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EVALUATION OF COMPRESSIVE INDEX OF CLAY SOILS OF IPETU TOWN IN IREPODUN LOCAL GOVERNMENT AREA OF KWARA STATE

[1]Gana. A. J, [2]Toba, A. P & [2]Okigbo, S. N
[1]Department of Civil Engineering, Landmark University, Omu-Aran, Kwara State
[2]Department of Civil Engineering, Federal Polytechnic Bida, Pmb 55, Bida, Niger State
Emails: doctorgana@yahoo.com, phildebo123@gmail.com
Corresponding author: Gana, A. J

ABSTRACT

The common practice in Engineering profession for soil Analysis usually requires the use of empirical equations for computing the Engineering properties of soils, especially in Geotechnical Engineering field. It has been observed that empirical formulas give a better result for soils which in most cases have dis-similar properties. It has also been observed that most of the existing correlations relationships have been used for Index of clay soils in terms of its index properties. This paper Examines the compressive index of clay soils values of Ipetu town; being a distance of 4 bilometres away from Omu-Aran In Irepodun Local Government area of Kwara state the study also considered the soil consolidation, correlation, Regression and Liquid Limit of the clay soil under study.

Keywords:-*soils consolidation, compressive Index, remolding, correlations, empirical formulas regression, Liquid Limit.*

INTRODUCTION

The consolidation characteristics of clay soils usually from an important aspect in the design of foundations and other earth retaining structures and embankments. The determination of consolidation, through the usual consolidation tests; properties or characteristics namely the compression index, the confliction of consolidation and the coefficient of secondary compression is time consuming and costly. In addition to the test; obtaining undisturbed samples for the consolidation test also requires consolidation test also requires great precaution during sampling and transportation of the material. In order to reduce the above problem, researchers have resorted to correlating the compressibility behaviors of soils with simple index properties. In addition, it has become a general practice to use the empirical equations developed by different authors for estimating the compressive index from Liquid limit for the calculation of settlement of foundations resting on construction sites with clay soils. Evidence has provide that these empirical formular give a better results for soils from which they are formulated. Base on the above points, it is then imperative to make an assessment on the empirical formulars that are being used to determine the compressive index parameter (Cc) for the clay soils obtained from Ipetu town. The evaluation on the correctness of applying the various correlation formulars provided by different authors such as Tezzaghi and peck given by Cc=O0007 (LL-10) becomes important for the assessment.

MATERIALS AND METHODS

A disturbed sample of red clay soils was collected from Ipetu town, being a distance of 4 kilometers away from Omu-Aran in Irepodun Local Government area of Kwara state. A consolidation and Index property tests was conducted on the sample in the Laboratory and used for the development of the intended empirical formulae.

Soil Remolding

In this study, samples of the red clay soil collected was remolded in the Laboratory in accordance with the provisions and procedures outlined by British standard [B.S] 1377-1990]. Using the specimens produced by the remolding, the consolidation Test was conducted following the procedures set forth by ASTMD2435-90

Existing Correlations

Over the past fifty years, numerous efforts have been used by different researchers in order to develop empirical equations that relate to compressive index of the soil properties. To this effect, there are a number of correlation methods that are available for estimating the compressive index of soil, based on the soil classification, other index test values, and also physical property measurement of the soil. Several empirical equations by some authors in terms of soil index are the ones presented in the table below

Table 1 various correction equations between index properties and compression index

No	Equation	Applicability	References
1.	Cc = 0.007 (LL-10)	Remolded clays	Skempton 1944
2.	Cc = 0.007 (LL-10)	Normally consolidation clay	Terzaghi and Peck, 1948
3.	Cc = (LL-13)/109	All clays	Mayne, 1980
4.	Cc = 0.0046 (LL-9)	Brazilian clays	Bowles, 1980
5.	Cc = 1.15 (eo-0.35)	All clays	Nishida, 1956
6.	Cc = 0.0093wn	All clays	Koppula, 1981
7.	Cc=0.37 (eo+0.003LL-0.34)	Not Specified	Azzouz et al., 1976
8.	Cc = 0.046+0.0104PI	Not Specified	Nakase et al., 1988
9.	Cc=0.40(eo+0.001 wn-0.25)	Not Specified	Nakase et al. 1976
10.	Cc=0.15 (eo+0.007)	Not Specified	Nakase et al. 1976
11.	Cc = 0.54 (eo-0.35)	Not Specified	Arora, 2004
12.	Cc=0.0054 (2.6wn-35)	Not Specified	Arora 2004
13.	Cc=0.008 (LL-10)	Italian Soft Clays	Burglignoli and Scapelli, 1985
14.	Cc=0.40 (eo-0.25)	Not Specified	Azzouz et al., 1976

15.	Cc=0.00234LLGs	Not Specified	Nagaraj and Murhy, 1986
16.	Cc = 0.01 (w-5)	Not Specified	Azzouz et al., 1976

Skempton conduct consolidation and Atterberg limit tests on remolded specimens of many different type of clay soils where the initial moisture content of the materials were at the liquid limit. The resulting relationship between compression index and liquid limit pursuant to his study is given as equation (1) in table 3,1 Terzaghi and Peck suggested that Skempton's equation can be modified to reflect compression index of normally consolidated clays by simple multiplying it by a factor of approximately 1,3, which resulted in equation (2) of the same table. The bases for the empirical expressions given in table 3.1 are many and varied with one commonality; they all are based on regression analysis performed on laboratory test date.

