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Pre-consolidation pressure using soil index properties

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Abstract

The study of civil engineering varies from cloud touching skyscrapers to daily use dwellings and commercial places. Roads for transportation purposes to environmental issues, from the study of fluids and their mechanics to different small and big structures such as Dams, canals, houses etc. one of the common and most important factor in these structures is the study of materials upon which the structure is to be constructed which mostly is soil. This is known as Geo-technical engineering. If the proper study of the properties of underlying soil is not taken into account, It may cause damage to the structure which may result in huge material losses to worst case scenario, human deaths or in case of a dam failure may result in extreme worst material and human tragedy, so it is clear that the study of the underlying materials is of vital importance. An important topic of Geo technical engineering is the study of Pre-consolidation pressure. Pre-consolidation pressure is the stress that a particular soil has sustained in the past. The proper knowledge of pre-consolidation pressure helps greatly in construction of a safe and serviceable structure. Various methods have been developed in the past for finding pre-consolidation pressure such as the consolidation test which is the most widely used method. The disadvantage with this method is that it is a very time consuming process plus extreme care should be taken during the whole process. Furthermore it takes place on undisturbed soil which is difficult to obtain. In this project, effort has been made to calculate pre-consolidation pressure, using soil index properties such liquid limit, plastic limit and to develop a correlation between soil index properties and pre-consolidation pressure, one that would give an accurate value of pre-consolidation pressure without taking much time.

INTRODUCTION

1.1 BACKGROUND

At the present time civil engineers usually rely on the Atterberg's limits for indications of soil characteristic, which is plasticity. The Atterberg's limits are liquid limit, plastic limit and shrinkage limit. Method of drying the soil samples before the tests are carried, it is because drying the soils in different degree will alter their properties significantly. Some of the physical properties of soils will undergo changes that appear to be permanent.

Atterberg's limits tests should be in natural form or in air-dried form. But in reality, soil in natural form is inconvenient for laboratory test and air dry the soil will take a lot of time. Therefore, many will run the Atterberg's limits tests by using oven dried soil and ignore the fact that drying the soil will affect their properties and provide a misleading result. This study is to determine the effect of two drying methods, air drying method and oven drying method, on the soil plasticity.

1.2**OBJECTIVE**

There are several objectives to be accomplished through this study:

i) Determine the Atterberg's limits of soils by using drying methods.
ii) Study the effect of air drying method and oven drying method on the soil plasticity.
iii) Prove that the oven drying method could not replace the air drying method in soil preparation for both liquid limit and plastic limit tests of Atterberg's limits tests.

1. In this project, some major experiments will be carried out,
   Consolidation test
2. Dry Sieving
3. Specific Gravity
4. Plastic Limit Test
5. Liquid Limit Test

CHAPTER NO.2

RESEARCH METHODOLOGY

2.1Soil

Aheterogeneous accumulation of unconsolidated sediments and deposits of solid particles derived from the disintegration of rock.

Types of Soils

2.1.1Sandy Soil

Sandy soil has the largest particles among the different soil types. It's dry and gritty to the touch, and because the particles have huge spaces between them, it can't hold on to water. Water drains rapidly, straight through to places where the roots, particularly those of seedlings

2.1.2 Silty Soil

Silty soil has much smaller particles than sandy soil so it's smooth to the touch. When moistened, it's soapy slick. When you roll it between your fingers, dirt is left on your skin. Silty soil retains water longer

2.1.3 Clay Soil

Clay soil has the smallest particles among the three so it has good water storage qualities. It's sticky to the touch when wet, but smooth when dry. Due to the tiny size of its particles and its tendency to settle together, little air passes through its spaces. Because it's also slower to drain, it has a tighter hold on plant nutrients

2.1.4 Peaty Soil

Peaty soil is dark brown or black in color, soft, easily compressed due to its high water content, and rich in organic matter. Peat soil started to form over 9,000 years ago, with the rapid melting of glaciers. This rapid melt drowned plants quickly and died in the process The most desirable quality of peat soil, however, is in its ability to hold water in during the dry months and its capacity to protect the roots from damage during very wet months

2.1.5 Saline Soil

The soil in extremely dry regions is usually brackish because of its high salt content, known as saline soil, it can cause damage to and stall plant growth, impede germination, and cause difficulties in irrigation

2.2 Methods for finding Pre-consolidation pressure

There are many graphical methods to determine pre consolidation pressure e Log method (1955) Schemertmann method, janbu method (1969). Butterfield method, (1979) Casgrande method (1936) is the oldest and appropriate method to determine pre consolidation pressure .this is the standard method comparison to all .pre consolidation also determine from disturbed soil sample experimental work .Atterberg's limit (liquid limit, plastic limit)

2.3 Site selection

For the purpose of test, three sample was taken from different region of bannu city (U.E.T Bannu Campus, township near khalifa gull Nawaz hospital municipal plaza Bannu city).the laboratory result of soil sample of different location were studied. the depth of soil is very from 2m to 7m for different location representing the maximum stress zone

- (U.E.T campus III) from depth of 5 feet
- Municipal plaza bannu City from depth of 10 feet
- Township from depth of 8 feet

2.4Sieve Analysis

In order to classify a soil for engineering purposes, one needs to know the distribution of the size of grains in a given soil mass. Sieve analysis is a method used to determine the grain- size distribution of soils, The method of sieve analysis is applicable for soils that are mostly granular with some or no fines. Sieve analysis does not provide information as to shape of particleS

2.4.1Breaking of soil lumps

Nodules or lumps of soil must be broken down into their individual particles in order for the grain size analysis to be valid, Washing the particles that are retained on the No 200 sieve with water accomplishes two things.

