GEOTECHNICAL CHARACTERISTICS OF SOME BORROW PITS AROUND AFE BABALOLA UNIVERSITY, ADO-EKITI, SOUTH WESTERN NIGERIA.

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ABSTRACT

This research work has analyzed the geotechnical characteristics of two borrow pits around Afe babalola university. The research work was carried out by collection of soil samples from borrowpit 1 (beside Federal polytechnic, Ado-Ekiti, Nigeria) and borrowpit 2 (along Afe Babalola farm, Ado-Ekiti, Nigeria) and taken to the laboratory for soil test. The particle size analysis shows that the percentages passing number 200 British Standard sieve are 22.18% and 13.02% for borrowpits 1 and 2 respectively. Atterberg limit results show that borrow pit 2 has sandy particle sizes predominating. Hence the soil sample as a result of its particle size composition happens to be a cohesionless soil with no plasticity while pit 1 has liquid limit of 32.5%, plastic limit of 27.77%, plasticity index of 5% and shrinkage limit of 5.8%. The natural moisture content for the soil samples are 5% and 9.7% for borrowpit 1 and borrowpit 2 respectively. The specific gravity for borrowpit 1 and borrowpit 2 are 2.67 and 2.60 respectively. The soaked CBR value for the soil samples are 70% and 66%. The maximum dry density for the soil samples are 1.82Mg/m^3 and 2.0Mg/m^3 for borrowpit 1 and borrowpit 2 respectively. While that of Optimum moisture content are 16.24% and 13.5% for borrowpit 1 and borrowpit 2 respectively. The unconfined compressive strength (q_u) for borrowpit 1 soil sample is 91.5kN/m^2. The unconfined compressive strength of borrowpit 2 could not be obtained as it is a sandy material. Hence borrowpit 1 can be classified as A-2-4 material (silty or clayey gravel and sand) while borrowpit 2 can be classified as A-3 material (fine sand).

Keywords: geotechnical characteristics, Borrowpits, lateritic soil, soil tests and soil classification

INTRODUCTION

The excavation of a borrow pit falls under the engineering discipline known as earthworks. Earthworks projects consist of engineering feats that include transporting large amounts of soil or rock from one area to another. Borrow pit construction may seem relatively easy to accomplish, though this type of digging actually requires an extensive amount of analysis prior to the first dig. Engineers must be sure that the amount of soil dug from a pit area will not disrupt the earth. Since massive quantities of earth must be moved in order to build roads, railways, canals, buildings, and other structures, the invention of various industrial tools has made this task easier. Bulldozers, loaders, production trucks, graders, and many other large pieces of equipment are often used to move soil from one place to another. Without these machines, digging a borrow pit would take years instead of months or weeks to accomplish. A borrow pit's volume really depends upon the construction project at hand. While major roads and freeways may take multiple tons of gravel to build, small projects may not require much soil. Borrow pits materials such as laterite and granite are one of the most important materials used in earth work engineering construction in the tropics and subtropics where it is in abundance like Nigeria. The use of lateritic soil for construction and civil engineering works is very common. Therefore, Ado the capital city of Ekiti state and its environs have been availed of this wonderful benefit. But when lateritic soil consist of high plastic clay, the plasticity of the soil may cause cracks and damage on pavement, road-ways, building foundations or any other civil engineering construction projects. Lateritic soils are one of important soils and are widespread in tropical areas and subtropical climates. Lateritic soil which is the product of borrow pit excavation is used as a sub-base and base course for construction of highway embankments (Head, 1992). Engineers and Contractors should ensure that the testing and quality control of pavement materials is done before the commencement of earthworks on site and the adequate quality of construction as the construction project is being executed (Owolabi and Aderinola, 2014). Laterite occurs mostly in the tropical and sub-tropical regions with hot, humid climatic conditions. It has been suggested that a mean annual temperature of around 25°C is needed for their formation and in seasonal situations there should be a coincidence of the warm and wet periods. If there is high rainfall during the cold season, laterites do not develop freely. The minimum annual rainfall required for laterite formation is generally at least 750 mm. Laterite as products of tropical weathering with red, reddish brown, or dark brown colour, with or without nodules or concreting and generally (but not exclusively) found below hardened ferruginous crust or hard pan (Ola, 1983).

