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Investigation into Some of Engineering Properties of Soil: A Case in Study in Seka Town, Jimma Zone, Ethiopia

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ABSTRACT

The main aim of this study is to investigate some of the engineering properties of soils found in Seka town in order to know the nature of the soil and also to give information for the design, construction and environmental assessment, so that suitable foundation can be recommended for better design and construction in the town. Laboratory tests were carried out including specific gravity ranges 2.65 to 2.77, natural moisture content, Atterberg limits, UCS ranges 143.52kN/m2 to 352.92kN/m2, compression index 0.23 and 0.39, and swelling index 0.19 and 0.02, MDD ranges from 1.180 g/cm3 to 1.480 g/cm3, and OMC range 35.9% to 48.00% and permeability ranges 3.75*10-5 to 2.75*10-4 cm/sec. Based on the results of this study, the grain size distribution indicates all soil samples have more than 90% fine grained material. Clayey silty type of soil is dominantly located in the study area.

INTRODUCTION

For designing and constructing the foundation for a structure, such as a building, plant or bridge; geotechnical site investigation is the primary process of collecting information and evaluating the conditions of the site (Ashton & Gidado, 2001), to safe from an adequate damage of the structure. Investigation of the sub-surface conditions at a site is prerequisite to the economical design of the substructure elements, and also necessary to obtain sufficient information for feasibility and economic studies of the proposed project (Haruna et al., 2013).

Engineering properties of soils are investigated by direct methods such as borings and trial pits or through indirect methods such as seismic acoustic, resistivity and ground penetrating radar (Emmanuel, 2014). Site investigation is an important part of civil engineering design whose aim is to reduce uncertainty of ground conditions by various combinations of field and laboratory testing (Alemayehu T. and Solomon Y., 1986). However, the scope of site investigations is usually dependent on the finances available and time required for carrying out the investigation (Jibril, 2017).

METHODOLOGY

Study Area Description

This study considered Seka town which is found in south western Ethiopia, Oromia Region, Jimma Zone, Seka Cokorsa Woreda specifically, and it is about 354 Km from Addis Ababa. It has latitude and longitude of 7040N and 36050 E respectively, and also its average elevation 1715 m-1835m above sea level. The topography of this region is predominantly flat. This study will be done on the expansive soil that had been collected under the surface of the earth in Seka town. It is possible to find vehicles for shipment of the collected samples. The town traverses vast flat land that is covered with red clay soil. The red clay soil is underlain by natural sand deposit. It was estimated that the sand deposit is found at depths of 1.0m – 3.0m from the surface of the natural ground.

Experimental Setup

Experimental tests were carried out at the Jimma Institute Technology, Jimma University in soil laboratory, Ethiopia. A total Sample from 8 (eight) test pit were collected and tested. The strength and Class of the soil of the town was investigated.

Natural Moisture content

The water content is the ratio, expressed as a percentage, of the mass of "pore" or "free" water in a given mass of soil to the mass of the dry soil solids. The value rang from 43.54 to 53.51 in percent

Specific gravity

The specific gravity of soils found in Seka town falls to 2.65-2.77 which was in the range proposed by Bowles and other researchers. The soil is clay soil and its specific gravity varies with the range based on mineral content of the soil.

Grain Size Analysis

The soils contain 38.44-54.98% clay, 37.56-51.74% silt, 5.24-9.82% sand and 0% gravel. Summary of the test

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result and graph of combined analysis Atterberg limits

