International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 04 | Apr-2018 www.irjet.net p-ISSN: 2395-0072

CORRELATION OF CBR WITH DIFFERENT SOIL PROPERTIES

Joyanta Maity[1], Suman Kumar Ghosh[2] and Sanchari Hati[3]

[1] *Assistant Professor, MSIT, Kolkata-150*
[2, 3] *PG student, MSIT, Kolkata-150*

Abstract – *California Bearing Ratio (CBR) value of subgrade is used for design of flexible pavements in differ rent parts of our world. In practice, determination of CBR value in laboratory is laborious, time consuming and costly. Moreover, the results sometimes are not accurate due to poor quality of skill of the technicians testing the soil samples in the laboratory. So, the evaluation of CBR of subgrade soils on the basis of simple and less time consuming tests may be necessary specially for low volume roads. Many attempts have been made in the past to correlate CBR value with easily determinable soil parameters such as grain size, plasticity index etc. But, such correlations are empirical, and therefore, would give reliable results only for the geographical region from which the soil data was collected for correlation.*

In the present study, an attempt has been made to develop a framework for prediction of CBR value of clayey soil. For this purpose, large number of test results on soil samples like Liquid limit, Plastic limit, Maximum dry density and percentage of sand content were collected from different sites in West Bengal and has been used as the generalized parameter to characterize the clayey soil. The correlation is established in the form of an equation of CBR as a function of different soil properties by the method of regression analysis. The reliability of the proposed method has also been validated with large number of tested values.

Key Words: CBR[1], Plasticity Index[2], Maximum dry density[3], Flexible pavement[4], Regression analysis[5].

1. INTRODUCTION

One of the requirements for economic upliftment of a country is proper development of transportation facilities. In India, as a national effort to increase such facilities, large scale road construction is being under taken over last decade through different schemes like Pradhan Mantri Gram Sadak Yojona and Golden Quadrilateral Project. As a result, large quantity of filling materials is being needed to construct the subgrades and embankments of such roads. Conventionally materials for such fills are the available and usable soils around the alignment of the road to be constructed. California Bearing Ratio (CBR) is an empirical test and results of such tests are widely applied in design of flexible pavement. This test has also been used for the design of rehabilitation of old pavements to determine the overlay thickness. However to obtain soaked CBR Value of a soil sample, takes minimum 4 days, making CBR test expensive time consuming and laborious. Also, improper handling and poor quality of testing conditions in sites may have some doubts about accuracy of the results produced. Thus for cost effective and quicker methods to evaluate the CBR value, on the basis of low cost, easy to perform, and less time consuming tests, becomes important. Development of prediction models might be useful and become a base of judgement on the validity of CBR values. In view of these, an attempt has been made in the present study to correlate CBR with different physical properties of soils.

2. REVIEW OF PAST WORKS

Many correlations studies for CBR have been reported, taking into account different soil parameters like grain size, soil classification, index properties, compaction characteristics, bearing capacity, modulus of subgrade relation, elastic stiffness etc.

Agarwal and Ghanekar (1970) developed a corelation to estimate the CBR value for cohesive soils in term of Optimum Moisture Content (W_{opt}) and liquid limit (LL)

$$CBR = 2 - 16\log(W_{opt}) + 0.07\,LL \quad \text{---------(2)}$$

But the validity of above relation could not be substantiated significantly (Sahoo et al.,2010). National Cooperated Highway Research Program (NCHRP – 2002) proposed the following equation to predict CBR from index properties for soils with 12% fines and with some plasticity.

$$CBR = \left(\frac{75}{1+0.728(w.PI)}\right) \quad \text{----------(3)}$$

Where, w = Percentage passing 75µ I.S. Seive,

PI = Plasticity Index.

Kin (2006) developed correlation for soaked CBR from optimum moisture content and maximum dry density, as given below,

$$CBR\ (Soaked) = OMC\left(\frac{MDD}{19.3}\right)^{20} \quad \text{----------(4)}$$

Where, MDD = Maximum dry density in kN/m^3,

OMC = Optimum moisture content (%)

3. OBJECTIVES AND SCOPE OF THE STUDY

The correlations as developed by several authors, being empirical in nature may give reliable results only for the geographical region from which such soil data for correlation were collected. Since alluvial soils exist over large part of North India and Coastal plains of India, and as alluvial soils are extremely erratic in nature, it was felt that an elaborate search need be made to develop a correlation for CBR values in soaked condition on the basis of results of simple, less costly, quick tests on such soils. Case study was made in alluvial soil deposits in different districts of West Bengal. Reported test results of LL, PL, and percentage of finer (W) and soaked CBR values in different sites of PMGSY roads, are used for this study to develop correlation of CBR (soaked) and Percentage Finer (75 micron) and Plasticity Index of the soils from alluvial plane of the country. Validity of the correlation developed was tested by comparing the predicted value of CBR (soaked) with tested value of CBR (soaked) on alluvial soil deposits in different districts of West Bengal.