Unsuitable soils are soils that expand when water is added and shrink when they dry out. This continuous change in soil volume can cause homes built on this soil to move unevenly and crack (Owolabi *et al.,* 2015).

Location of the Study Area

The soil samples were collected from two borrow pits around Afe Babalola University, Ado Ekiti. The first borrow pit is along Afe Babalola-Ijan road and second borrow pit is along Afe Babalola farm. Ado-Ekiti (urban township capital of Ekiti state, Nigeria) lies on latitude 7^0 37'North of the equator and on longitude 5^0 13'East of the Greenwich Meridian. It stands on the altitude of about 455 meters above the sea level. The first borrow pit (borrow pit 1) lies on latitude 7^0 35'North of the equator and on longitude 5^0 18' East of the Greenwich meridian with altitude 377.3m. The second borrow pit (borrow pit 2) lies on latitude 7^0 36'North of the equator and on longitude 5^0 18' East of the Greenwich meridian. The altitude is 357m. The soil samples were taken at a depth of 1.0m from the surface.

METHODS

The following laboratory tests were conducted on the samples: Specific gravity test, Particle size analysis, Moisture content test, Compaction test, California bearing ratio and Unconfined compression test. Unconfined compression test was carried out on the disturbed samples at 0.08mm/min rate of strain. The tests were carried out in accordance with British standard code of practice (BS1377:1990)

RESULTS AND DISCUSSION

SIEVE ANALYSIS

The particle size analysis shows that the percentages passing number 200BS sieve are 22.18% and 13.02% for borrowpits 1 and 2 respectively. These are shown in figure 1and 2