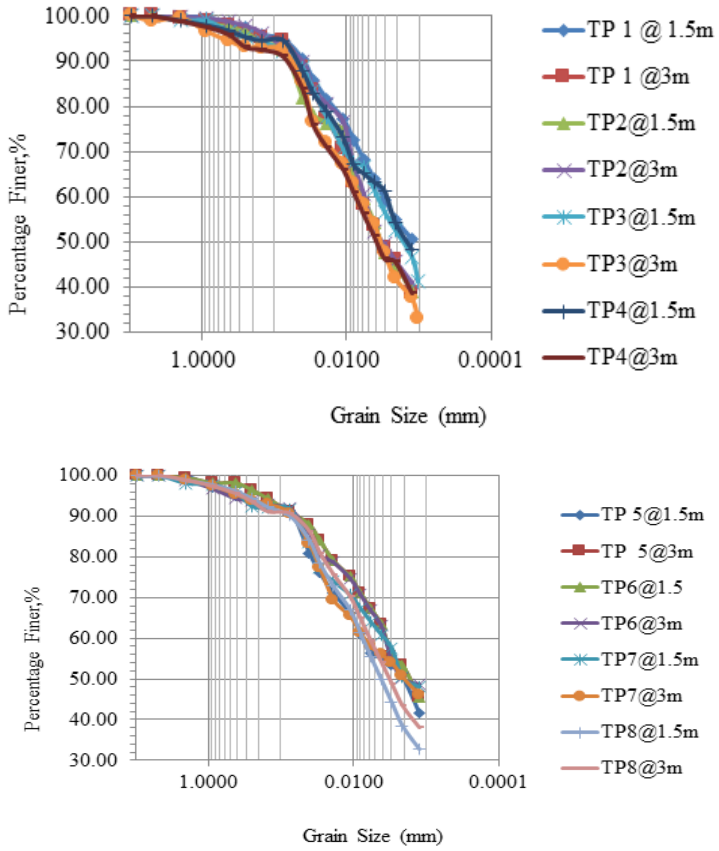

Figure 1: Grain Size Analysis result and graph of combined analysis is shown respectively

Atterberg limits

Liquid limit of Seka town falls in the range of 69.4-90% and plastic limit was in the range of 24.67-49.47%. The plasticity index range of the soils was from 25.93% to 54.55%. According to Burmister (1947) the plasticity of the soils is high plasticity.

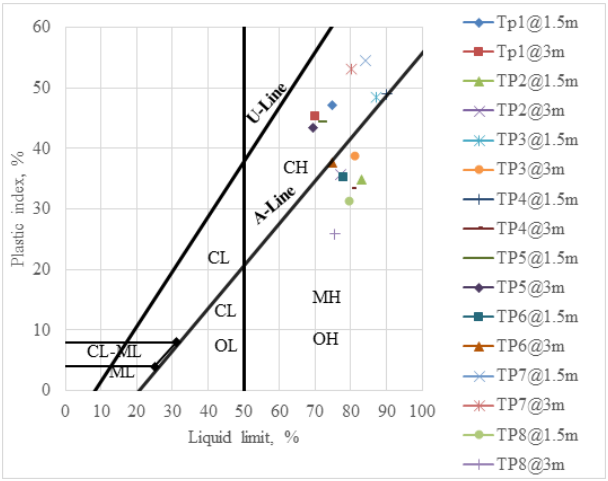

Figure 2: Atterberg limits

AASHTO Soil Classification System

Soil classification of the study area based on AASHTO, all soils fall in A-7-5 and A-7-6. So, the general rating for all soil is not fair for subgrade material depend on PI.

Compaction Test

From the test results the maximum dry density (MDD) of Seka town ranges from1.359 g/cm3 to 1.480 g/cm3 for modified compaction and from1.185 g/cm3 to 1.36 g/cm3, and the optimum moisture content ranges 29.7% to 35.50% for modified compaction and 35.9% to 48.00% for standard compaction

Unconfined compression strength (UCS) test

The summary of the unconfined compressive strength and cohesion result of soils for the area under study

