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Available online at: www.jrrset.com
ISSN (Print) : 2347-6729
ISSN (Online) : 2348-3105
JIR IF : 2.54
SJIF IF : 4.334
Cosmos: 5.395
Volume 8, Issue 12 - December 2020 - Pages 28-37

ESTABLISHING RELATIONSHIP BETWEEN CBR VALUE AND PHYSICAL PROPERTIES OF SOIL

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ABSTRACT

Sub grade strength is mostly affected by thickness of pavement, in Highway design. California Bearing Ratio (CBR) is the one of the method to determine the sub grade strength.CBR test is laborious and time consuming, hence a method is proposed for correlating CBR value with the LL, PL, SL, PI, OMC and MDD. In the present study, different soils samples (Liquid limit ranges from 20-70) were collected from different locations. Various laboratory tests including Atterberg limit, Specific Gravity, Gradation Analysis, CBR and compaction were performed on the samples. Various linear relationships between index properties and CBR of the samples were investigated using simple and multiple linear regression analysis and also predictive equation estimating CBR from the experimental index values were developed.

KEYWORDS: California Bearing Ratio (CBR), Atterberg limit, OMC and MDD.

1. INTRODUCTION

All civil engineering works such as the construction of highway, building structure, dam and other structure have a strong relationship with soil. All those structures need a strong layer of soil to make sure the structure are strong and stable. But the soil conditions vary from one location to another location; hence, virtually no construction site present soil conditions exactly like other site. Hence it is difficult to predict the behaviour of soil. As a result, soil conditions at every site must be thoroughly investigated for proper design. There are different methods of design of flexible pavement. The California Bearing Ratio (CBR) test is an empirical method of design of

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flexible pavement,Subgrade soil bearing capacity plays very important role for the design of highway structure. It determines the thickness of the pavement, CBR values can be measured directly in the laboratory test in accordance with IS 2720 part-XVI on soil sample obtained from the site.

CBR test in laboratory requires a large soil sample and is laborious as well as time consuming. This would results in delay in the progress of the project as well as cost. To overcome these difficulties, an attempt has been made in this study to correlate CBR value statistically with the liquid limit (LL). Plastic limit (PL), Plasticity index (PI), maximum dry density (MDD) and optimum moisture content (OMC) of soil, because these tests are simple and can be completed with less period of time.

OBJECTIVES OF THE STUDY

1. To understand relationship between CBR values and physical properties of soil (liquid limit, plastic limit, shrinkage limit, plasticity index, maximum dry density, Optimum moisture content) samples collected from different location.
2. The main objective of the study is to carry out regression analysis from laboratory experimental results.

2. MATERIALS AND METHODOLOGY

Initially experiments were conducted to find out different properties of soil such as index properties, grain size distribution and. Later on light compaction tests were conducted to find out the optimum moisture content & corresponding maximum dry density. Then CBR tests were made at moisture contents including OMC. Then the data was analyzed and the suitability of the data with the published correlation in predicting CBR value was checked. Analyses of results were done in the next chapter.

SAMPLE COLLECTION

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Twenty soil samples were collected from in and around the Bagalkot region which is having Latitude 16 9' 30"- 16 9' 10" and Longitude 75 36' 52"- 75 44' 20". The selected sample consists of both coarse as well as fine grained soil. Soil samples were collected at a depth of 0.5-1m below ground level to avoid organic matter. The selected soil samples tested for CBR value, Optimum moisture content, maximum dry density, particle size distribution, plastic limit and liquid limit. Based on Indian Standard optimum moisture content and maximum dry density was carried out on soil samples that collected by bulk samples. All the soil samples are having different Liquid Limit.

3. RESULTS AND DISCUSSION

All the laboratory test results are presented and discussed. Regression analyses carried out to meet the objective of the study based on laboratory tests results of twenty soil samples collected from different locations of Bagalkot region.