Compression Index and Atterbeg Limits

According Gospel Ranjan ad A.S.R Rao (2000) the natural structural of a clay soil has a marked influence on its engineering properties. However, except for shrinkage limit, which can be determined for both undisturbed and remolded soil conditions, the consistency limits are determine on thoroughly remoled soils. And yet the Atterberg Limits are found to correlate well with the engineering properties of soils because both the Atterberg Limits and the engineering properties are found to be influenced by the same set of factors such as the clay minerals, the ions in pore water, the stress history of the soil deposit, etc. Generally the effect of liquid and plasticity index on the engineering properties of clay soils is indicated in table 3.2

Table 2 General relationship between Atterberg Limits and engineering properties

Characteristics	*Comparing soil properties at equal LL with PI increasing*	*Comparing soil properties at equal PI with LL increasing*
Strength	*Increases*	*Decreases*
Toughness near plastic limit	*Increases*	*Decreases*
Compressibility	*About the same*	*Increases*
Permeability	*Decreases*	*Increases*
Rate of volume change	*Decreases*	*Increases*

Some researchers report that though there are a number of empirical formulas developed to correlate the compression index with index properties, the compressibility behavior has not been considered together in any single study to examine which of the compressibility behavior, especially with the same set of test results. Despite this fact, it has been compression index with the liquid limit has received a higher preference and many empirical formulas derived so far tired to make use of the same. On the other hand, Amir A1-Khafaji (2005) has made a thorough investigation on the available empirical correlations in the light of comprehending the applicability of the existing formulae. In accordance with the paper presented by Amir A1-Khafaji, almost all empirical equations, developed so far, do not seem to have theoretical basis to justify their development. Furthermore the author reported that the developers of these empirical equations are for undisturbed samples or remolded sample except their mentioning that the equations are for all clay soils. In this respect the author is of the view that there is a need for the development of objective and rational procedures which could provide a meaningful measure of validity and applicability of regression equations. It is to be noted here that this study covers exclusively the correlation between liquid limit and compression index for remolded clay soils.

ANALYSIS AND DISCUSSION

General

A statistical analysis technique termed as regression analysis is usually employed to develop relationships between engineering properties of material. The method of regression analysis is a statistical technique used for modeling and investigation the relationship between two or more variables. Regression analysis may take the form liners, parabolic, logarithmic etc depending on the trend that may exist between the variable under consideration. Usually, a linear regression model is employed in problems of geotechnical engineering. Such type of regression analysis can be further divided into either simple regression or multiple regression analysis pertinent to the number of variables involved in the system. A regression model that contains more than one regressor variables involved in the system. A regression model that contains more than one regression variables is called multiple regression models. On the other hand, a regression model containing one independent variable or regressor is termed as simple regression model. Where the terms described in the preceding sentences are defined as follows. A variable whose value is to be predicted is called dependent variable or response. A variable (s) used to predict the value of dependent variable is termed independent or regressor variable (s). According to Douglas C. M. George C. Runger (2003), the development and subsequent fitting of regression model entails several statistical assumptions. Estimations of the model parameters requires the assumption that, the residuals (actual values less estimated values or the response values) corresponding to different observations are uncorrelated random with zero mean and consant variance, □2. Tests of hypotheses and interval estimation require that the errors, commonly denoted by ε, be normally distributed. In addition, we assuming that the order of the model is correct; that is, if we fit a simple liners regression model, we are assuming that the phenomenon actually behaves in a linear or first order manner. This is indeed fundamental assumption of any tests of hypothesis and interval estimation.