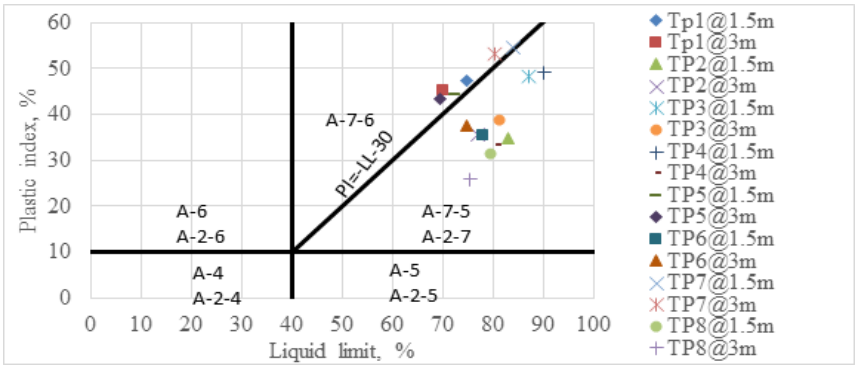

Figure 3: AASHTO Soil Classification System

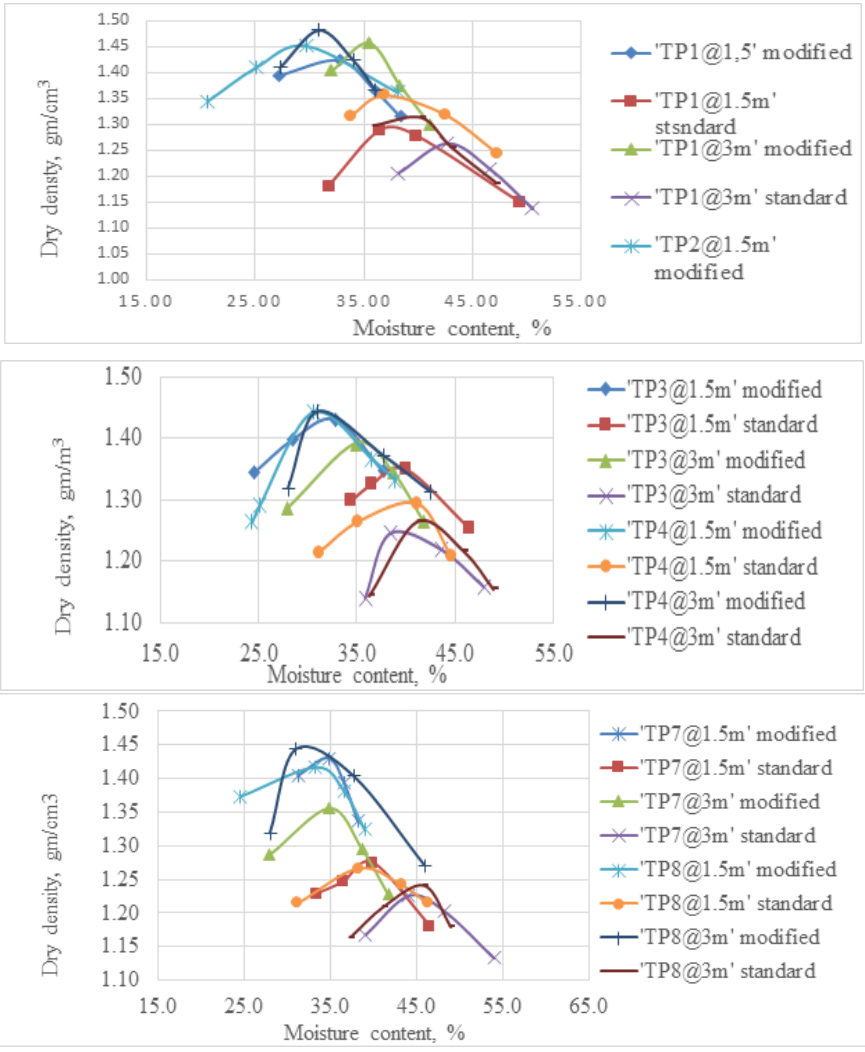

Figure 4: Compaction Test analysis

and Fig 8 indicate the graph of unconfined compressive strength of Seka town area. It is observed that the consistency of Seka soil is low to medium

Pressure – void ratio curve

The pressure-void ratio curve can be obtained if the void ratio of the sample at the end of each increment of load is determined. The basic data used to determine this curve are natural moisture content, Specific gravity, density, cross sectional area and height of the sample, initial void ratio and applied loads. From these curve important parameters such as coefficient of compressibility (av), compression indexes (Cc), Swelling index (Cs) and pre-consolidation pressure (pc) are determined.

