"Study of correlation of CBR value with engineering properties and index properties of coarse grained soil."

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ABSTRACT-California Bearing Ratio test is a very important and common test performed to assess the stiffness modulus and shear strength of sub grade material so as to determine the thickness of overlaying layers. Conducting CBR test is an expensive and time taking test, also it is very difficult to keep the sample in desired condition. To overcome this problem other method such as regression (Simple and Multiple) analysis has been used. This paper describes correlation of cbr with index properties and engineering properties of coarse grained soil. For this purpose disturbed soil samples are collected from different region of Jabalpur city.

Keywords-CBR, regression models, index and engineering properties.

1. INTRODUCTION

Most of the road network system in our country is consist of flexible pavements. There are several methods of design of flexible pavement. California bearing test is one of them. California bearing test is an empirical method of flexible pavement design. Flexible pavement consists of four components. These are usually named as soil subgrade, subbase course, base course, surface course. Flexible pavement layers transmit the compressive stresses to the lower layer (sub grade) by grain to grain transfer through the points of contact. Hence the design and performance of pavement largely depends upon the strength of subgrade soil.CBR test is used to determine the strength of subgrade soil.CBR value can be determine by laboratory test according to IS2720 part 16. The thickness pavement depends on CBR value, higher the CBR value, then the designed thickness of the sub-grade is thinner and vice versa.

CBR value can be determine both in un-soaked and soaked condition. It takes 4 days to perform soaked cbr on each soil sample, which makes CBR test expensive, time taking and laborious. Therefore it is very difficult to carry out to entire stretch of road in a short duration and leads to serious delay in the project and increases its cost. To overcome these problems, an attempt has been made to correlate cbr value with index properties and engineering properties of soil, as

these values can be calculate in less time. Breytenbach (2009) did research work to develop prediction models for estimation of CBR value using natural road construction materials in South Africa [1]. Ferede (2010) developed correlations to predict CBR value using D60, OMC and MDD for granular soils and LL, PL, PI and F200 for fine grained soils [2]. And many other investigators like Taskiran, 2010; Venkatasubramanian and Dhinakaran, 2011; Patel and Desai, 2010; Yildrim and Gunaydin, 2011 Talukdar, 2014; Singh, Reddy and Yadu, 2011; McGough, 2010 etc) [3, 4, 5, 6, 7, 8, 9,] developed prediction models based upon index properties of soil. .

2. EXPERIMENTAL WORK

Disturbed soil samples were collected from eight different locations of Jabalpur city (M P) India. The collected soil samples are tested for CBR value, optimum moisture content, maximum dry density, particle size distribution ,all these tests are performed as per the guidelines provided by IS Code. In this study, regression models, both simple linear regression analysis (SLRA) and multiple linear regression analysis (MLRA), were developed for determining soaked CBR value using index and engineering properties of coarse grained soils.

Table 1-Summary of test results

S No	D_{30} (mm)	D_{60} (mm)	D_{10} (mm)	C_U	C_C	OMC %	MDD (g/cc)	CBR %	SOIL TYPE
1	7.1	13.44	1.15	11.2	3.26	10.8	2.14	18	GP
2	8.2	30.2	2	15.1	1.11	8	2.2	32	GW
3	5.1	18.62	1.4	13.3	1	9	2.17	21	GW
4	5	13.2	1.2	12	1.57	9.2	2.15	20	GW
5	.46	1.1	.17	6.47	1.13	9.8	2.06	12	SW
6	.49	1	.247	4.04	0.97	10.5	2.05	11.4	SP
7	.5	.8	.33	2.42	0.94	10.9	2.03	9.2	SP
8	.48	.7	.34	2.18	0.96	12	2	8.4	SP

3. RESULTS AND DISCUSSION

The results obtained from the tests are shown in table 1. For further calculations simple linear and multiple linear regression analysis are performed. Simple linear regression analysis is used to establish relation between soaked *CBR* and different soil properties, graphs are plotted with *CBR* against different soil parameters and suitable trend line is drawn with higher correlation coefficient. Fig 1 shows variation of OMC with the CBR value. The value of R^2 was found to be 0.7698. From figure 2 it can be observed that the relationship between MDD and CBR is linear

with a coefficient of correlation R^2=0.889. Fig 3 shows variation of Cu with the CBR value. The value of R^2 was found to be 0.8809.