Correlation between CBR and Liquid limit

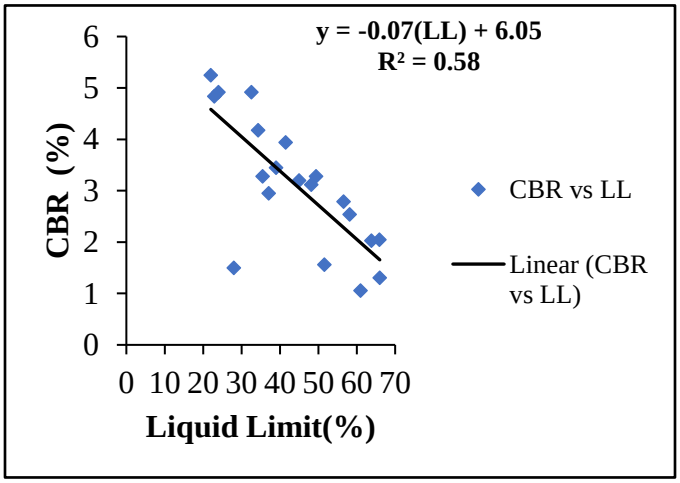

Fig 3.1

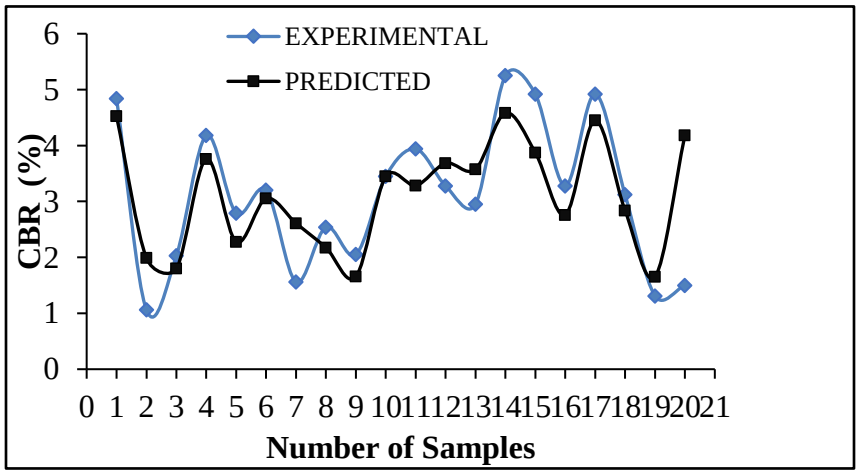

Fig 3.2

Correlation between CBR value and Liquid limit & Comparisons between experimental and predicted CBR values

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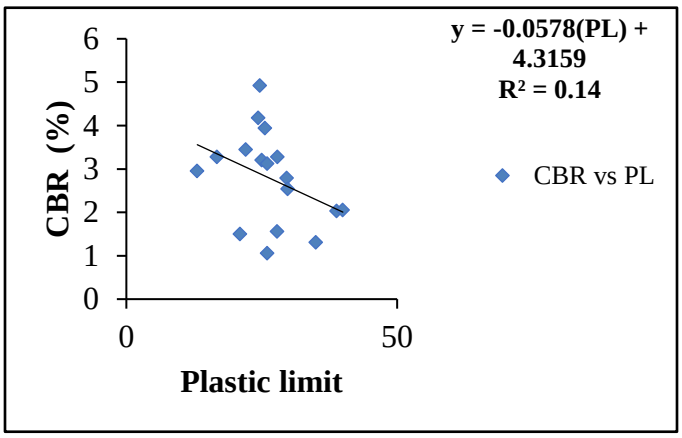
Correlation graph between CBR and Plastic limit