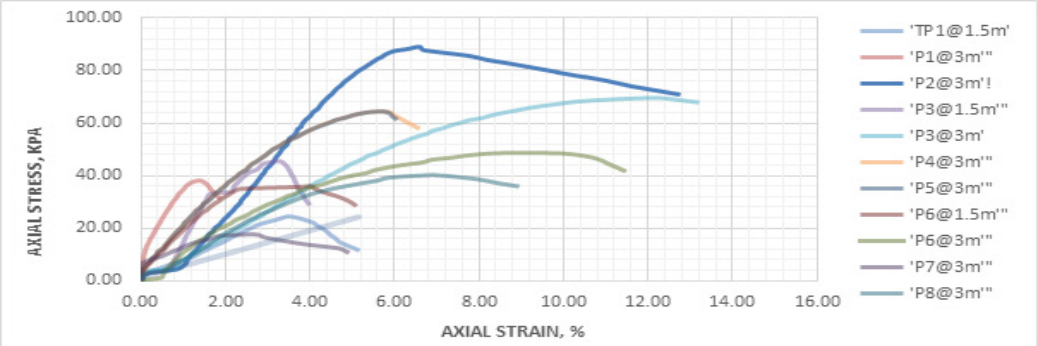

Figure 5: Unconfined compression strength (UCS) test

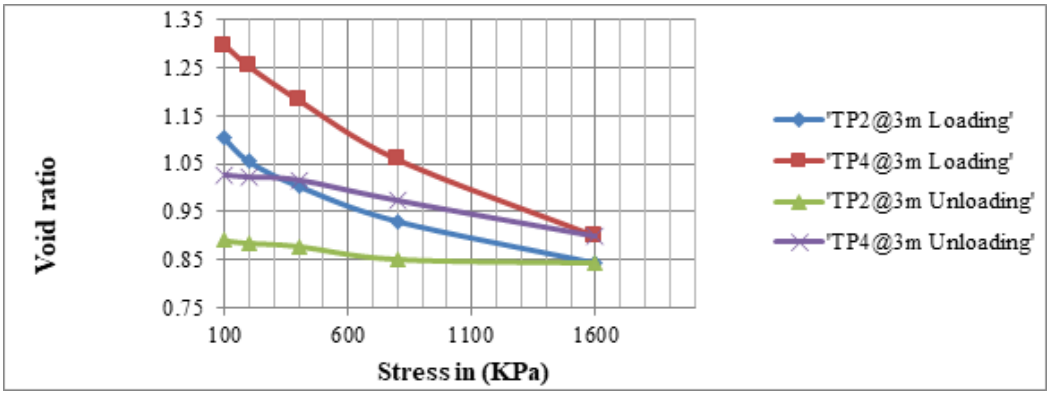

Figure 6: Pressure – void ratio curve

Permeability

The flow of water through soils depends upon its permeability coefficient I use falling head permeability test since this test is appropriate for fine grained soil. Since my soil is fine grain soil, I prefer this test. A representative permeability tests were run on samples of two disturbed samples on two different test pits, where the remaining test pits have the similar result with either of these test pits. In void ratio versus log coefficient of permeability graph all soil samples taken from study area have nearly straight-line relationship

Coefficient of permeability for TP-2 is 3.05*10^-4, for Tp-4 is 3.11*10^-5. The values of coefficient of permeability for the tested soils using falling head test lie between 2.75*10-4 and 3.75*10-5 cm/sec, which indicates that the soils are practically impervious. Refer Appendix-V.

CONCLUSIONS

No significant variations of engineering properties within the investigated depths as well as in different pits which were found in the research work.

According to USCS the soils of the study area fall under CH and MH region, which shows that the soils are inorganic high plastic clay and high plastic Silt. And AASHTO classified the soil as (A-7-5 and A-7-6).

Grain size analysis result shows the soil under investigation is dominantly clay and silt types. Since, 92.2% average of the soil is fine grained soil; which have higher in plasticity. According to ERA manual not recommended for suitability of soils as sub grade material. Since, Plasticity Index is greater than thirty. The values of specific gravity are within the same range's standards. The moisture content of the soil is medium.

As determined from the one-dimensional consolidation test conducted on undisturbed soil samples; we can conclude that: Since pit excavation method of exploration is used, the outcomes would be applicable only for light structures which under lie their foundation up to depth of 3m. Compaction tests results shows that, OMC is very high and MDD is very less. Which says that the soil is highly compressive. From Unconfined Compressive Strength (UCS) result the consistency of soils is Stiff to very Stiff. And, the values of Liquidity Index classify the soil under the class of Intermediate strength, which the soil deform like a plastic material.

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