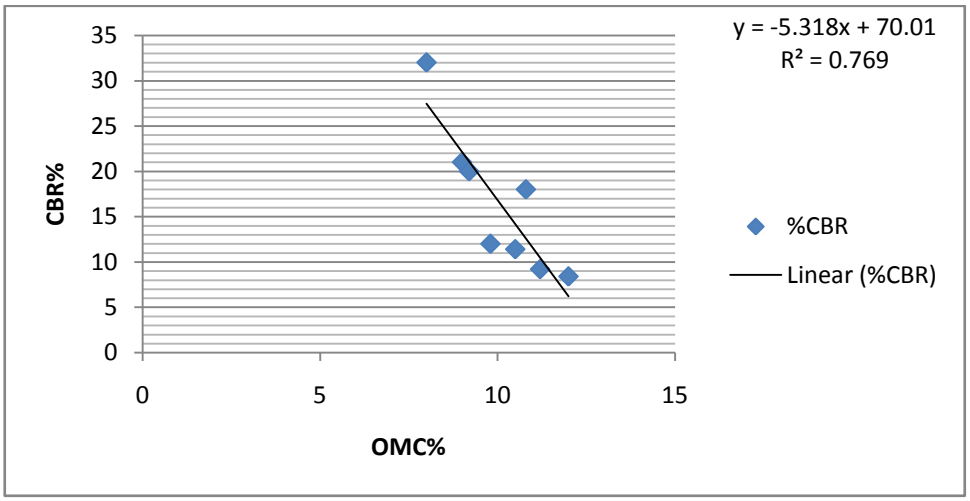

Figure 1: Variation of CBR with OMC

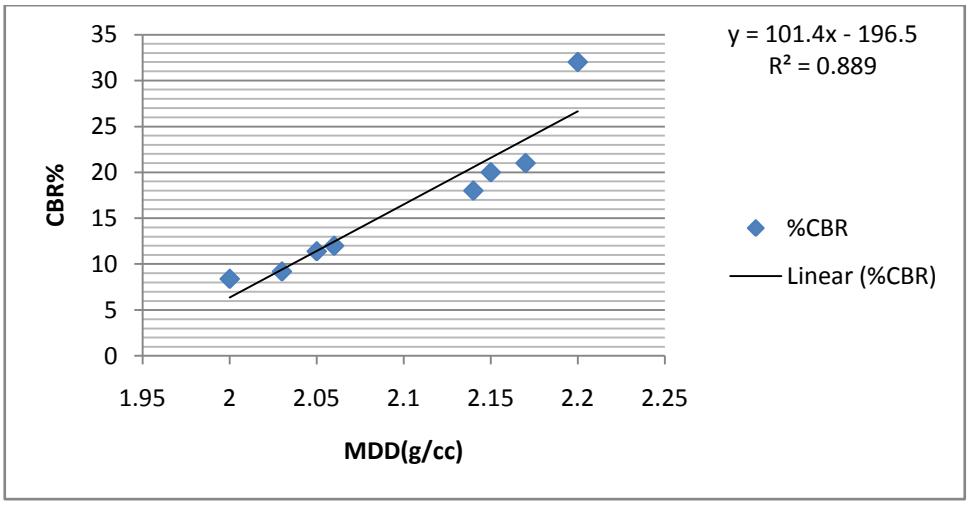

Figure 2: Variation of CBR with MDD

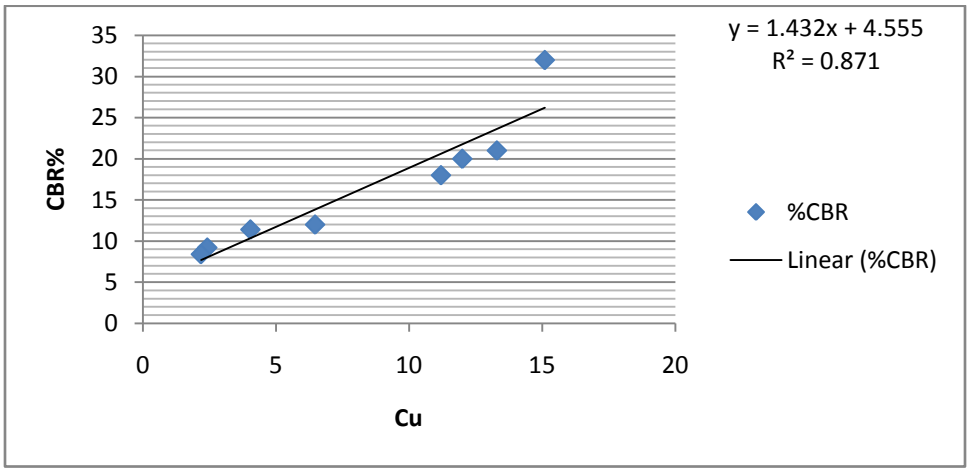

Figure 3: Variation of CBR with Cu

As the main purpose of this study was to develop a correlation between the CBR value of the coarse grained soil and soil properties like GRAIN SIZE DISTRIBUTION, OMC, MDD, for this multiple regression model is developed using the data analysis tool pack of Microsoft excel. The mathematical equation developed is as follows:-

$$\mathbf{CBR= 198.63-3.78*OMC-73.37*MDD+0.34*D_{60}+1.64\ *D_{30}}$$

The coefficient of correlation (R^2) for the above equation was found to be 0.9728, this shows the equation holds good in correlating the CBR value with other soil properties.

The comparison between laboratory CBR value and predicted CBR value are shown in the table below.