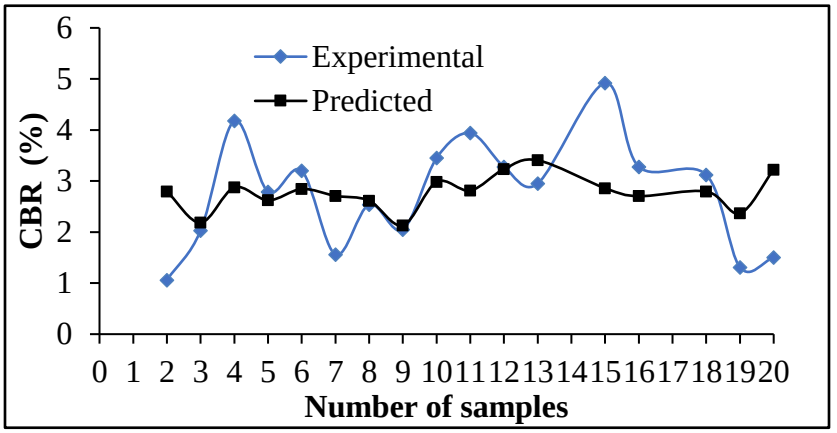
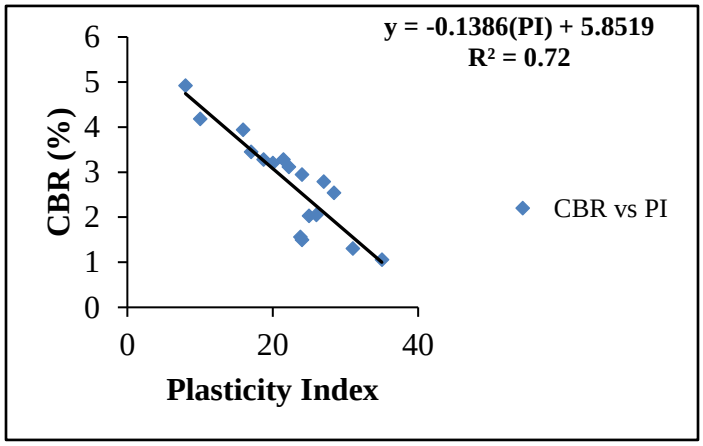


Fig 3.3 **Fig 3.4**

Correlation between CBR value and Plastic limit & Comparisons between Experimental and Predicted CBR value for plastic limit

Relationship between CBR and plasticity index



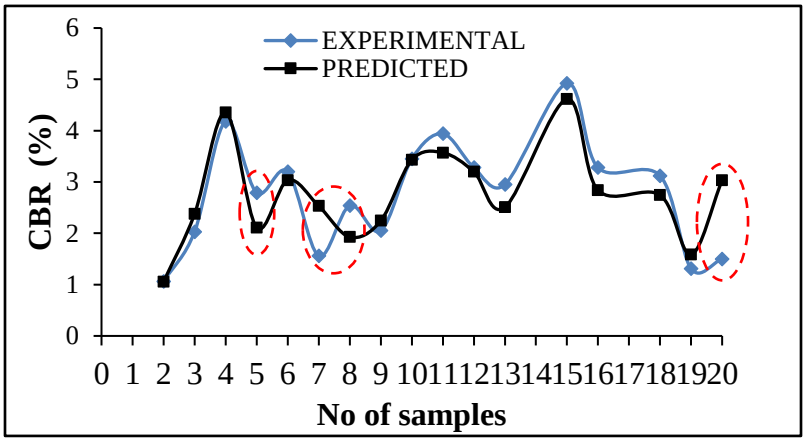


Fig 3.5 **Fig 3.6**

Correlation between CBR value and Plasticity index & Comparisons between Experimental and Predicted CBR Value for PI

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Correlation graph between CBR and Maximum dry density