4. DEVELOPMENT OF RELATIONSHIP BETWEEN CBR (SOAKED) AND PLASTIC PROPERTY

To develop the relationship between CBR (soaked) and plastic property, a large number of test results on soil samples collected from different sites in West Bengal have been used as the generalized parameter to characterize the clayey soil. Table 1 gives the test results (LL, PL, and percentage of finer (W) and soaked CBR) of the soil sample collected from different districts in West Bengal.

Table 1: Test results of the soil sample collected to develop the correlation

LL	PL	PI	W	W*PI	CBR(%)
44	25	19	94	1786	3.8
44	23	21	85	1785	3.8
39	17	22	77	1694	4
41	20	21	75	1575	4.3
39	19	20	89	1780	3.8
42	23	19	91	1729	3.9
47	27.2	19.8	87	1722.6	3.91
45	23	22	85	1870	3.6
41	20	21	89	1869	3.6
41	20	21	80	1680	4
39	18	21	78	1638	4.1
39	18	21	76	1596	4.2
38	17	21	84	1764	3.8
40	21	19	90	1710	3.9
36	18	18	92	1656	4
42	22	20	87	1740	3.8
38	20	18	95	1710	3.86
36	18	18	91	1638	4
45	26	19	85.9	1632.1	4.01
39	18	21	82	1722	3.8
42	23	19	86	1634	4
44	24	20	88	1760	3.7
47	28	19	86	1634	3.98
40	20	20	90	1800	3.6
39	18	21	77	1617	4
42	23	19	85	1615	4
39	19	20	75	1500	4.3
41	22	19	87	1653	3.9
38	19	19	77	1463	4.4
43	23	20	87	1740	3.7
39	20	19	89	1691	3.8
43	22	21	85	1785	3.6
41	23	18	87	1566	4.1
40	19	21	78	1638	3.9
37	17	20	84	1680	3.8
41	22	19	86	1634	3.9
37	16.8	20.2	81	1636.2	3.89
39	20	19	88	1672	3.8
41	23	18	86	1548	4.1
42	19	23	61	1403	4.5
38	18	20	75	1500	4.2
40	21	19	85	1615	3.9

Now, measured CBR values are plotted against (W*PI) value and the best fitted straight line is found as shown in fig. 1. The equation of the best fit straight line is:

CBR (soaked) = - 0.001(W*PI) + 7.116

(R^2 = 0.847)

Where, W= Percentage Finer through 75 micron
PI = Plasticity Index

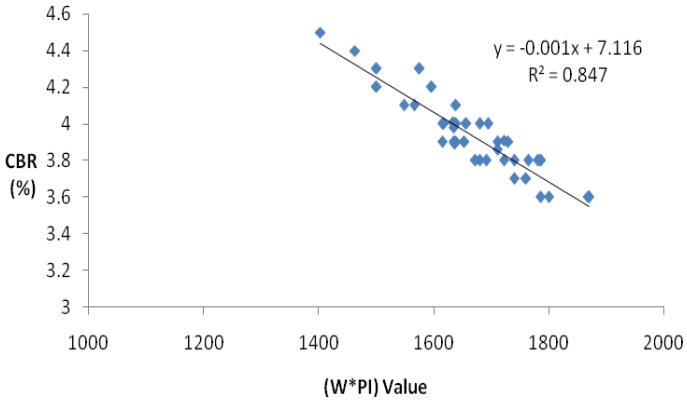

Fig 1. CBR (soaked) vs. (W*PI) relationship of clayey soil.

5. VALIDATION OF CORRELATIONS:

Validity of the correlation developed was tested by comparing the predicted value of CBR (soaked) with tested value of CBR (soaked) on alluvial soil deposits in different districts of West Bengal as reported for PMGSY roads, which are reproduced in Table 2.

Table 2 Tested value of CBR (soaked) on alluvial soil deposits in different districts of West Bengal

LL	PI	W	MEASURED CBR	PREDICTED CBR	ERROR
43	17.5	90.5	3.62	4.02	-9.94
42.9	17.6	90.3	3.62	4.01	-9.69
41.3	17.6	84.5	3.8	4.21	-9.79
41.2	17.9	100	3.25	3.61	-9.90
41.6	17.9	89.9	3.63	3.97	-8.53
37	18	94	3.46	3.80	-9.02
43	18	92.8	3.4	3.85	-11.60
37	18	91	3.64	3.91	-6.93
43	18	89	3.7	3.98	-7.11
43	18	88	3.7	4.02	-7.94
41	18	87	3.9	4.06	-3.82
42	18	87	3.8	4.06	-6.29
41	18	85	4.1	4.13	-0.65
44	18	85	4.06	4.13	-1.62
40	18	84	4	4.16	-3.92
41	18	84	4.1	4.16	-1.51
40	18	82	4	4.24	-5.55
36	18	79	4.8	4.34	10.52
36.8	18.2	90	3.54	3.91	-9.49
40	19	89	4.2	3.81	10.38
40	19	86	3.7	3.92	-5.59
42	19	85	3.7	3.96	-6.49
37	19	79	4.1	4.19	-2.03
37	19	78	4.1	4.22	-2.91
39.6	19.1	100	3.02	3.37	-10.31
42.3	19.1	100	3.1	3.37	-7.93
46.2	19.3	81.1	3.97	4.06	-2.13
38	19.3	80.9	4.5	4.06	10.72
38.5	19.5	83.3	4.3	3.94	9.18
39.5	19.5	70.2	4.36	4.45	-2.00
38.4	19.8	85	4.1	3.82	7.30
41.3	19.8	76.7	4.6	4.15	10.85
49.8	20	92	3.3	3.51	-5.90
42	20	91	3.8	3.55	7.13
37	20	90	3.8	3.59	5.94
44	20	87	3.6	3.71	-2.89
37	20	86	4	3.75	6.75
42	20	82	4.2	3.91	7.50
37	20	80	3.8	3.99	-4.69
37	20	78	3.8	4.07	-6.57

