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Prediction of CBR Value with Soil Index Properties; Case Study on Yadadri Region

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Abstract: Geotechnical engineer creates empirical equations for a specific area and soil. CBR test is tedious and laborious test. This review developed the correlation between's CBR values with soil index properties particular to yadadri region. A soil index property includes sieve analysis, Atterberg limits and compaction tests. Eighteen samples gathered from parts of yadadri and required research laboratory tests have been conducted to accomplish the correlation. The review analyzes single linear regression analysis and multiple linear regression analysis in SPSS. Then using the correlation we predicted the CBR values

Keywords: California bearing ratio, Regression models, Soil index properties.

I. INTRODUCTION

California Bearing Ratio (CBR) is a common and comprehensive test at present practiced in the design of pavement to survey the stiffness modulus and shear quality of sub grade material. CBR value not only influenced by the soil type but also with various soil properties. CBR is an indirect measure which speaks about correlation of the strength of sub grade, sub base and base course material to the strength of standard crushed rock cited in rate values.

To acquire CBR estimation of a soil specimen, it takes about seven days, making CBR test costly, tedious and laboratory. As a result, a predetermined CBR test could be performed for a region of any developmental projects. Such few constrained number of CBR test outcomes may not only cover large area helps financial also and for safe development.

Researchers previously developed few correlation based on their research like Graft-Johnson and Bhatia (1969) based on suitability index with CBR. NCHRP based on weighted plasticity index and Agarwal and Ghanekar (1970) had built up an enhanced relationship between's CBR values with liquid limit and optimum moisture content. Recently, Naveen and Santosh (2014) established correlation between CBR and soil physical properties. Rakaraddi and Gomarsi (2015) established relationship between CBR and different properties of soil. To overcome the problems mentioned it is aimed to predict the CBR value of soil using soil index properties that is Liquid Limit, Plastic Limit, Plasticity Index, Maximum Dry Density, Optimum Moisture Content and % passing Sieve P_{200}.

II. EXPERIMENTAL WORK

For the research study eighteen soil samples were collected from different locations of Yadadri (Telangana) India. The soil samples are tested for liquid limit, plastic limit, plasticity index, CBR value, optimum moisture content, maximum dry density, particle size distribution ,all these tests are performed as per the IS Code. In this research, single linear regression analysis and multiple linear regression analysis are done in SPSS for determining correlations. Based on the correlation ten control tests are used to predict the CBR values

Based on laboratory tests i.e, atterberg limits, grain size analysis, modified proctor test, soil classification and california bearing ratio test results are tabulated

Table 1-Summary of test results

Item no.	Sample Code	% passing 0.075mm	LL (%)	PL (%)	PI (%)	SOIL TYPE	MDD (gm/cc)	OMC (%)	DENSITY (g/cc)	CBR (%)
1	R-37	22.1	31.9	17	15	SW	1.97	9.2	2.02	22.12
2	R-38	30.2	33.6	18	15	SM	1.98	9.4	2.06	21.03
3	R-36	27.5	34	20	14	SM	1.95	9.4	1.99	22.6
4	R-40	20.3	33.2	20	13	SM	1.89	9.9	2.015	24.22
5	R-41	21.8	32	17	15	SC	1.94	9.8	1.99	24.51
6	R-43	24.6	32	18	13.5	SP	1.9	8.6	2.02	23.31
7	R-42	22.8	31.8	16	16	SM	1.89	9.4	2.015	24.12

8	B3-1	21.2	32	17	15	SP	2.02	9	1.99	23.4
9	B3-2	26.4	33	18	15	SM	2.02	9.1	2.02	23.6
10	B3-3	29.2	33.1	19	14.1	SM	2.01	9	1.99	22.19
11	B3-4	20.3	33.3	17	16.3	SM	2.01	9.01	2.01	22.5
12	B3-37	20.2	33.8	20	13.5	SM	2.08	8.9	2.04	21.75
13	B3-36	20.3	33.9	20	14.1	SM	2.03	8.3	2.0	23.88
14	B3-43	23.7	32.3	17	15.2	SP	2.02	8.6	2.04	23.5
15	B3-42	21.2	33.1	18	15.2	SC	2.02	8.6	2.02	22.5
16	B3-40	22.6	33.2	19	14.2	SP	2.05	8.9	2.06	23.1
17	B3-38	22.6	33.2	18	14.8	SM	2.03	8.3	2.04	23.7
18	B3-41	24.2	32	16	16	SW	2.02	8.6	2.03	23.9

III. RESULTS AND DISCUSSION

The obtained results from tests are shown in table-1. Based on the values single linear regression analysis and multiple linear regression analysis are done. Single linear regression model established with cbr as dependent variable and independent variables are ll, pl, pi, mdd, omc and p200 in spss software.