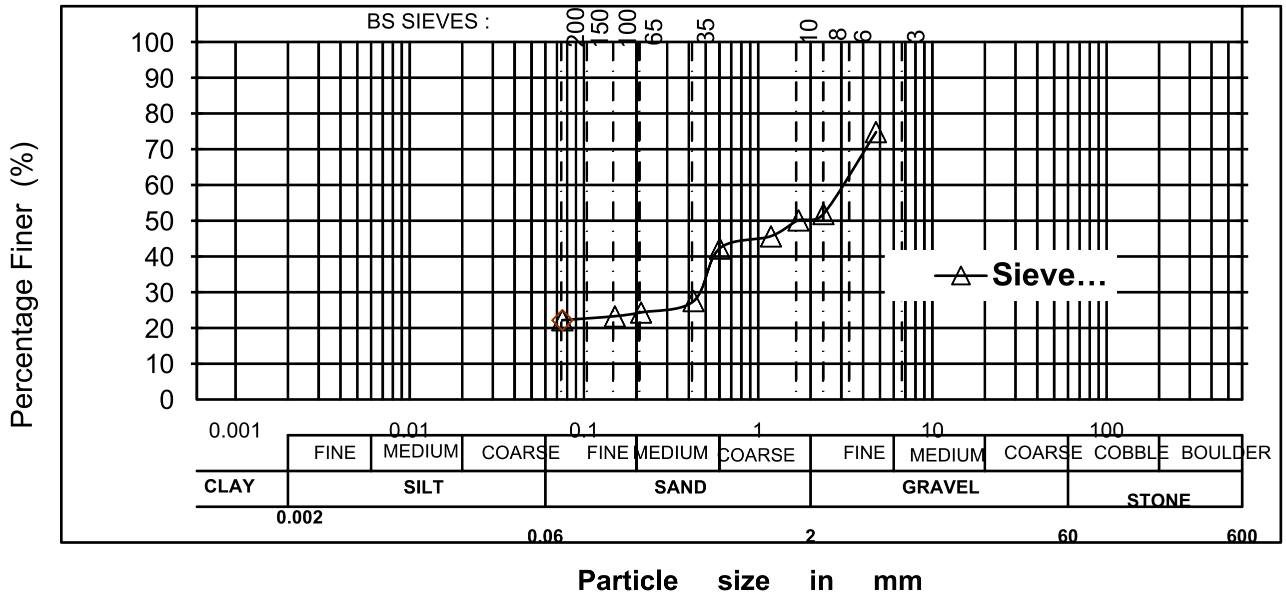

Figure 1: Particle size distribution for borrowpit 1

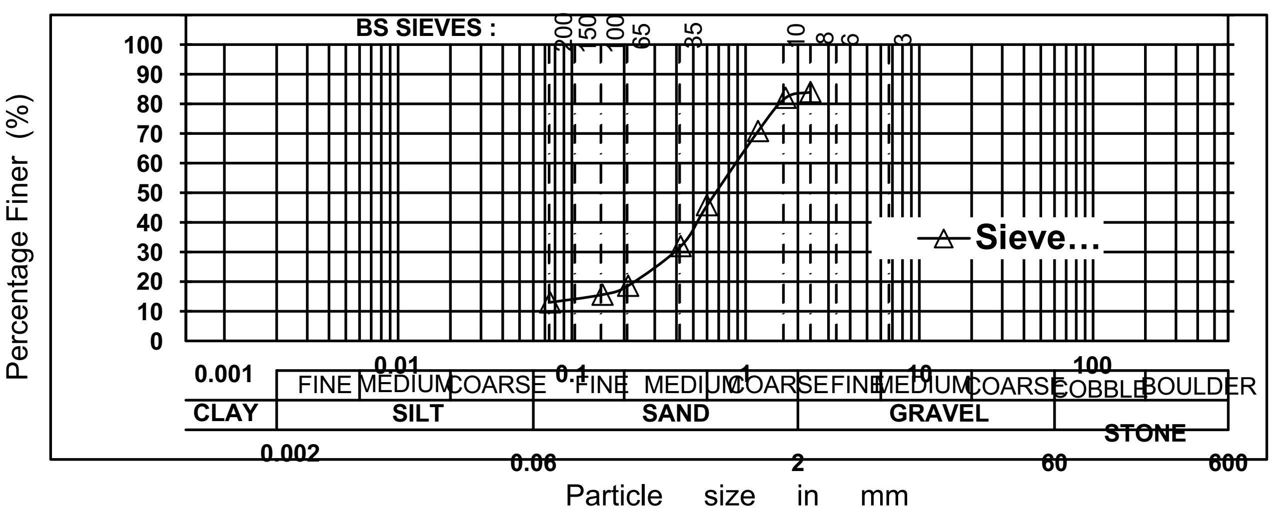

Figure 2: Particle size distribution for borrowpit 2

ATTERBERG LIMIT

The results show that borrow pit 2 has sandy particle sizes predominating. Hence the soil sample as a result of its particle size composition happens to be a cohesionless soil with no plasticity while pit 1 has liquid limit of 32.5%, plastic limit of 27.77%, plasticity index of 5% and shrinkage limit of 5.8%. The result is shown in figure 3. Federal ministry of works general specification requirements for roads and bridges (1997) recommend liquid limit not greater than 50% for sub-grade and not greater than 35% for sub-base and base course. Also, plasticity index not greater than 30% for sub-grade and not greater than 12% for both sub-base and base. From the soil samples, both borrowpits fall within this specification, thus making them suitable for sub-grade, sub-base and base material.