Scatter Plot

In this work, the Compression index value is considered as the dependent variable where as Liquid Limit is the independent variable s for the subject clay soil. In carrying out the whole statistical analysis, a statistical software program called SPSS software (which can be accessed through the URL http"//www. Wessa.net/ website and readily available software) was used using six laboratory test results conducted by the researcher and marking use of four test data taken from previous research work, relationships between the two variables, first a diagram called scatter diagram is applied. Precisely, it can be defined as a visual method used to display the relationship between two variables. The scatter plot of the dependent variable Cc (yi) with the regressor variable (xi), using the test data described herein above is shown below in figure

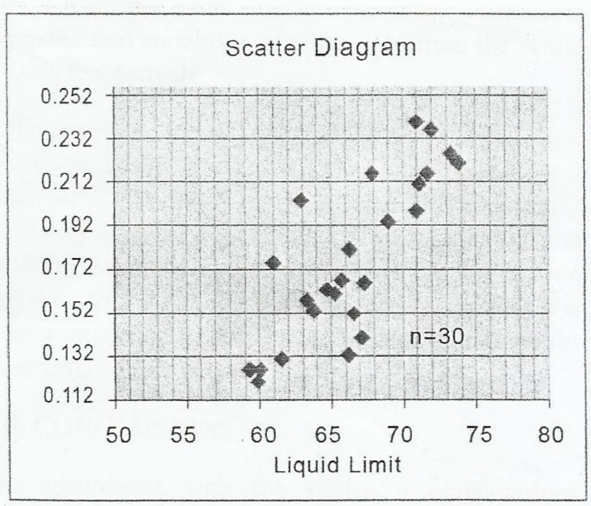

Figure 4.1 Scatter Diagram of Cc versus Liquid Limit

The scatter diagram is just a graph on which each (xi, yi) pair is represented as a point plotted in a two dimensional coordinate system. The above scatter diagram was produced by making use of excel spreadsheet, by selecting an option that shows dot diagrams of the x and y variable marking it easy to see the distributions of the individual variables. Inspection of the above scatter diagram indicates that, although no simple curve will pass exactly through all the points, there is a reasonable indication that the points lie scattered randomly around a straight line. The relationship between the variables then can be approximated by the following straight-line relationship. Here, it is probably reasonable to assume that the mean of the random variable Y is related to x.

$Y(x) = b_0 + b_1 x$…………………… 4.1

Where, the slope, b_1, and intercept, b_0, of the line are called regression coefficients and ε is the random error of the estimate. The above equation is a simple linear model as it has only one independent variable

Regression Analysis

As stated earlier statistical software called SPSS has been employed to study the relation between the regressor variables and the response to be predicated and the analysis is presented in this section. The basic assumption in this analysis is based on the least square method. The estimates of b_0 and b_1 will have the property that the sum of the squared differences between the observed and predicted $(y-y)^2$ is minimized using ordinary least square (OLS). Thus the regression line represents the Best Linear and Unbiased Estimators of the intercept and where the error sum of squares line (*best fitting line*)- is a line where the error sum of square $S\varepsilon^2$, is at a minimum and the technique that produces this line is the least squares method. Linear regression models are widely used when the response is found to be linear. Linear relations are generally represented by equation (4.1). Accordingly, the following result was observed with respect to the dependent and inpendent variables.

Correlation between Compression Index (Cc) and Liquid (LL)

The resulting equation from the regression analysis made between compression index liquid limit is presented as follow

Cc = -0.229 + 0.064 and sample size, n = 30

The above equation can also be re-written in a more convenient from as

Cc = 0.006 (LL-38)

Comparisons between the Exiting and the Developed Equations

Comparison has been made by selecting one of the existing empirical equation and the newly developed equation. These equations are utilized to analyze the significance of both formulas to the Addis Ababa red clay soils. To this effect, comparison have been made between the actual and the previously develop relationship. The actual compression index obtained from the Oedometer test is compared with the empirical relation developed by Skempton for remoleded clay soils, which is given by Cc = 0.007 (LL-10) and the following newly developed correlation equation, Cc = 0.006

(LL-38). Based on the comparison depict that the existing equation, which is developed for clay soils of the other country, and the newly developed equation gave different values of compression index which in turn provides us the evidence that soil properties depend on the location of their formation. Furthermore, we can see that it is not appropriate to directly adopt such equations for our soils.

CONCLUSION

In accordance with the statistical computations made, the relationship that has been made between compression index and liquid limit is found to give a coefficient of determination (R_2) value of 66.4% where the correlation equation for the same is given by:

$Cc = 0.006$ (LL-38 percentage).

The equation developed by Skempton for remolded clays on the other hand is

$Cc = 0.007$ (LL-10 percent)

In accordance with comparisons made between the result of the newly developed equation and that of the existing one with the actual Cc value, the newly developed equation has produced has a better result.

In view of the above points and the analysis carried out to relate compression index to the index property, the following conclusion are made.

1. The comparisons made between the newly developed equations and the existing equations reveal that the newly developed equations approximate compression index value of red clay soils of Addis Ababa in better way.
2. Generally, the existing equations result in higher compression index values when compared with the actual for a given index property of the clay soil.
3. This study shows that the compression index increases as the Liquid Limit increases for the particular soil considered in the study.
4. In order to enforce the conclusions drawn herein above and determine the extent of applicability of the newly developed empirical equations, it is suggested that addition, further works with greater number of data obtained from additional locations with similar soil nature are imperative to ensure the applicability of the newly developed equations as the research was limited to only 30 data points

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