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To Study the Effect of Calcium Chloride on Laterite Soil

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***Abstract*: The principle objective of this project is to comparison between laboratory test values and predicted values using MLRA. Many of the study has been done using traditional stabilizer(cement, fly ash, lime etc) on laterite soil ,this study uses non traditional stabilizer($Cacl_2$) which is an electrolyte and has readily dissolvability properties which time and cost saving material proves beneficiary. This study comprises the experiment results like UCS, CBR on laterite soil by using four percentage (0.5,1.0,1.5,2.5%) of chemical.**
***Keywords:* MLRA, Traditional Stabilizer, Electrolyte, UCS, CBR.**

I. INTRODUCTION

Soil Stabilization has been introduced by many researchers for a long time ago in geotechnical engineering field. Soil stabilization is the process of improving the physical and engineering properties of a soil to obtain the predetermined targets. Soil stabilization can be done by two methods mechanical stabilization and chemical stabilizations. Currently, using chemicals for soil stabilization gets more attention than other soil stabilization methods. This popularity is due to the low cost and convenience of this technique, especially in the geotechnical projects that require a high volume of soil improvement. The objective of this stabilization technique is to increase the strength parameters, enhance the loading capacity, and decrease the settlement of the soil.

Laterite soils are regarded as good foundation material as they are virtually non swelling but laterite soil contains amount of clay minerals that its strength and stability could not be guaranteed especially under presence of water, when Laterite consists of high plastic clay, the plasticity of soil may cause cracks and damage on building foundations, pavement highway or any other construction projects. It is therefore important to understand the behaviour of Laterite soil and thus the method of soil stabilization is figure out.

Among the chemical compounds, using the various combinations such as liquid polymers, resins, acids, silicates, and lignin derivatives is more common than others. But reviews on previous researches, show that the performed analysis on traditional stabilizers such as lime and cement are more common when compared with the researches that are done on non traditional stabilizer.

The concept of earth stabilization using calcium chlorides has recently gained a lots of attention by researchers and geotechnical scientists. Calcium Chloride own its advantage of availability, cost effectiveness, eco- friendliness and biodegradability ,earth preservation ,reduced dependency on non- renewed energy and enhanced energy recovery and reproducibility. These factors became the basis for the choice of calcium chloride as a stabilizing material in this paper. The main objective of this paper is focused on the understanding the effect of calcium chloride on the strength of lateritic soil.

In this study multiple linear regression method models is used to depicts the relationship that exists between a set of dependent and independent variable using statistical approaches. soil forms a basis of support for all engineering structures. Of all the methods of pavement design the CBR method has been found as the most reliable means for evaluating the strength of the sub grade and construction material. Therefore by keeping CBR values constant and varying the index properties of soil the MLRA model is prepared.

A. Obectives

1) To check the chemical with its suitability to the strength and properties of laterite soil.
2) To determine the CBR value, UCS with different percentage of chemicals.
3) To study the engineering properties of laterite soil by using chemicals with its varying proportion.
4) To study the MLRA model for analysis point .

B. Need

1) Laterite soil which is good foundation material but cannot guarantee under the loading. Therefore to study behaviour of laterite soil this study is necessary.
2) The study using $CaCl_2$ on laterite soil has been done only with index properties of soil which shows results of improvement in strength of the soil, therefore to study the mechanical properties of soil i.e. bearing capacity; shear strength etc has been needed for the study.
3) This research aims to implement a similar task but using chemicals additive as a soil stabilizer in road embankment and construction purpose in varying proportions by weight of soil sample.

II. METHODOLOGY

A. Soil sample for investigation is collected from Anjaneri Hill, Nasik.
B. Reference paper related to soil, chemicals should be collected which required for the investigation of study.
C. Developing an adequate experimental program to study the use of chemicals in road embankment.
D. Performing research work on the Laterite soil by using chemical stabilizers.
E. Analysing the experimental output test results to draw Future Scope of the project

III. EXPERIMENTAL WORK

A. Materials used

1) *Soil Used For Study:* For present study i.e. laterite soil which taken from the Anjaneri hill of Trimbakeshwar in Nasik district. Laterite soil is reddish in colour due to the presence of iron oxide in it. The black cotton soil has a property of high volume change and develops cracks in summer. The laterite soil is good foundation material but cannot guarantee under the heavy load