- It separates those small lumps that might not have been broken up with the rubber-tipped pestle into the individual particles.
- It washes the “Dust sized" particles off the larger particles and through the No. 200 Sieve

2.4.2Particle Size Distribution Curve

Information obtained from the grain-size analysis is presented in the form of a curve, on a semi-logarithmic plot. The aggregate weight, as a percentage of the total weight, of all grains smaller than any given diameter (percentage finer) is plotted on the ordinate using an arithmetic scale, while the size of a soil particle, in millimeters is plotted on the abscissa which uses a logarithmic scale.

2.5Consolidation test

When structures are built on saturated soil, the load is presumed to be initially by incompressible water within the soil because of additional load on the soil. Water will tend to be extruded from the voids in the soil, causing in the reduction in void volume, The phenomenon of compression due to very slow extrusion of water from the slow extrusion of water from the voids in a fine-grained soil as a result of increased loading (such as weight of a structure on a soil) is known as consolidation. And the associated settlement is known as consolidation settlement,The consolidation test is carried out on three undisturbed and three disturbed soil sample. the test result obtained from consolidation test on disturbed and undisturbed soil sample have different moisture content , liquid limit , plastic limit, specific gravity , unit weight , sieve analysis . And presented in form of Void Ratio – effective log pressure.

2.6Consolidometer

A standardized device to hold the sample in a ring that is either fixed at the base or floating. The Consolidometer must also provide a means of submerging the sample, applying a vertical load and measuring the change in the thickness of the soil
Sample

2.7Atterberg's limit

In the early 1990s, a Swedish scientist named Atterberg's developed a method to describe the consistency of fine-grained soils with varying moisture contents, The four states of consistency in Atterberg's limits are liquid, plastic, semisolid and solid. . The liquid, plastic and shrinkage limits are therefore quantified in terms of the water content at which a soil changes from the liquid to the plastic state. The difference between the liquid limit and plastic limit is the plasticity index. Because the liquid limit and plastic limit are the two most commonly used Atterberg's limits

OCM (KPa)	Classification

2.7.1 **Plastic index**

The plasticity index (PI) is a measure of the plasticity of a soil. The plasticity index is the size of the range of water contents where the soil exhibits plastic properties. The PI is the difference between the liquid limit and the plastic limit (PI = LL-PL). Soils with a high PI tend to be clay, those with a lower PI tend to be silt, and those with a PI of 0 (non-plastic) tend to have little or no silt or clay

2.8 Specific gravity

It is sometimes required to compare the density of the aggregate soil solids to the density of water. This comparison is in the form of ratio and is termed as specific gravity of the soil solids

The specific gravity of any substance is defined as the unit weight of the material divided by the unit weight of water

Type of soil	Specific gravity
Sand	2.63-2.67
Silt	2.65 -2.70
Clay and Silty Clay	2.67 -2.90
Organic Soil	< 2.0

2.9 Void ratio at liquid limit

The sample at liquid limit is kept in the consolidometerring. It is then weighted, Afterthat. The mass of the consolidometer is subtracted to get the void ratio at liquid limit

CHAPTER 3

Results and Discussion

TABLE 1 Subsoil Charastictics of Alluvial soil of study Area

Soil Properties	Most Range
Sieve Analysis at Percent Passing	56.2
Liquid Limit (WL)	25
Plastic Limit (WP)	18.75
Plastic Index (IP)	8.25
Void Ratio e_0	0.61
Dry Unit Weight(γd)	11.0
Water Content (W)	13.4
Specific Gravity (Gs)	2.27

Over Consolidated Margin

0 Normally Consolidated	0 – 100 Slightly over consolidated
100 – 400	Moderately over consolidated
> 400	Heavily over consolidated

Table1: Overconsolidated margin

Chapter 4

RESULTS AND CONCLUSIONS

4.1Derivation of correlation

$$e/e_L = 1.122 - 0.188 \log Pc - 0.0463\ Po$$

Using soil index and consolidation test data of alluvial deposits of Bannu soil region new empirical correlations are derived for pre consolidation pressure kN/m² and over consolidation ratio for deposits.

$$Pc = 137.924 - 0.179\ po - 30.48\ (e/eL)\ kN/m^2$$
$$OCR = 1.85 - 0.007\ P_o - 0.255\ (e/eL)$$

$P_o = ɤ.z$

Where

- E = void ratio
- eL = void ratio at liquid limit,
- pc = pre consolidation pressure in KN/m²
- P_o = existing over burden pressure in KN/m²
- ɤ = unit weight
- z = depth of soil sample

4.1Table Preconsolidation Pressure

Final result (Pc)	Bannu campus	Municipal plaza bannu city	KGNH
Graph value	23.5	36	32.5
Correlation value	109.11	92.69	110.786

Table2 :Preconsolidation pressure

4.2Table : Over consolidation ratio

Final result (OCR)	Bannu campus	Municipal plaza bannu city	KGNH
Graph value	1.95	1.25	1.24
Correlation value	1.56	1.31	1.48

Table 1:Over consolidated ratio.

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