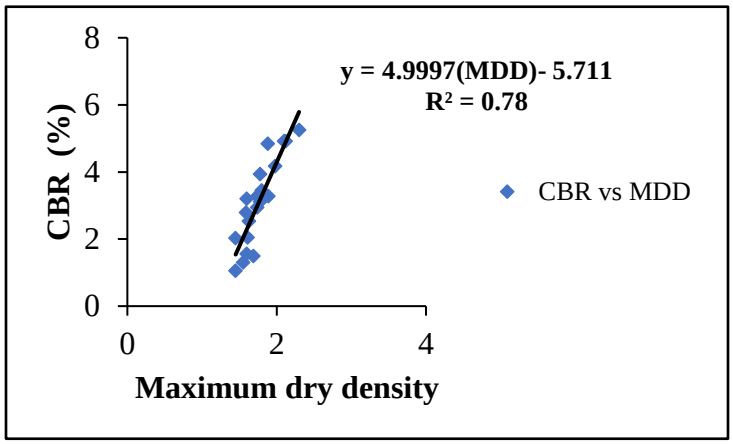

Fig 3.7

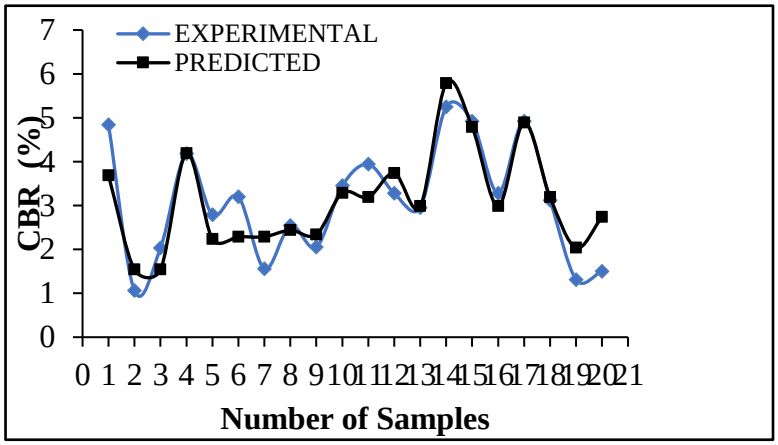

Fig 3.8

Correlation between CBR value and maximum dry density & Comparisons between Experimental and Predicted CBR Value for MDD

Correlation graph between CBR and Optimum moisture content

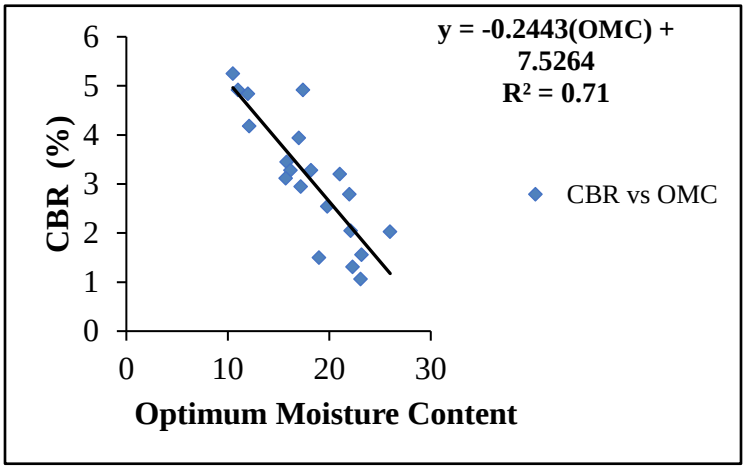

Fig 3.9

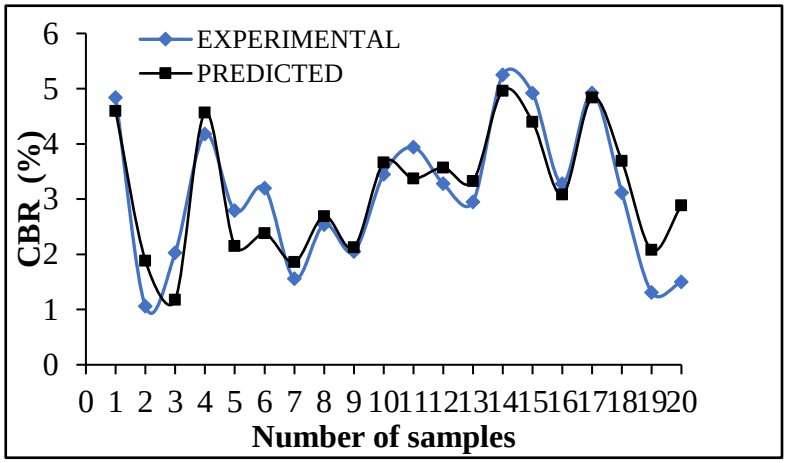

Fig 3.10

Correlation between CBR value and optimum moisture content & Comparisons between Experimental and Predicted CBR Value for optimum moisture content

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Correlation graph between CBR and Shrinkage Index