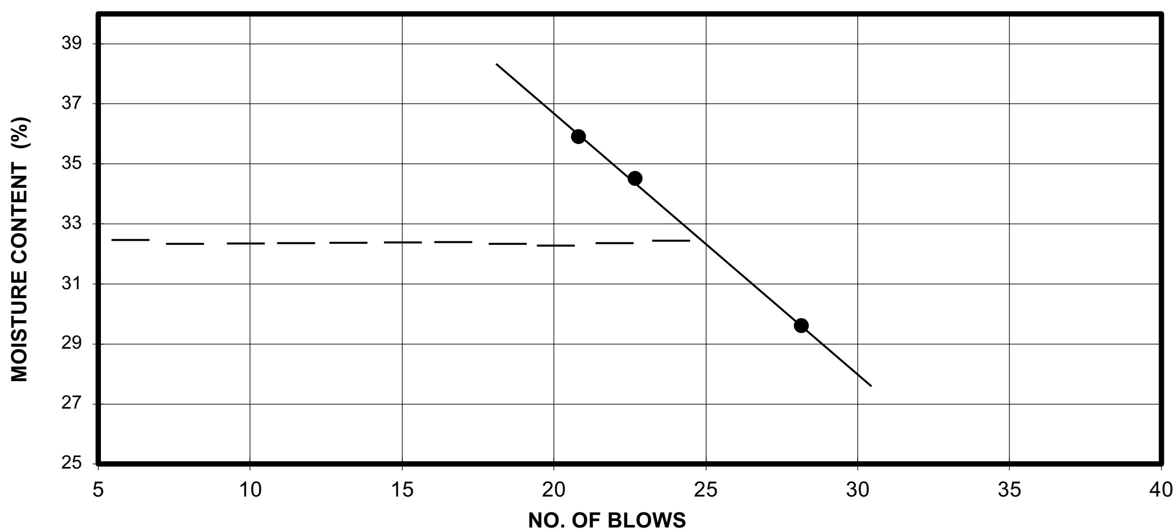

Figure 3: Liquid limit for borrowpit 1

4.3 NATURAL MOISTURE CONTENT

The natural moisture content for the soil samples are 9.7% and 5%. These values are suitable in accordance with Emesiobi (2000) which states the classification for moisture content for different soil types and indicate that natural moisture content in soil may range from below 5% to 50% in gravel and sand.

SPECIFIC GRAVITY

The Specific gravity of the samples are 2.60 and 2.67, these values are suitable in accordance with wright (1986) who states that the standard range of values of Specific gravity of soils lies between 2.60 and 2.80.

CALIFORNIA BEARING RATIO

The soaked CBR value for the soil samples are 70% and 66%. Federal ministry (1997) recommended soaked CBR for sub-grade and sub-base soils not less than 5% and 30% respectively. For the base (unsoaked and soaked CBR) not less than 80%. The result for soil samples shows that all the soils are suitable for sub-grade and sub-base course. The graphs are shown in Figure 4 and 5

