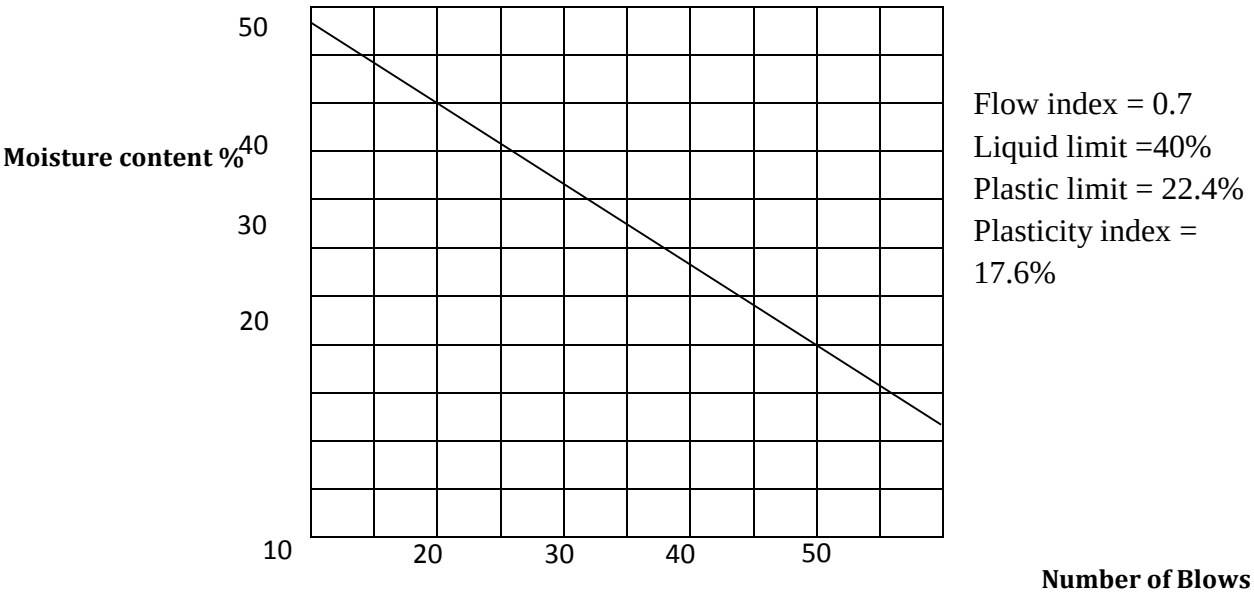

Figure 1: Graph of moisture content against number of blows

(iii) Compaction: It can be seen that the results of the maximum dry densities and optimum moisture content range from (1763.2 – 1891.3)kg/m^3 and (7.1 – 10.4)% respectively. These soil will be mechanically forced to pack more closed together during compaction. This will lead to expulsion of air from the voids, thereby leading to increase in soil density, shear strength and reduction in compressibility, permeability, subsidence as well as deterioration.

(iv) Grain size analysis: The result of the particles size distribution test show that the soil sample is mainly sand that is having an average value of coarse sand fracture as 36.3%, medium sand fraction as 37.3% and fine sand fraction as 13.6%

The coefficient of Uniformly (CU) of the sample have an average value of 4.2 which is less than 5 of

British Standard (BS:1377). And that shows that the soil is poorly graded. Hence the soil is not suitable for base course materials. Moreover, as a result of their poorly graded nature, they will have negative effective such a high effective porosity, large mean pore sizes and low density.

CONCLUSION

The sample analysis results from various locations in Warri Delta State show very high percentage of fine soil (i.e. silts clays and fine sand) without gravel sized particles. This is usually classified under the unified soil classification scheme (USC) as poorly graded since it does not contain particles of all sizes. This high percentage of fine and shows high porosity, low permeability with decreasing stability.

The moisture content (MC) values range from 8.1 – 26%. This shows that some areas are well drained while others are not. The significance of the moisture content is that, the greater the amount of water a soil contains, the less interaction there will be between adjacent particles and the more the more the soil will behave like a liquid, i.e. decreasing shear strength. The liquid limit values range between 19.5 – 22.4%. This shows that the soil is of intermediate plasticity, and is an indication of low strength. The plasticity index values range from 2.1 – 17.9%. This indicates that the soil is of low medium swelling potential. The larger the plasticity index, the greater is the engineering problem associated with using the soil as an engineering material.

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