2) *Calcium Chloride ($CaCl_2$):* Calcium chloride is derived from limestone as a by product of the Solvay process. Calcium chloride is used to prevent ice formation and is used to deice. Calcium chloride is relatively harmless to plant and soil. As a de-icing agent, it is more effective at lower temperatures than sodium chloride. Calcium chloride was sprayed on road to prevent the weathering. A concentrated solution keeps a liquid layer on the surface of dirt roads which is suppressing formation of dust. Using calcium chloride reduces the need for grading by as much as 50% and the need for fill in materials as much as 80%.It is produce by the chemical process of high purity limestone and salt brine to produce soda ash and calcium chloride.

$$CaCO_3 + 2\ NaCl = Na_2CO_3 + CaCl_2$$

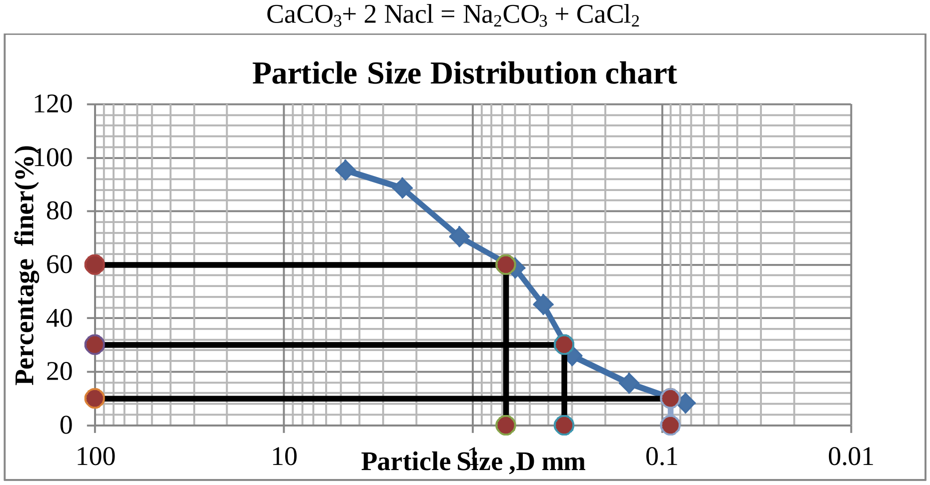

Fig Particle size Distribution curve

Table I :Test Carried On the Lateritic Soil

Sr.No	Test	IS Codes	Test Value
1	Specific gravity	IS:2720 (part III/sec 1)-1980	2.56
2	Moisture Content		14.23%
3	Particle size distribution	Sieving test(IS: 460-1962)	CI
4	Atterbergs limit Liquid limit Plastic limit Plasticity index	IS:2720 (Part V)- 1985	 58.735% 15.45% 43.285
5	Modified Proctor test Maximum Dry Density Optimum moisture content(OMC)	IS: 2720 (Part VIII)	1.68 gm/cc 29.33%
6	Unconfined compression test	I.S. 2720 (Part-8) 1964.	0 days= 188kpa 7 days =414kpa 14 days =500kpa 28 days= 588kpa
7	California Bearing ratio (CBR)	IS: 2720 (Part 16) – 1979	0 days =16.003 4days=5.89

IV. RESULTS AND DISCUSSION

Modified Proctor Test (for Laterite soil)

Table 4.1 Values of MDD and OMCfor different percentage of chemicals

Percentage	MDD	Water content(%)
0	1.612	10.93
0.5	1.645	12.54
1	1.66	16.44
1.5	1.68	29.33
2	1.67	38.12