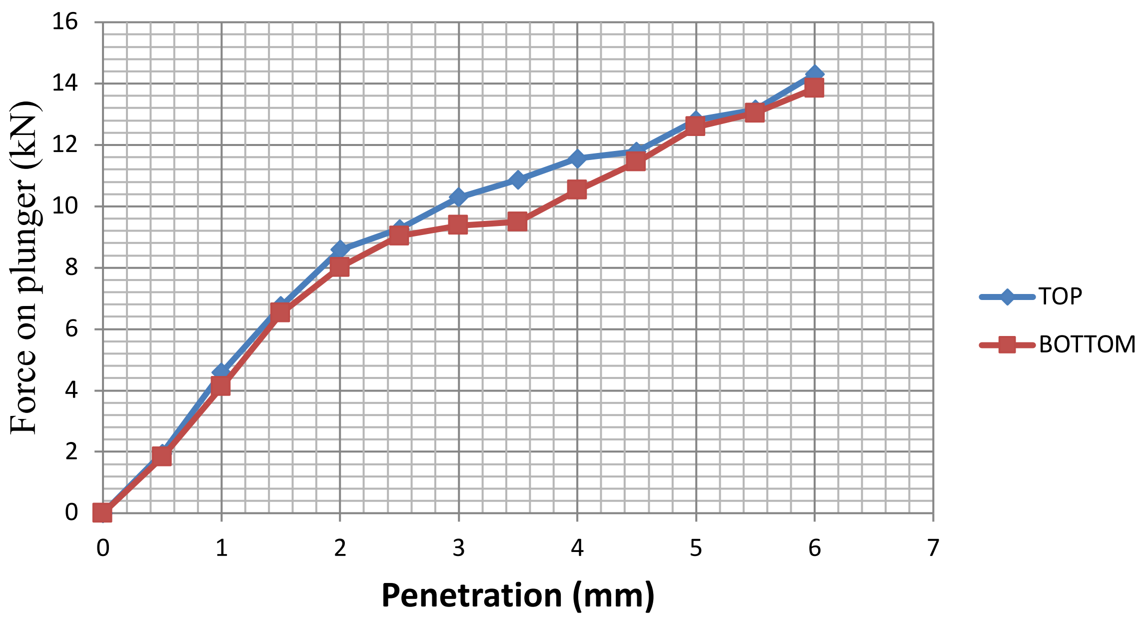

Figure 4: CBR graph for borrowpit 1

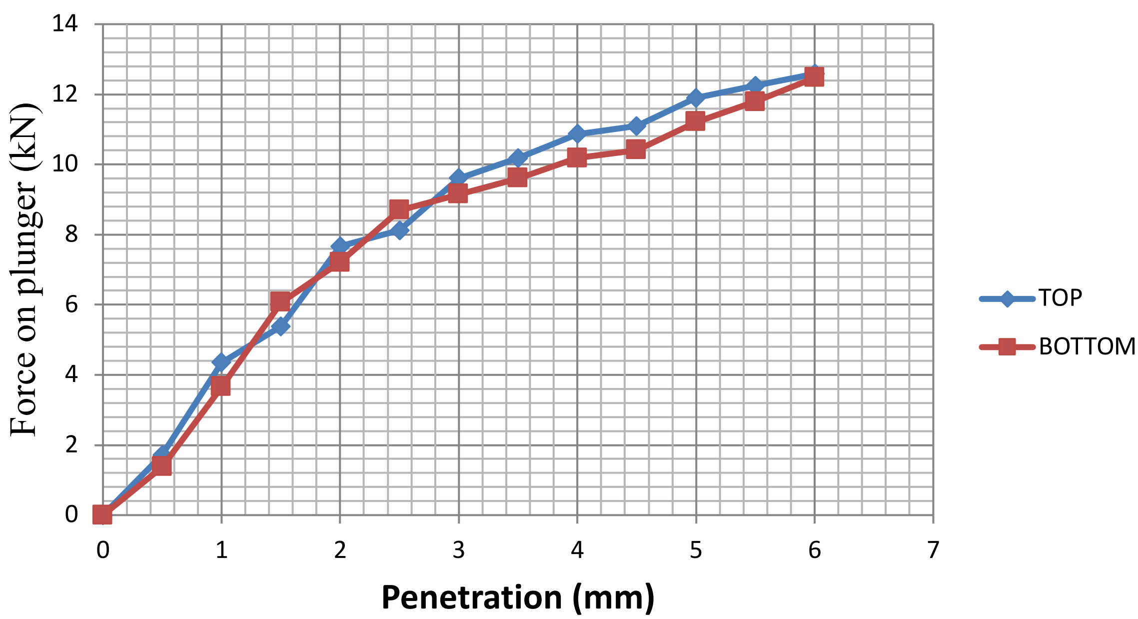

Figure 5: CBR graph for borrowpit 2

COMPACTION

The maximum dry density for the soil samples are 1.82Mg/m^3 and 2.096Mg/m^3 while that of optimum moisture content are 16.24% and 13.5%. Figure 6 and 7 shows the behavior of the soil for compaction.

