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REGRESSION ANALYSIS OF REMOULDED SOIL SAMPLE IN RELATION SHIP WITH COEFFICIENT OF CONSOLIDATION AND INDEX PROPERTIES

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ABSTRACT

Coefficient of consolidation of soil sample is necessary in time rate settlement calculation. To obtain coefficient of consolidation (C_v) it is necessary to conduct the one-dimensional consolidation test. However, it takes a long time to measure the value of C_v in laboratory. Hence, in this study an attempt is made to establish the relation between C_v with some index properties/indices of soil. Therefore this study will help in the determination of C_v from index properties/indices of soil without conducting one-dimensional consolidation test. The experimental work is carried out in laboratory on twenty different soil samples (Liquid limit range from 20 to 70) which is collected from different location of Bidar district of Karnataka state. For consolidation test, soil samples are remoulded at their respective liquid limit and it is consolidated to gradually increment of stress from 0.05kg/cm^2 to 1.6kg/cm^2. Regression analysis carried out between index properties/indices and C_v value obtained from laboratory using Microsoft Excel software. Analysis reveals that, C_v value has good correlation with some index properties/indices and developed models estimates the reasonable C_v value.

Keywords: Coefficient of Consolidation, Index Properties, Regression Analysis.

I. INTRODUCTION

When a soil mass is subjected to compressive force, like all other materials, its volume decreases. The property of the soil due to which a decrease in volume occurs under compressive forces is known as the compressibility of soil. The compression of soils can occur due to one or more of the following causes.

1. Compression of solid particles and water in the voids.
2. Compression and expulsion of air in the voids.
3. Expulsion of water in the voids.

Compression of solid particles is negligibly small. Compression of water in the voids is also extremely small, as the water is almost incompressible in the range of stresses involved in soil engineering. Therefore, the compression due to the first cause is not much significant.

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Air exists only in partially saturated soils and dry soils. The compression of the air is rapid as it is highly compressible. Further, air is expelled quickly as soon as the load is applied. However, the compression due to the second cause is not relevant for saturated soils.

When the soil is fully saturated, compression of soil occurs mainly due to the third cause, namely, expulsion of water. Only this cause is relevant.

The compression of a saturated soil under a steady static pressure is known as consolidation. It is entirely due to expulsion of water from the voids. It is similar to the action of squeezing of water from a saturated sponge under pressure. The soil behaves as a saturated sponge. As the consolidation of soils occurs, the water escapes. The solid particles shift from one position to the other by rolling and sliding and thus attain a closer packing. It is worth noting that the decrease in volume of soil occurs not due to compression of solids or water but due to the shifting of positions of the particles as the water escapes. Small volume changes may occur due to bending, distortion and fracture of the soiled particles, but such changes are insignificant in the ordinary range of stresses involved in soil engineering problems. However, bending, distortion and fracture are indirectly responsible for a further decrease in volume due to shifting of particles.

A study of consolidation characteristics is extremely useful for forecasting the magnitude and time of the settlement of the structure. These characteristics are usually described using two well known coefficients. Compression index C_c and the coefficient of consolidation C_v. The coefficient of consolidation (C_v) used to predict required time for a given amount of compression to take place and the compression index (C_c), is directly used for calculation of settlement.

Generally the value of C_v is obtained from the laboratory one dimensional consolidation test by means of curve fitting procedures and based on Terzaghi one-dimensional consolidation theory. The routine oedometer test is complex, time consuming and expensive and also this value may not be representative of the soil which experiences the deformation in the field due to various factors such as the inherent assumptions involved in the consolidation theory in the methods for evaluation of C_v from the laboratory consolidation test data and the differences between laboratory testing conditions and those in the field. These aspects are not taken into account during laboratory tests.

In view of the complexity of obtaining C_v from a consolidation test any attempt to obtain the same from the correlation with the index properties for preliminary design will be most welcome. In the present study an attempt is made to correlate coefficient of consolidation with index properties and to obtain a correlating equation for the same.

II. METHODOLOGY

In this research, twenty Soil samples were collected from different places in and around Bidar region which is having latitude $16^0$9'30" to $16^0$9'10" and longitude $75^0$36'52" to $75^0$44'20". The soil samples were disturbed and picked up from depth of about 0.5m to 1m below ground level. It was tried to cover wide range of index properties (liquid limit ranges from 20 to 70) of the soil samples. Then their physical and index properties including specific gravity(G_s), Atterberg limit: liquid limit(LL), plastic limit(PL), shrinkage limit(SL), plastic index(PI), shrinkage index(SI) and their classification (USCS) were determined based on IS 2720 .