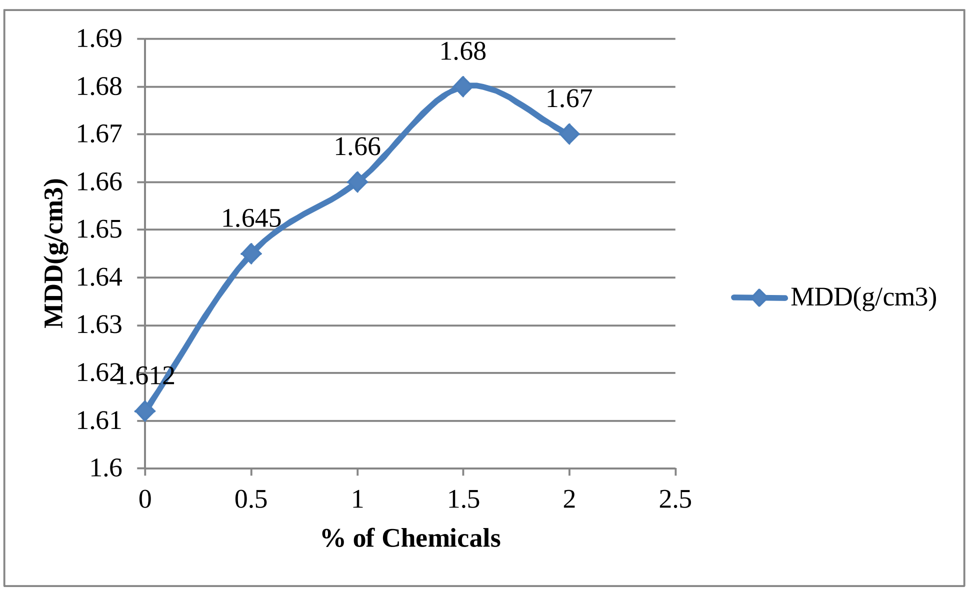

Figure 4.1 variation of MDD for laterite soil with different percentage of $cacl_2$

The MDD of soil decrease with increase in percentage of CaCl2 this due to the immediate reaction between the chemical and soil, which is represented as a flocculation and agglomeration. The present chlorides content in chemical also have an effect on soil structure which also changes particle size distribution of soil. The MDD of laterite soil is maximum for 1.5 percentage of CaCl2 which is 1.68 g/cm3 and then slight decrease in MDD due the behaviour of salt in chemicals. The reverse reaction is seen in addition of increasing percentage due to the salt reaction with soil.

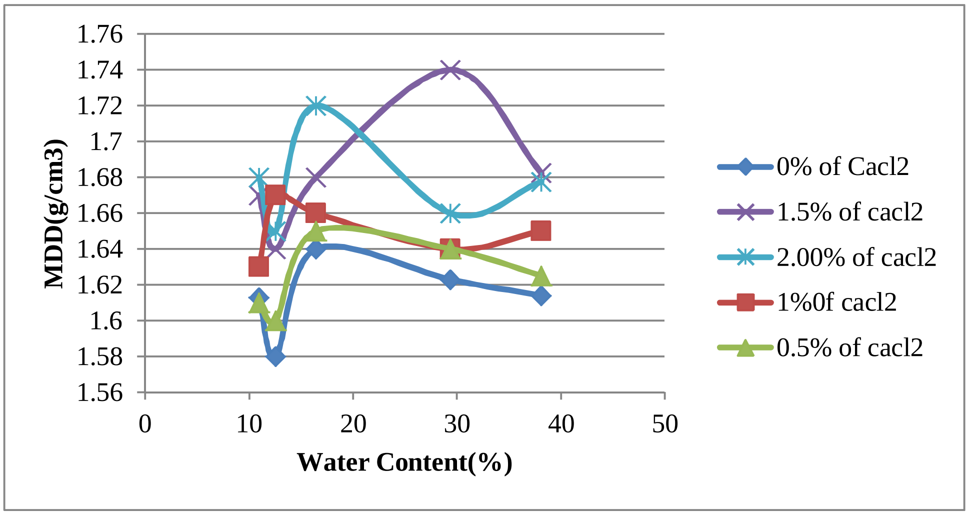

Figure 4.2 variation of OMC and MDD for laterite soil with different percentage of $cacl_2$

The $CaCl_2$ affect the MDD and OMC of the soil. It is increases with the increasing percentage of chemical.it are highest for the 1.5 % of $CaCl_2$. This behaviour is due to the interaction between the soil and $CaCl_2$. The ion exchange is also a factor for the improvement in the soil properties.