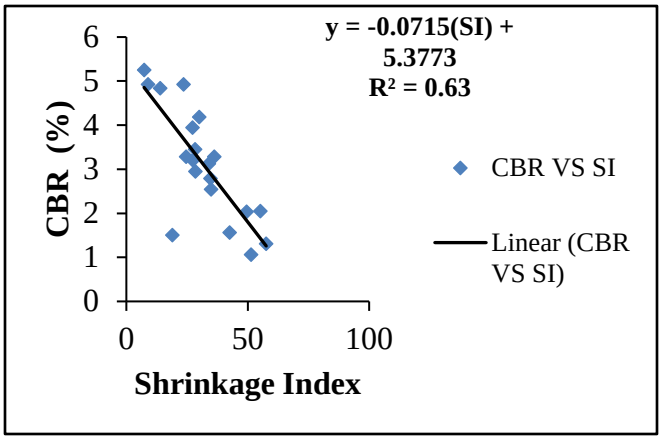


Fig 3.11

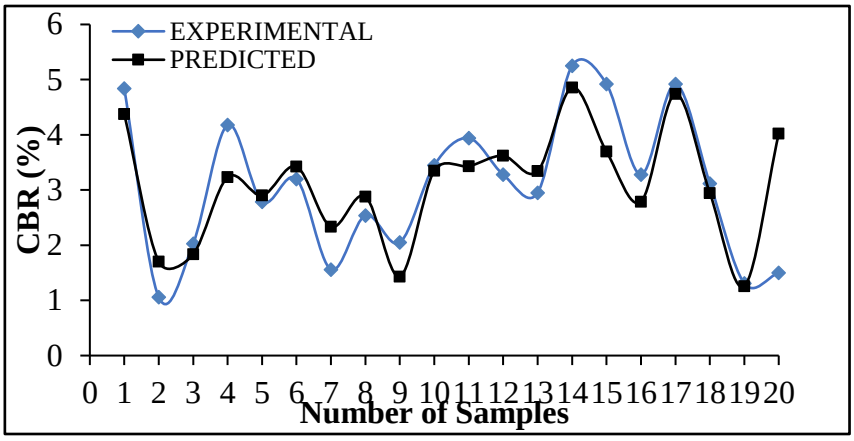


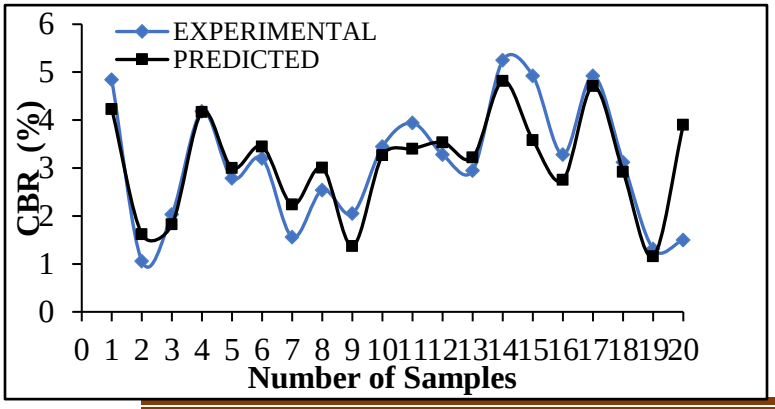
Fig 3.12

Correlation between CBR value and Shrinkage Index & Comparisons between Experimental and Predicted CBR Value for shrinkage index

MULTIPLE LINEAR REGRESSION ANALYSIS (MLRA)

MLRA has been carried out by considering soaked CBR value as the independent variable and the remaining soil properties as dependent variable. MLRA can be carried out by using standard statistical software like Data Analysis Tool Bar of Microsoft Excel in order to derive the relationship statistically.