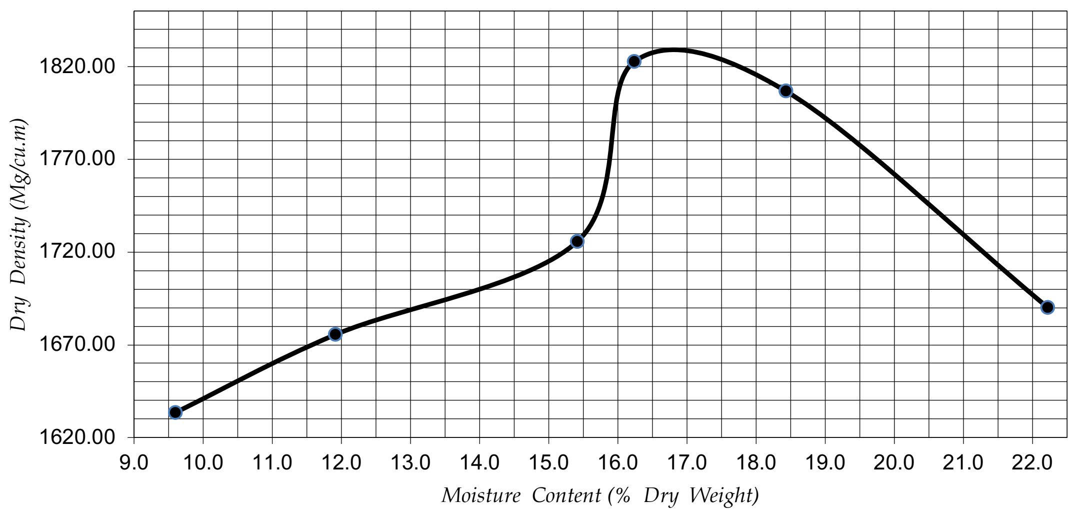

Figure 6: Compaction graph for borrowpit 1

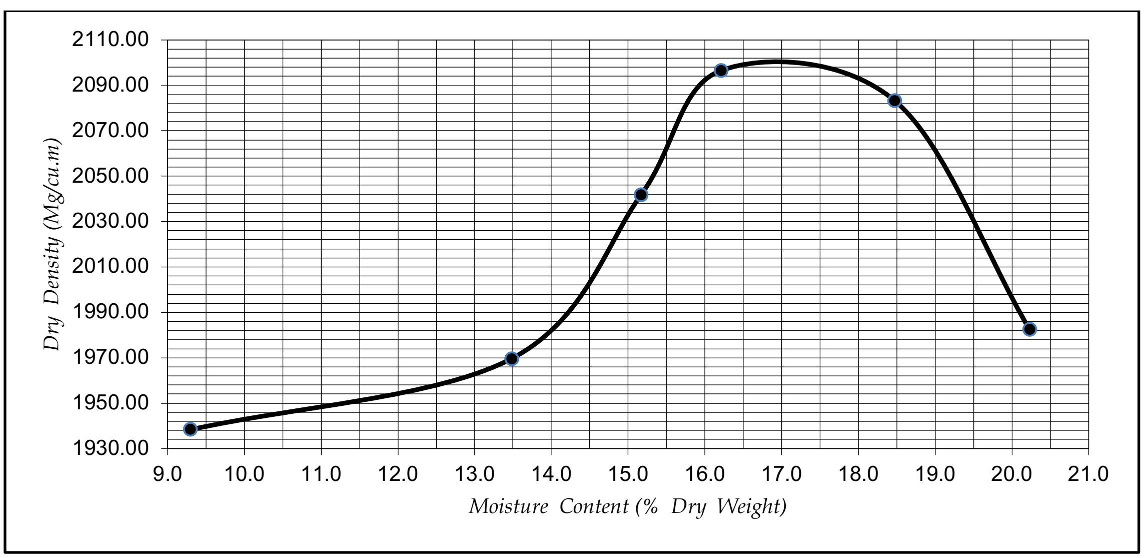

Figure 7: Compaction graph for borrowpit 2

UNCONFINED COMPRESSIVE STRENGTH TEST

Figure 8 shows the behavior of the soil samples for the strength test. The unconfined compressive strength q_u for borrowpit 1 is 91.5kPa. This shows that the shear strength of the soil samples is adequate for use as either a foundation or sub-grade material. Borrowpit 2 has no unconfined compressive strength value because it is a sandy material and a cohesionless soil does not form an unsupported cylindrical shape