Unconfined compression test

Table 4.1 Values of UCS for different percentage of chemicals

% of Chemical	7 days	14 days	28 days
0	154	154	154
0.5	200	240	300
1	349	440	519
1.5	414	500	589
2	407	480	520

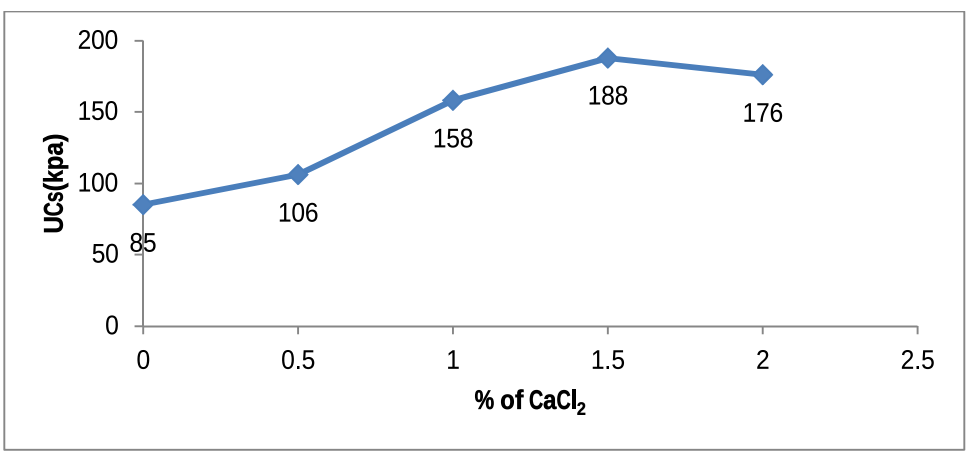

Figure 4.3 variation of 0 days UCS for laterite soil with different % of $CaCl_2$

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1.5 % $CaCl_2$+ Laterite soil gives the maximum the value we can say that optimum % of $CaCl_2$ for laterite soil is 1.5 %. The addition of salt content to the soil causes an increase in the ion concentration of the pore water with contaminant reduction in the double layer thickness and this, in turn causes a reduction in the inter particles repulsions and an increase in the attraction ,resulting increase in cohesion . The compactio effort also effect the strength of the cohesive soil.

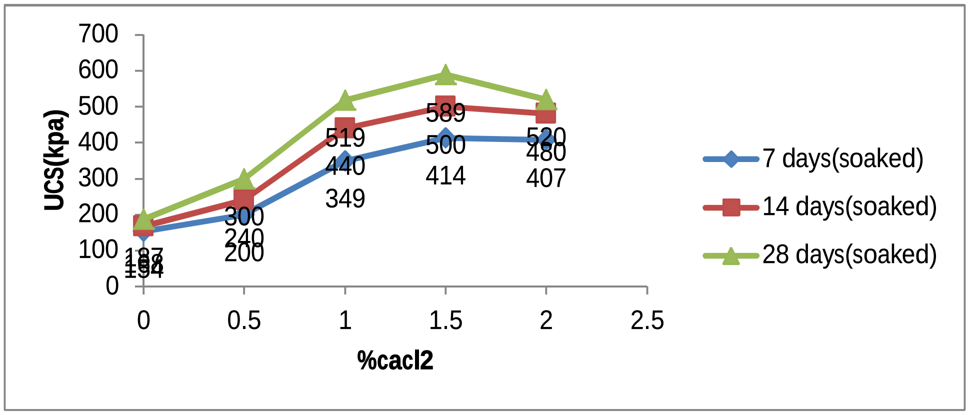

Figure 4.4 variation of different days UCS for laterite soil with different % of $CaCl_2$

The increase in strength with addition of chemicals may be attributedto the cation exchange of $CaCl_2$ between the minerals layer and due to the formation of silicate gel. The reduction in gel beyond the 1.5 % of $CaCl_2$ may be due to absorption of more moisture at higher $CaCl_2$. The increase in strength of the stabilized soil may be attributed to the physiochemical phenomena namely cation exchange that takes place between lime and negatively charge clay particles together with the flocculation – agglomeration mechanism.