CBR = f (LL, PL, SL, MDD, OMC)



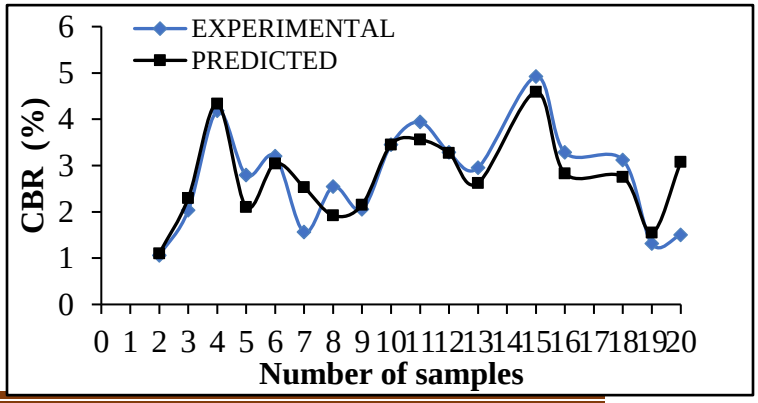


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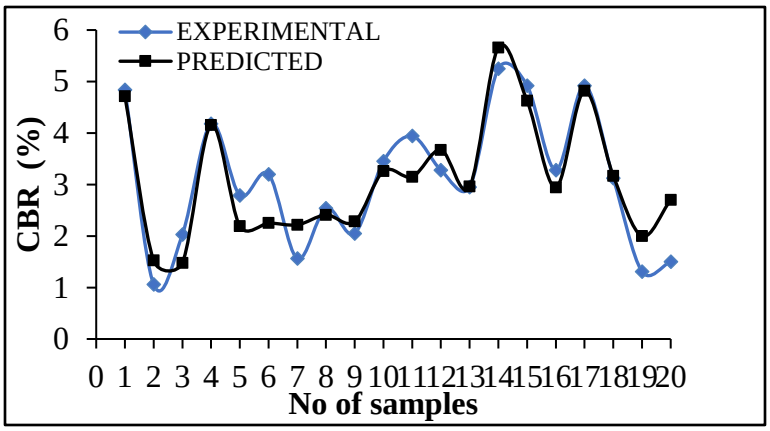
Fig 3.13 MLRA between CBR and liquid limit, shrinkage limit, shrinkage index

Fig 3.14 MLRA between CBR and liquid limit, plastic limit.



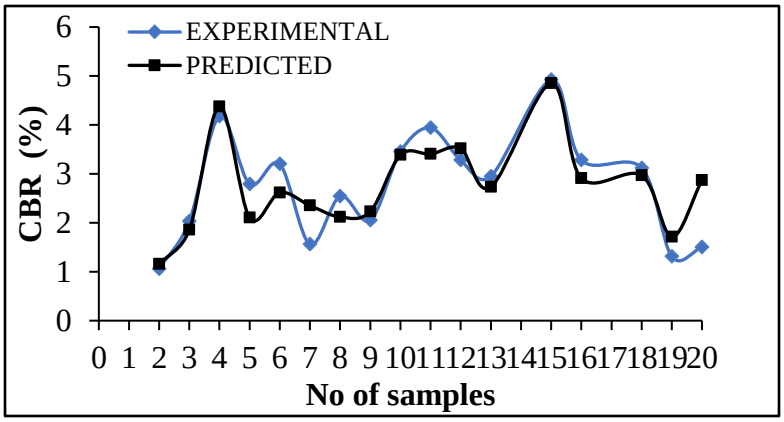


Fig 3.15 MLRA between CBR and optimum moisture content, maximum dry density

Fig 3.16 MLRA between CBR and plasticity index, maximum dry density.