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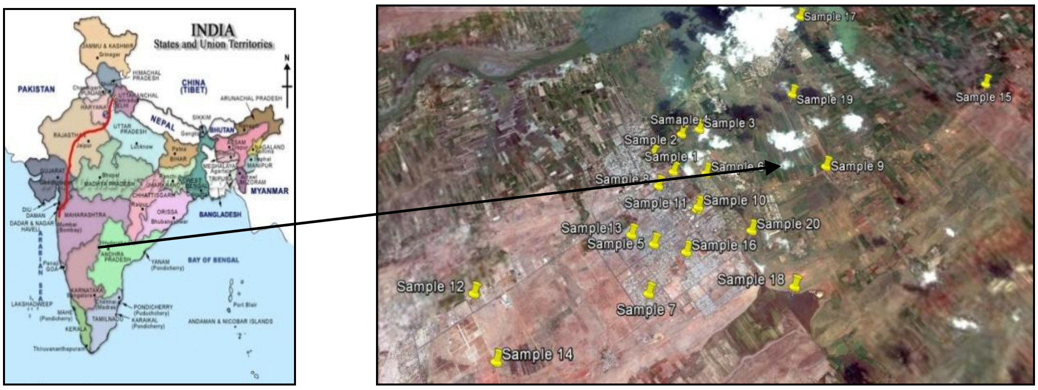

Fig1. Study Area

III. EXPERIMENTAL RESULTS OF INVESTIGATING SOIL SAMPLES

The following are the different properties of Sample-1 to sample-6 and the same experimental work has been carried out for all 20 samples.

Properties	Sample-1	Sample-2	Sample-3	Sample-4	Sample-5	Sample-6
Specific Gravity	2.6	2.7	2.69	2.62	2.67	2.4
Atterberg's Limit						
Liquid Limit	22.9	61	63.83	34.35	56.64	45
Plastic Limit	NP	30.881	31.887	20.7	29.21	24.769
Shrinkage limit	8.71	9.6	14.29	14.62	22	17.67
Plastisity Index	NP	30.119	31.943	13.65	27.43	20.231
Shrinkage Index	14.189	51.4	49.54	19.73	34.64	27.33
I.S Classification	SC	CH	CH	SC	CH	MI
Grain Size Distribution						
Gravel %	3.6	1	3.03	5.33	0.47	0.1
Sand %	86.67	28	25	63.67	22	37.3
Silt and Clay %	9.73	71	71.97	31	77.53	62.6
Engineering Properties						
Coefficient of Consolidation (C_v) in cm^2/sec	0.00057	0.000109	0.000046	0.0044	0.000028	0.00091

IV. RESULTS

Regression analysis is a statistical technique for modeling and investigation the relationship between two or more variable. A variable whose value is predicted is called dependent variable. A variable used to predict the value of dependent variable is termed as independent variable.

Simple linear regression of coefficient of consolidation and index properties of twenty remoulded soil samples

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Simple Linear Regression Analysis (SLRA) has been carried out to develop the correlation between individual soil property and coefficient of consolidation value. SLRA can be carried out using standard statistical software like Data Analysis Tool Bar of Microsoft Excel in order to derive the relationship statistically.