Table 4.1 Values of CBR for different percentage of chemicals

% of $cacl_2$	CBR (%)(unsoaked)	CBR (%) soaked
0	6.664	2.982
0.5	9.872	3.665
1	13.098	4.873
1.5	16.003	5.89
2	14.987	5.23

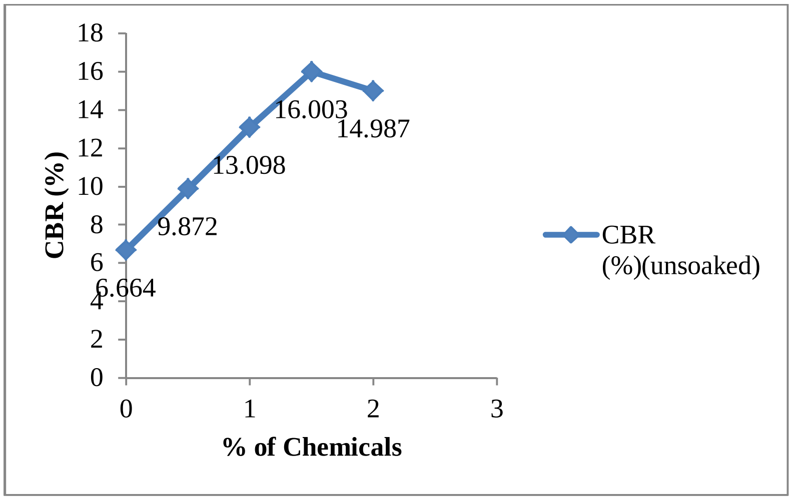

Figure 4.5 variation of unsoaked CBR for laterite soil with different percentage of $cacl_2$

At 1.5% $CaCl_2$+ laterite soil gives the maximum values of i.e 16.003 so we can say that optimum % of $CaCl_2$ for laterite soil is 1.5%. The increase in strength is attributed to the cation exchange of $CaCl_2$ between the minerals layers and due to the formation of silicate gel. The reduction in improvement in CBR beyond 1.5% of $CaCl_2$ may be due to the more absorption of moisture content at higher chemical content.

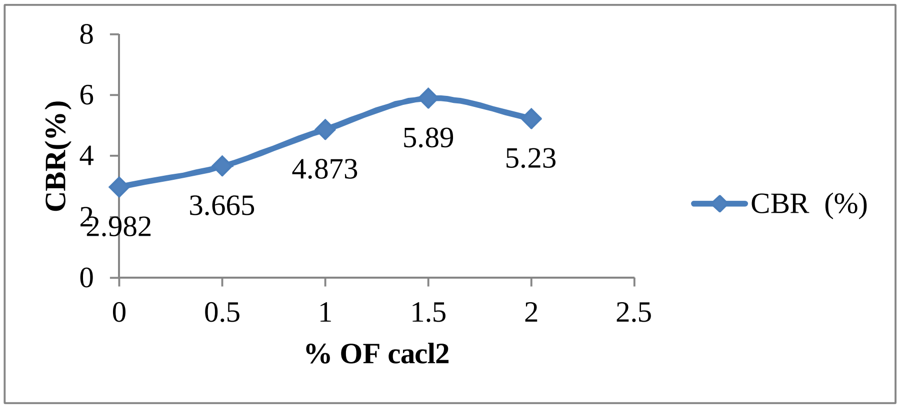

Figure 4.6 variation of Soaked CBR for laterite soil with different percentage of $CaCl_2$

The results shows the decrease as compare to the unsoaked condition due to the more absorption of moisture. At 1.5 % of $cacl_2$ it gives the highest result after 2% the value of CBR starts decreasing because of the reverse nature of $cacl_2$. After certain percentage of $cacl_2$ the chemical shows the reverse nature due the ions exchange. The increase in the strength with addition of chemicals may be attributed to the cation exchange of $CaCl_2$ between mineral layers and due to the formation of silicate gel.

A. Regression Analysis

1) *Multiple Linear Regression Analysis (MLRA) :* The variations in CBR value which is considered as independent variable with Specific Gravity, LL, PL, PI, MDD ,OMC and UCS value which are considered as the dependent variables presented in Fig 4.1 – 4.25 for the Same locations respectively.