Fig. 1 output of single linear regression analysis in spss

Model B: Correlation of CBR with MDD, OMC, PI, LL, PL and P_{200}

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.895[a]	.801	.692	.52675

a. Predictors: (Constant), PI,LL
b. Dependent Variable: CBR

Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (constant)	55.423	9.944		5.574	.000
MDD	5.288	4.161	.282	1.271	.230
OMC	.318	.411	.152	.775	.455
PI	-.274	.400	-.273	-.685	.507
LL	-1.206	.216	-.937	-5.574	.000
PL	-.170	.247	-.256	-690	.504
P_{200}	.037	.130	.050	.283	.782

a. Dependent Variable: CBR

The best fit from 6 models which has R^2 value 0.765 and correlation can be written as

CBR = 60.05 – 1.125*LL,with R^2 = 0.765, n = 18

Multiple linear regression analysis done with all 6 variables as independents and cbr as dependent in spps

Fig. 2 output of multiple linear regression analysis in spss

Model B: Correlation of CBR with MDD, OMC, PI, LL, PL and P_{200}

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
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PL	-.170	.247	-.256	-690	.504
P_{200}	.037	.130	.050	.283	.782

a. Dependent Variable: CBR

The best fit from 4 models which has R^2 value 0.801 and correlation can be written as

CBR = 55.423 – 1.206*LL+0.037*P_{200}+5.288*MDD+0.318*OMC-0.17PL -0.274*PI R^2 = 0.801, Adj. R^2 = 0.692, n = 18

From the value of coefficient of determination R^2 the correlation is picked. After developing correlation for further calculation ten control tests are used for predicting the values of cbr.

Table-2 validation of developed correlation

Sample No.	Control test results						Predicted CBR
	P_{200} (%)	LL (%)	PI (%)	MDD (g/cc)	OMC (%)	Actual CBR	
1	22.1	33.65	15.15	1.965	9.25	22.12	22.21
2	30.2	34	15.16	1.989	9.4	21.03	21.75
3	24.6	31.8	13.44	1.9	8.6	23.31	24.09
4	29.2	33	15.73	2.012	9.05	22.19	22.98
5	21.8	31.9	14.74	1.94	9.8	24.51	24.37
6	20.2	33.9	13.54	2.018	8.9	21.75	21.92
7	21.2	33.2	15.19	2.025	8.6	22.5	22.63
8	22.6	32.5	14.88	2.02	8.3	23.7	23.42
9	24.2	32	16.07	2.025	8.9	23.9	24.23
10	26.4	32.33	15.01	2.023	9.1	23.6	23.83

Fig. 3 Graph between predicted and laboratory CBR values

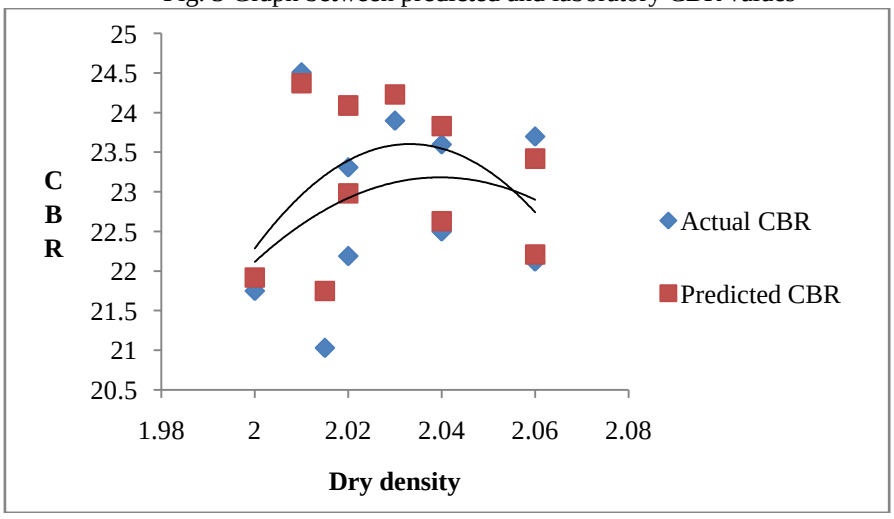

Table-3 Evaluation of the predicted and existing correlation

Sample No.	Actual CBR value (A)	Developed Correlation	
		Predicted CBR Value (B)	Variation (%) (B-A)*100/A
1	22.12	22.21	0.4
2	21.03	21.75	3.42
3	23.31	24.09	3.34
4	22.19	22.98	3.56
5	24.51	24.37	-0.57
6	21.75	21.92	0.78
7	22.5	22.63	0.57
8	23.7	23.42	-1.18
9	23.9	24.23	1.38
10	23.6	23.83	0.97

The developed correlation anticipated the CBR value with normal variety of not more than 4% from the real CBR value. So this correlation is acceptable and can be used in future.

IV. CONCLUSION

Among the single linear regression examination the correlation amongst CBR and liquid limit.
Relatively an enhanced correlation than the single regression when multiple regression analysis is been utilized with LL, PL, MDD, OMC, P_{200} and PI.
In the overall, the soil index properties associates better with strength quality for CBR than individual soil properties.
The predicted CBR values of the soils are very close to lab values and hence the proposed correlation is acceptable.
The coefficient of correlation R^2 for the CBR value found from SPSS analysis is found to be 0.801 & 0.692.
For preparatory plan reason the above relationship may be utilized, if the anticipated CBR is inside the scope of 0.2 to 3.5%. Something else, a detailed research test ought to be done to acquire the real CBR value.

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