COMPARISON OF LAB AND SOAKED CBR

CBR(%) from laboratory test	CBR(%) from mathematical equation
18	17
32	30.692
21	20.09
20	18.796
12	11.57
11.4	9.675
9.2	8.445
8.4	7.552

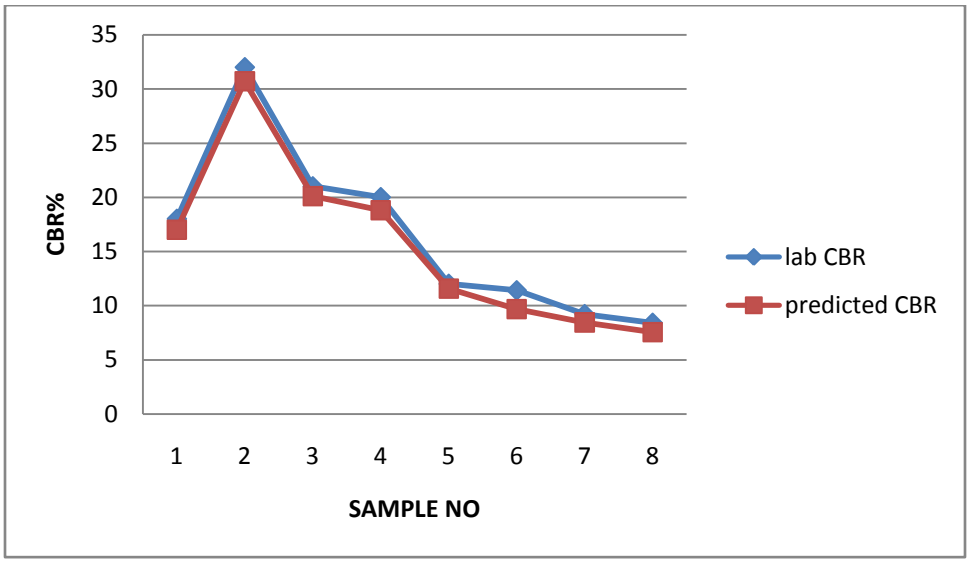

Figure 4: Predicted and laboratory CBR value comparison

4. CONCLUSIONS

Following conclusions are drawn from above study

- CBR value of coarse grained soil bears significant correlation with Cu, MDD and OMC.
- CBR value decreases with increase in OMC but also increases with increase in MDD and grain size.
- From regression analysis the coefficient of variation (adjusted R^2) for the CBR value is found to be 0.998.
- From the formula and table 2, we can conclude that the correlation equation can be used for evaluating different values of CBR, but this research is limited for coarse grained soil only.

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