Correlation graph between C_v and liquid limit

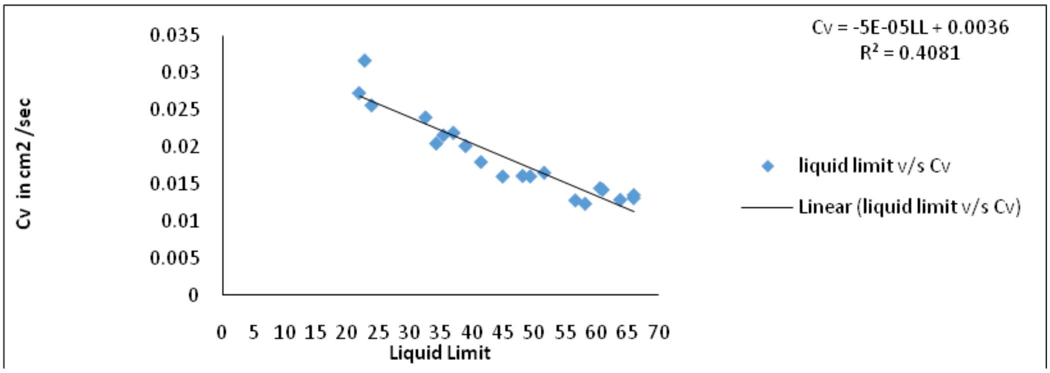

Fig 2 Correlation graph between C_v and liquid limit

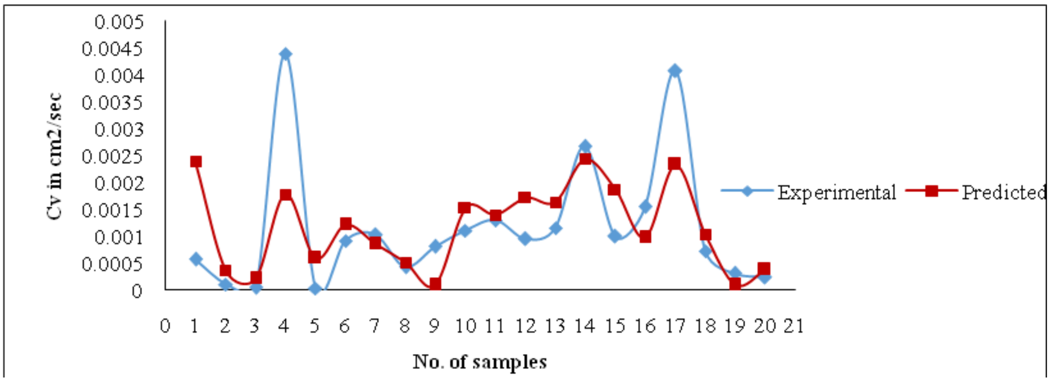

Fig 3 Comparison between experimental and predicted C_v value for liquid limit

Correlation graph between C_v and plastic limit

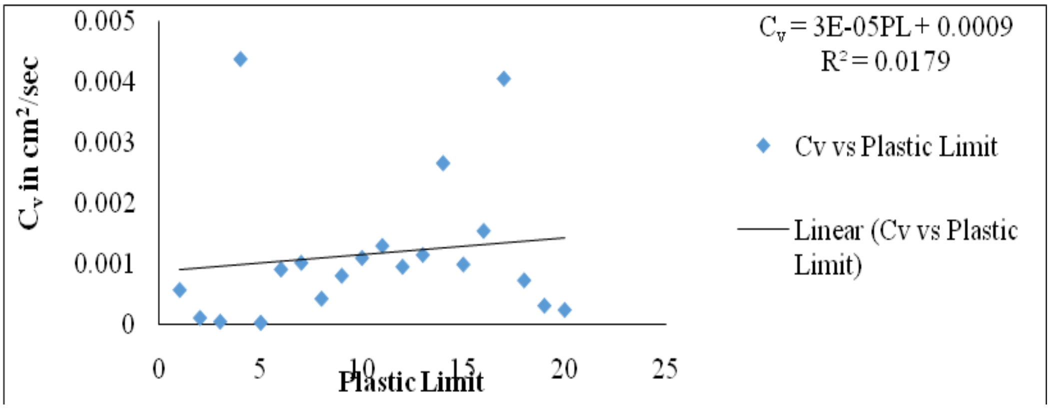

Fig 4 Correlation graph between C_v and plastic limit

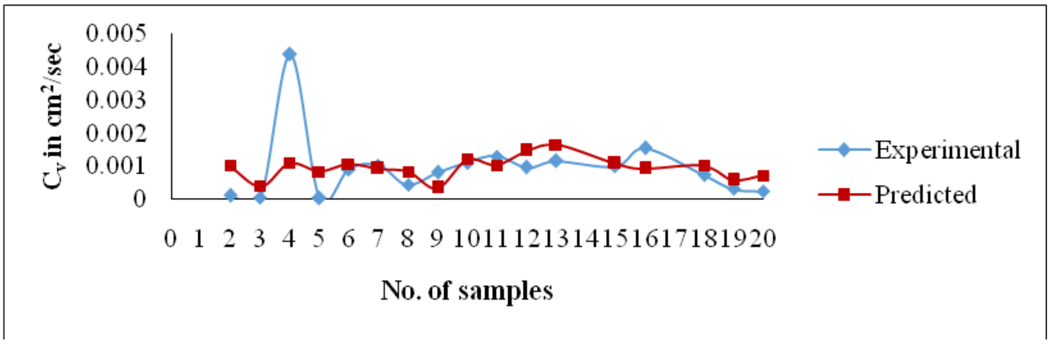

Fig 5 Comparison between experimental and predicted C_v value for plastic limit

Correlation graph between C_v and shrinkage limit

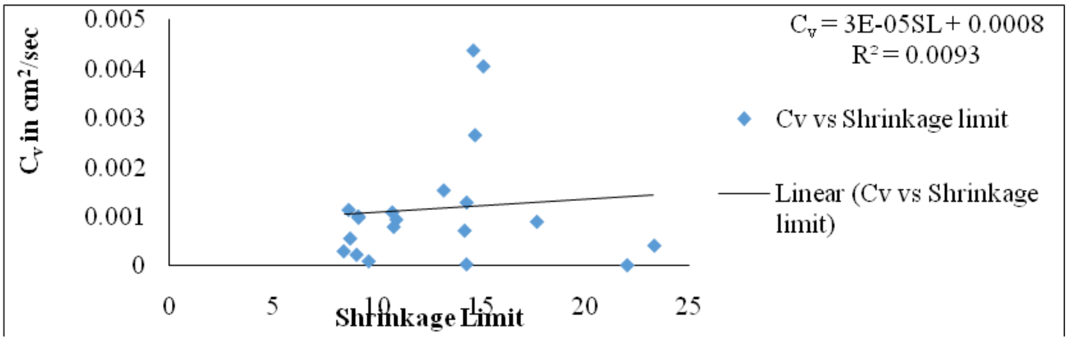

Fig 6 Correlation graph between C_v and shrinkage limit

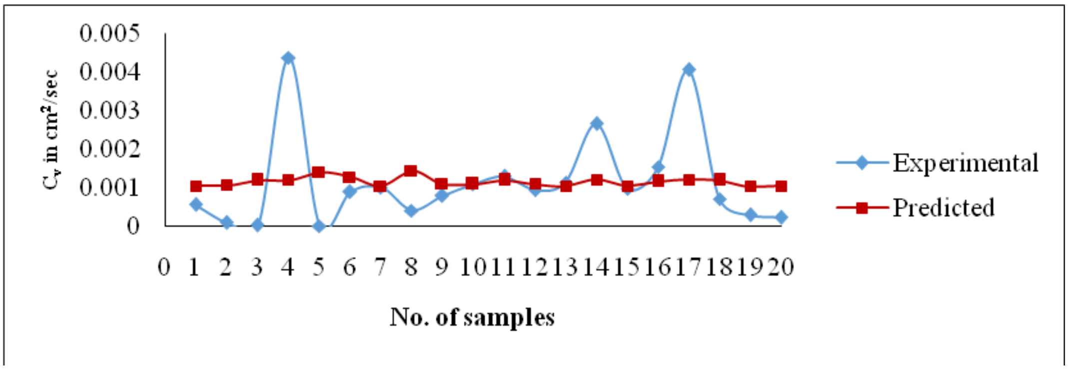

Fig 7 Comparison between experimental and predicted C_v value for shrinkage limit

V CONCLUSIONS

In this study an attempt has been made to correlate the coefficient of consolidation with index properties/ indices. Twenty soil samples of both fine grained and coarse grained are taken and empirical equations has been developed using Microsoft Excel.

The following conclusions can be drawn from the experimental and regression analysis of results:

1. The results of coefficient of consolidation (C_v) and index properties tests are interpreted together to infer and to understand the relation between them.

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2. The model developed by Simple Linear Regression Analysis (SLRA) for correlating coefficient of consolidation (C_v) with shrinkage index has shown better performance with coefficient of correlation (R^2) 0.715.

$$C_v = 128.7/ (Is)^{3.54} + 0.0002$$

3. Other models developed by SLRA for correlating coefficient of consolidation (C_v) with Liquid limit, Plastic limit and Shrinkage limit shows less significance to predict the coefficient of consolidation.
4. However, in the absence of shrinkage limit data, which is normally not determined in routine testing of soils as compared to plastic limit, the correlation between coefficient of consolidation and plasticity index, although less strong, can be used for prediction purposes.

VI SCOPE FOR FURTHER INVESTIGATION

This investigation has influence the study to further some more detail investigation in order to get best correlation to predict C_v value. Large number of samples (which belongs to different soil group) with more experimental research should be carried out to increase accuracy for predicting C_v value from different properties of soil.

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