Further the plotting of measured and predicted values of CBR (Soaked) are also given in figure 2 for visual comparison. It may be observed from the fig. 2, that the predicted soaked CBR values are quite close to the measured values using the present correlation for majority of test results.

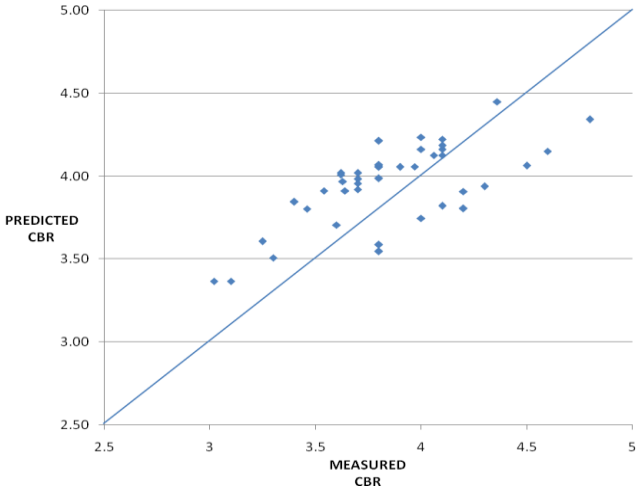

Fig. 2 Measured and Predicted values of CBR (Soaked) in %.

6. CONCLUSIONS

On the basis of extensive test results for CBR (Soaked) value of various Alluvial soil, a generalized correlation between soaked CBR value and Percentage Finer (75 micron) and Plasticity Index of Alluvial soils have been established.

1) New correlations have been proposed for predicting the CBR value from Percentage Finer (75 micron) and Plasticity Index.

$$CBR\ (soaked) = -0.001(W*PI) + 7.116 \qquad (R^2 = 0.847)$$

Where, W= Percentage Finer through 75 micron
PI = Plasticity Index

2) When experimental values of CBR (soaked) are compared with predicted value of CBR(soaked) with large number of data, the predicted value of CBR on the basis of presented correlation gives very excellent results and the variation between predicted and observed values are generally below 10%.

ACKNOWLEDGEMENT

Data used in this study was kindly provided by Dr. Sudip Kr. Roy, Professor of Civil Engg. Dept. IIEST, Shibpur and also Chief Coordinator, State Technical Agency, PMGSY in West Bengal. We thankfully acknowledge him for utilization of stored data for advancement of technology.

REFERENCES

[1] Agarwal, K. B. and Ghanekar, K. D. (1970) "Prediction of CBR from Plasticity Characteristics of Soil", Proceeding of 2nd South-east Asian Conference on Soil Engineering, Singapore. June 11-15, 1970. Bangkok: Asian Institute of Technology, 571-576.

[2] IRC: SP: 20 (2002), "Rural Roads Manual" Indian Roads Congress, New Delhi.

[3] IRC: SP: 72 (2007), "Guidelines for the Design of Flexible Pavements for Low Volume Rural Roads". Indian Roads Congress, New Delhi.

[4] Kin M. W. (2006), "California Bearing Ratio Correlation with Soil Index Properties", Masters Thesis, Faculty of Civil Engineering, University of Technology, Malaysia.

[5] National Cooperative Highway Research Program (2002), "Guide for Mechanistic and Empirical - Design for New and Rehabilitated Pavement Structures", Final Document, West University Avenue Champaign, Illinois, USA.

BIOGRAPHIES

Joyanta Maity, PhD (JU) is Assistant Professor of C.E. Dept., MSIT, Kolkata. His research interests include ground improvement techniques, use of alternative materials and use of natural geo-fibers in Civil Engineering.

Suman Kumar Ghosh, M.Tech student, of C.E. Dept., Meghnad Saha Institute of Technology, Kolkata.

Sanchari Hati, M.Tech student, of C.E. Dept., Meghnad Saha Institute of Technology, Kolkata.