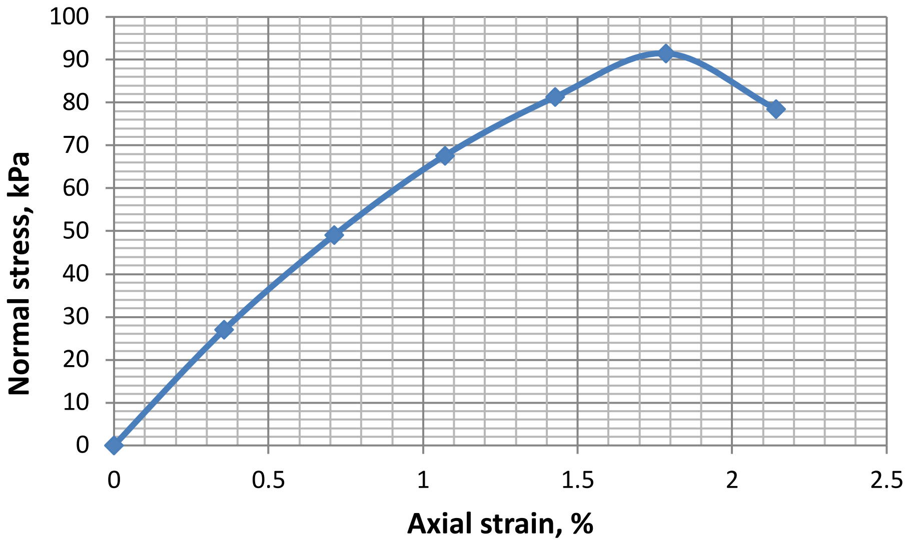

Figure 8: Unconfined compressive strength graph for borrowpit 1

CLASSIFICATION OF THE SOIL SAMPLES

According to AASHTO soil classification borrowpit 1 can be classified as A-2-4 material (silty or clayey gravel and sand). They are rated as good materials for sub-grade material; it also satisfied condition for construction materials while borrow pit 2 can be classified as A-3 material (fine sand) which is non-plastic. They are also rated as excellent to good material for sub-grade.

CONCLUSION

From the tests carried out on the soil samples obtained from the two borrow pits around Afe Babalola university, Ado-Ekiti, Ekiti State Nigeria. The sieve analysis shows that the samples have less than 35% passing 200BS sieve. Borrowpit 1 contains silty or clayey gravel and sand while borrowpit 2 contains fine sand. The unconfined compressive strength of borrowpit 2 could not be obtained as it is a sandy material. Hence borrowpit 1 can be classified as A-2-4 material (silty or clayey gravel and sand) while borrowpit 2 can be classified as A-3 material (fine sand).

The samples are granular materials which can be used as a subgrade and subbase materials.

RECOMMENDATION

Soil samples should be collected and taken to the laboratory for testing before the commencement of earthworks on site. Further geotechnical investigation can also be done on other borrowpits at Bank road, Ilawe road, Iworoko road, and Ikere road, Ado-Ekiti, South Western Nigeria.

REFERENCES

AASHTO. 1986. Standard Specification for Transportation Materials and Methods of Sampling and Testing, 14th Edition. American Association of State Highway and Transportation Officials: Washington, D.C.

BS1377:1990. Methods of test for soils for civil engineering purposes British standards Institute, London.

Emesiobi F.C. 2000. Testing and quality control of materials in civil and highway Engineering. ISBN 078-2009-36-16 Pp 5-7

Federal Ministry of Works and Housing. 1997. "General Specifications for Roads and Bridges". Volume II.145-284.

Head, K.H. 1992. "Manual of Soil Laboratory Testing". Soil specification and Compaction Tests. 2nd edition. Vol. 1. Pentech Press: London, UK.

Mtallib, M. O. A. and Bankole, G. M. (2011) The Improvement of the Index Properties and Compaction Characteristics of Lime Stabilized Tropical Lateritic Clays with Rice Husk Ash (RHA) Admixtures. Electronic journal of Geotechnical Engineering (EJGE) United State Vol. 16 , Bund. I

Okengwo O.N. , Okeke O. C., Okereke C.N. and Paschal A. C. (2015) Geological and Geotechnical Studies Of Gully Erosion at Ekwulobia, Oko and Nanka Towns, Southeastern Nigeria. Electronic journal of Geotechnical Engineering (EJGE) Vol. 20, Bund. 1

Ola, S.A. 1983. "Geotechnical Properties of an Attapulgite Clay Shale in Northwestern Nigeria". Engineering Geology.19:1-13.

Owolabi T.A. and Aderinola O.S. 2014. Goetechnical Evaluation Of Some Lateritic Soils in Akure South, Southwestern, Nigeria. Electronic journal of Geotechnical Engineering (EJGE) Vol. 19, Bund. R, Pp 6675 – 6687, United State

Owolabi T.A, Wasiu j., Fatile M.R and Koroye P. 2015 Performance Evaluation Of Snail Shell Powder As Partial Replacement For Unsuitable Soils. Academia Arena 7(9) http://www.sciencepub.net/academia

Wright, P.H. and Dixion, K.K. 2003 Highway Engineering, John Wiley and Sons Publishers, New York