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Prediction of CBR Characteristics of Fine-Grained Red Soils

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Abstract: Red soils of fine grained nature are prominent for foundation layers in the construction of civil engineering Structures especially sub-grades of flexible and rigid pavements. Strength and deformations are the main parameters to explain durability of the pavements. CBR is the parameter to explain strength and sub-grade which decides the total thickness of the pavement. In the present investigation grain size distribution, plasticity characteristics are used to explain CBR characteristics. Prediction models are developed for estimation of CBR using the above characteristics with R^2 values in the range of 0.42 – 0.49.

Key words: CBR, Strength, Deformation.

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I. INTRODUCTION

California Bearing Ratio is the standard parameter which indirectly explains the strength of sub-grade soils of pavements. Computation of CBR from laboratory tests consumes time and laborious. To avoid disturbance in sample representation, for quick verification of test result, reduce delay in project time indirect methods for estimation of CBR are necessary. In recent times the importance in prediction models for estimation of CBR has been gaining prominence. Some of the earlier models are listed below. In the present investigation 25 number of red soils of fine grained nature has been used in correlation analysis for prediction of CBR values.

1. Agarwal and Ghanekar (1970)
CBR=2-16log (OMC) +0.07(LL)
2. Vinod,Reena and Cletus (2008)
CBR=-0.889(W_{LM}) + 45.616,
Patel and Desai (2010)
$(CBR)_S$=43.907-0.093(PI)-18.78(MDD)-0.3081(OMC)
3. The National co-operative highway research program (NCHRP) (2003) [3]
CBR = 75/ 1+0.728(WPI)
4. Yildirim and Gunaydin (2011)
CBR = 0.62 OMC + 58.9 MDD+ 0.11 LL + 0.53 PL – 126.18,
CBR=0.22 G+0.045S+4.74MDD+0.122 OMC,
5. A.A. Bello (2012):
CBR = 13.56 + 1.04 (PL)
CBR = 28.87 + 0.22 (LL)
CBR = -70.22 + 50.28 (MDD)
Following correlation for CBR un- soaked value with index properties of lateritic soils:
CBR_u= 65.31 + 0.8 (PL)
CBR_u = 83.19+ 0.031 (LL)
CBR_u= 65.88+ 8.66(MDD)
6. Rama Subba Rao G.V and Siva Sankar G (2013**)**
$(CBR)_S$=0.064 F+0.082 S+0.033 G-0.069 LL+0.157(PL)-1.810MDD-0.061 OMC,

II. MATERIAL AND RESULTS

To study the inter-relationship 25 red soil samples were collected from different regions of north coastal districts of Andhra Pradesh at a depth of 1.0-1.5m from ground level and tests for grain size distribution (Dry and Wet analysis) (IS 2720 part 4). Plasticity characteristics (W_L, W_P, &I_P), soaked CBR tests have been conducted as per IS 2720 and the results are as shown in the table 1.

S.NO	S	F	Wl	Wp	Ip	CBR
1	43	57	34	20	14	5.5
2	40	60	33	20	13	5.8
3	38	62	32	19	13	5.6
4	35	65	34	20	14	5.7
5	48	52	30	19	11	6.0
6	42	58	33	20	13	5.6
7	36	64	32	19	13	5.8
8	30	70	34	20	14	5.5
9	44	56	32	19	13	5.8
10	39	61	33	19	14	5.5
11	37	63	33	20	13	5.4
12	32	68	33	19	14	5.7
13	38	62	33	19	14	5.4
14	37	63	34	20	14	5.0
15	40	60	30	19	11	5.4
16	44	56	30	19	11	5.5
17	48	52	29	19	10	5.8
18	47	53	28	19	9	6.0
19	35	65	33	20	13	5.2
20	38	62	35	20	15	5.0
21	42	58	30	19	11	5.5
22	46	54	30	19	11	5.8
23	42	58	28	19	9	6.0
24	40	60	28	19	9	6.0
25	30	70	30	18	12	5.8

S= SAND (%), F= FINES (%), WL=LIQUID LIMIT, W_P= PLASTIC LIMIT, I_P= PLASTICITY INDEX, CBR=CALIFORNIA BEARING RATIO D_{10}= SIZE OF SOIL PARTICLES AT 10% FINERD_{60}= SIZE OF THE SOIL PARTICLES AT 60% FINER C_U= COEFFICIENT OF UNIFORMITY

PARAMETRIC ANALYSIS OF RED SOILS:
The following identifications are made from the test results of Red soils.

- Increasing the percentage of sand particles increases the CBR values whereas increasing the fine particles decreases CBR values.
- Increasing a small percentage of fines increases Dry density and CBR values. High CBR values are due to occupation of more solids, availability of wide range of particles.
- Increasing the huge percentage of fines increasing plasticity index values highly there by reducing CBR under soaked condition. Increasing the percentage of fines increases the deformability conditions there by decreasing the shear strength and penetration resistance under condition.

CORRELATION:
Based on the test results like grain size distribution i.e. (Gravel, Sand, Fine particles), their range in terms of gradation coefficients such as coefficient of uniformity (C_u), with respect to soaked CBR values, various relationships are established. It is further included plasticity characteristics in terms of Liquid Limit and plasticity index are correlated with CBR values. Correlation models have been generated by choosing CBR as dependent variable and gradation characteristics, Plasticity characteristics as independent variables using excel Microsoft analysis. Multiple linear regression analysis (MLRA) has been done and the following correlation equation with R^2 values are shown in below table

TABLE NO: 2 CORRELATION EQUATIONS OF CBR LINEAR EQUATIONS

SNO	VARIABLE	EQUATION	R^2
1	f (S, F, WL)	CBR = (0)S-0.00072(F) – 0.0892 (WL) + 8.478	0.46
2	f (S, F, IP)	CBR = (0)S+0.006(F)-0.03(IP)+6.843	0.42
3	f (S, F, WL, IP)	CBR = (0) S-0.0027(F)+0.064(IP)-0.138(WL)+9.387	0.47
4	f (S, F, D_{60}, IP)	CBR = (0)S-0.00062(F) -0.899(D_{60}) -0.107(IP) +7.0015	0.42
5	f(S, F, D_{60}, Cu, WL)	CBR = (0)S+0.0035(F) +7.96(D_{60}) -0.0068(Cu) - 0.099(WL)+8.589	0.49
6	f (S, F, D_{60}, Cu, IP),	CBR = (0)S+0.0046(F)+7.27(D_{60}) -0.0066(Cu) +0.119(IP)+6.84	0.45

The strength, effectiveness of these correlations can be represented by R^2 values by performing multiple regression analysis. Shows that the correlation with grain size distribution (S, F, D_{60}, & C_u) have considerable influence on CBR values which representing wide range of particles with improved correlation coefficients (R^2).

It is also noted that inclusion of plasticity index with grain size distribution and gradation characteristics of rose correlation coefficient (R^2) to 0.49. Inclusions of plasticity characteristics (Ip) have high Influence of CBR characteristics. Inclusion of more number of effective parameters improves the prediction of CBR values with high correlation coefficients. It is further identified that involvement of more than one variable in the correlation analysis (Regression analysis) made more accurate in the prediction of CBR values. In the present study the predicted equations are simple and can be effectively used for the prediction of CBR values of red soils are with high accuracy.

IV. CONCLUSION

1. Soil with wide range of particles with low percentage of fines exhibited high soaked CBR values.
2. The models developed by MLRA for correlating soaked CBR value with gradation characteristics (S,F,D_{60}, C_u,W_L, I_p) have shown relatively with high R^2 values

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