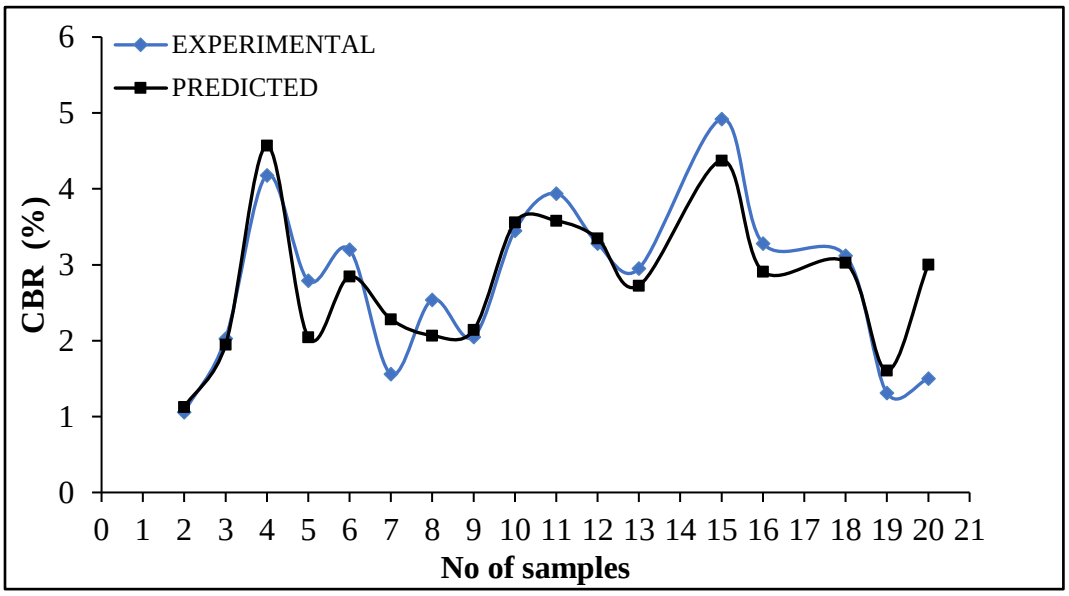


Fig 3.17. MLRA between CBR and optimum moisture content and plasticity index.

The above figure shows comparison between experimental and predicted CBR results using multiple regression analysis by considering CBR as dependent variable and moisture content, plasticity index as independent variable. It shows that the effect of moisture content and

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plasticity index on CBR value of soil samples collected for investigation. It is known from simple linear regression analysis (SLRA) that CBR value decreases with increase in plasticity index (Figure 4.3(a)) and CBR decreases with increase in moisture content (Figure 4.5(a)). Also coefficient of correlation R^2 for optimum moisture content and plasticity index are 0.71 and 0.72 respectively. An attempt is made to correlate CBR value with these two variables using multiple linear regression analysis as shown in equation-5 and R^2 value found to be 0.75. Therefore it is concluded that MLRA holds good for these two parameters.

4. CONCLUSION

The present study was undertaken to develop regression based models to estimate CBR values for coarse and fine grained soils. A total of twenty soil samples were tested for CBR values. The equations are developed using Microsoft Excel. The following conclusion can be drawn from the results of the present study:

1. The results of the CBR and index properties tests are interpreted together to infer and to understand the relation between them.
2. Based on experimental results and SLRA, there is no significant relation exists to predict CBR value from liquid limit and plastic limit.
3. Linear relation exists between plasticity index and CBR value with a coefficient of correlation of R^2=0.72.
4. It is found that good empirical relations y=4.99MDD- 5.711 (R^2=0.78) and y=-0.2443OMC+7.5264 (R^2=0.71) obtained by SLRA to predict CBR value from MDD and OMC.
5. The empirical relation CBR= -4.8353–1.56856(OMC) +4.6351(MDD) (R^2=0.82) obtained from multiple linear regression analysis (MLRA) shows good relation to predict CBR value from MDD and OMC.
6. The model developed by SLRA for correlating CBR value with liquid limit and plastic limit have shown less significant. But fair to good correlation can be obtained from the model developed using MLRA by showing R^2 value of 0.72.

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7. From the correlation analysis it is clear that, large variation can be observed between experimental and predicted CBR value particularly in case of high compressible clays (CH).

5. ACKNOWLEDGEMENT

I thank management R.T.E. Society's, Rural Engineering College, Hulkoti,Gadag and Principal and **my Parents** for their support, without them this project would not have been completed.

It is a genuine pleasure to express my deep sense of thanks and gratitude to my colleagues **Soumya Hiremath** Assistant Professor, Dept. of Civil Engineering R.E.C Hulkoti and **Gireesh Mailar** Assistant Professor, Dept. of Civil Engineering R.E.C Hulkoti.
It's my pleasure to thank all those who have rendered their help during the period of my project work directly or indirectly.

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