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Correlation Of CBR Value With Properties Of Red Soil

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Abstract – *California Bearing Ratio (CBR) is a commonly used indirect method to assess the stiffness modulus and shear strength of sub grade in pavement design. CBR value of soil depends on many factors like maximum dry density (MDD), optimum moisture content (OMC), liquid limit (LL), plastic limit (PL), type of soil and permeability of soil. In this paper an attempt has been made to establish relationship between CBR value and index properties of red earth, a type of locally available soil in Kerala.*

Keywords— *Coefficient of correlation (R) [2], MLRA, Regression, Soaked CBR value, SLRA*

1. INTRODUCTION

A pavement is a relatively stable crust constructed over natural soil for supporting and distributing wheel loads and providing durable wearing surface. Pavement is usually built in several layers, and these are usually termed sub-grade, sub-base, base and surfacing. The design and the behaviour of flexible pavement depend mainly on the strength of sub-grade soil, and hence it is necessary to assess its strength. CBR test is now an empirical test widely applied in design of flexible pavements over the world.

The CBR test is essentially a penetration test, which can be carried out either in the laboratory or in the field.CBR value can be measured directly in the laboratory test in accordance with IS 2720 part XVI on soil sample acquired from site. Laboratory test takes at least four days to measure the CBR value for each soil sample. Civil engineers always encounter difficulties in obtaining representative CBR value for design of pavement. In addition, CBR test in laboratory requires a huge soil sample and is laborious as well as time consuming. This would result in serious delay in the progress of the project, since in most situations the materials for earth work construction come from highly variable sources. Any delay in construction inevitably leads to rise of project cost. To overcome this situation, it is better to predict CBR value of sub-grade soil with easily determinable parameters. This paper aims to establish relationship.

Magdi M. E. and Zumrawi (2012), have established a reliable strong correlation between CBR values and plasticity index. The primary objective of the paper was to predict the CBR values (soaked and unsoaked) of clayey soils using soil index properties such as water content, dry density, void ratio and plasticity index.

Dilip Kumar Talukdar (2014) conducted a test to establish correlation between CBR value with other index properties like maximum dry density, optimum moisture content, liquid limit, plastic limit and plasticity index of soil. About sixteen number of disturbed soil samples were collected from different sites of Nagaon district of Assam. CBR test was conducted and their correlation was tested using Multiple Linear Regression Analysis (MLRA) with index properties.

Mukesh A Patel and H S Patel (2013), developed correlations between various properties like maximum dry density(MDD), optimum moisture content(OMC), unconfined compression strength, direct cone penetration value and CBR of soil in soaked condition. The paper presents the empirical correlations developed from multiple variable regression analysis from test results obtained from experimental investigation of soil sample taken from different locations of Gujarat region.

2. METHODOLOGY

Soil samples were collected from three different locations in Kothamangalam, Kerala. Field density was calculated using core cutter method. The various steps involved in the correlation includes determination of index properties of the soil like specific gravity, field density, liquid limit, plastic limit (PL), plasticity index (PI), optimum moisture content, determination of CBR value of the sample followed by correlation of the index properties of the sample using Simple Linear Regression Analysis (SLRA) and Multiple Linear Regression Analysis (MLRA) by using Excel software. The geotechnical properties of the soil samples were tested as per IS 2720 and the results are presented in Table1.

3. RESULTS AND DISCUSSIONS

The various test results were initially correlated with the observed CBR value to determine the degree of correlation existing between the values and then arrived at five simple regression models and 21 multiple regression models.

Table -1: Geotechnical Properties of Soil Samples

Index properties	Sample1	Sample 2	Sample 3
Field unit weight	20.4kN/m³	21.3kN/m³	17.3kN/m³
Specific gravity	2.667	2.22	2.71
Moisture content	39.84%	33.09%	20.02%
Dry density	1.45g/cc	1.6g/cc	1.44g/cc
Atterberg limits			
Liquid limit	44.7%	36.5%	57.8%
Plastic limit	27.26%	28.144%	26.76%
Plasticity index	17.44%	8.356%	31.04%
Proctor test			
OMC	19.2%	21%	20%
MDD	1.74g/cc	1.41g/cc	1.46g/cc
Theoretical max. dry unit weight	18.0kN/m³	17.1Kn/m³	17.3kN/m³
CBR value	6.93%	20.69%	20.29%

From the correlation results it is clear that the higher degree of correlation exist between OMC and CBR, the degree of correlation is 0.7034 and the least correlation exist between PI and CBR, the degree of correlation is 0.0236. Since all the correlation values are positive, the relation can be said to be as linear simple positive correlations.

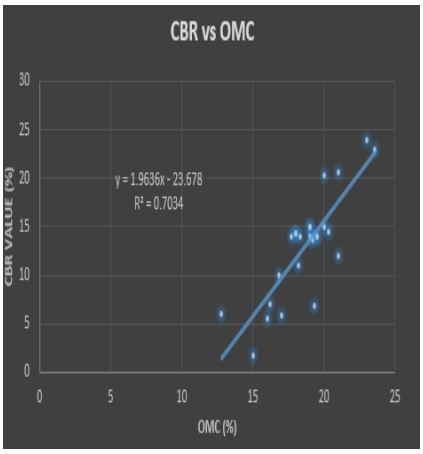

Fig 1: Regression Analysis between CBR and OMC Using SLRA

From the SLRA results it is observed that the higher value of regression coefficient is for OMC, i.e., 0.7034. In MLRA using two variable the highest value of regression coefficient is for PI and OMC, i.e., 0.817, for three variables the highest value of regression coefficient is for PI, OMC and MDD, i.e., 0.852 and for four variables the highest value of regression coefficient is for LL, PI, MDD and OMC, i.e., 0.857.

From validation results it is seen that the predicted value conforms with the actual value to some extent. The least difference between the actual and predicted values is observed in the case SLRA for LL, i.e., 0.348. In MLRA using two variables the least difference is for PI and MDD, i.e., 0.09, for three variables the least difference is for PL, LL and MDD, i.e.1.002 and for five variables the least difference is 1.608.

Table -2: comparison between actual and predicted CBR value

Regression Model	Regression Equation	Actual CBR values	Predicted CBR values	Difference	R^2
3	CBR=1.9636 OMC-23.678	14	14.612	.612	.7034
12	CBR= 2.206OMC-0.5188PI-23.318	14	16.171	2.171	.817
17	CBR = 1.369OMC-16.73MDD-0.741PI+21.785	14	15.218	1.218	.852
25	CBR=1.356 OMC-13.843MDD -0.79PI+0.1108LL+13.4717	14	15.717	1.717	.857
26	CBR=1.278 OMC-14.259MDD +0.104LL-0.779PI+0.0335PL+14.804	14	15.608	1.608	.846

This is negligibly small value which may be due to any observational error during testing of samples. So it can be concluded that there exists a good relationship between CBR value and soil properties.

The sample shows a maximum difference of 2.296 from actual CBR among best regression models obtained.

4. CONCLUSIONS

Based on the analysis carried out, the conclusions can be summarized as follows:

- Analysis of the experimental results demonstrates very clearly that a direct linear relationship exist between CBR and soil properties. From the correlation results it is clear that good degree of correlation exist between OMC and CBR.
- Comparison between measured CBR and calculated results using developed equations clearly indicate the reliability of these equations for red earth.

- Validation results show the strength of the relationship obtained. It can thus be concluded that regression analysis provides a sound background for predicting CBR.

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