Non-linear MLRA was carried out using standard statistical software like Data Analysis Tool Bar of Microsoft Excel in order to derive the relationship statistically. Seven non-linear models have been developed to show the effect of CBR values of soil. The proposed non-linear models for the different soil locations are shown in Figures 4.1 to 4.25. Model 1: CBR vs. Specific Gravity, Model 2: CBR vs. LL, Model 3: CBR vs. PL, Model 4: CBR vs. PI, Model5: CBR vs. OMC and Model 6: CBR vs. MDD, Model 7: CBR vs. UCS. The statistical parameters indicate that models 4.2.2, 4.2.4, 4.2.6, 4.2.8,4.2.10,4.2.12 and 4.2.16 have R-square value (R^2) of 0.782,0.650,0.888,0.783,0.641,0.936and 0.972 respectively, which is according to above 50%. This implies that a good relationship exist between the dependent and independent variable of the models. If the R^2 for models are less than 50%, therefore they have less influence on CBR values and will not constitute variables for multiple regressions for the respective location.

Table II: Summary results of Multiple Regression Analysis

Model	Correlation of CBR with	Equation of Correlation	Coefficient of correlation(R2)
1	Specific Gravity	y = -4.790x + 15.62	$R^2 = 0.782$
2	LL	y = -0.163x + 13.02	$R^2 = 0.650$
3	PL	y = 0.203x - 0.229	$R^2 = 0.888$
4	PI	y = -0.094x + 7.212	$R^2 = 0.783$
5	OMC	y = 0.080x + 2.800	$R^2 = 0.641$
6	MDD	y = 43.18x - 66.88	$R^2 = 0.936$
7	UCS	y = 0.006x + 1.641	$R^2 = 0.972$

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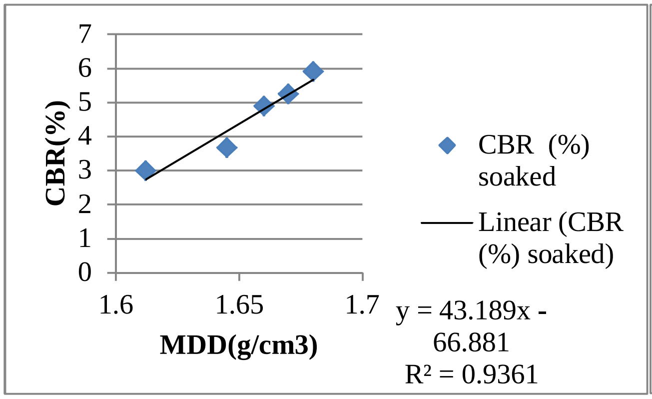
B. Correlation between MDD and soaked CBR



4.4.11Correlation of soaked CBR and MDD

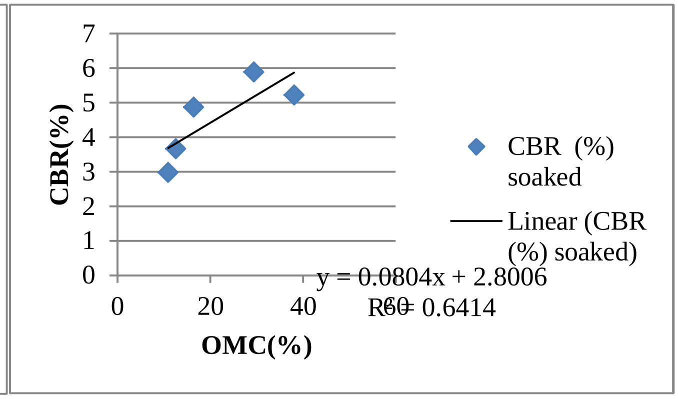
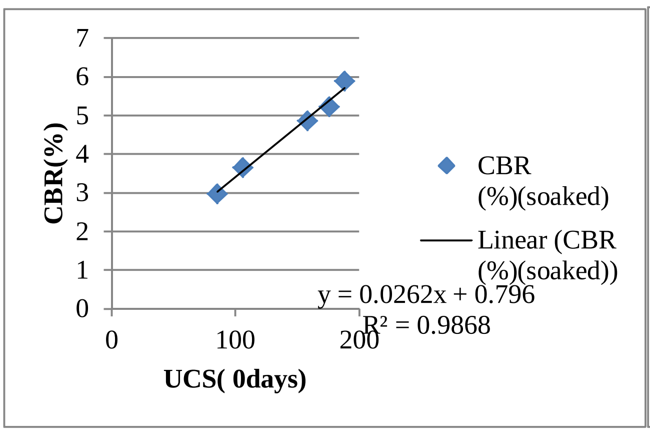


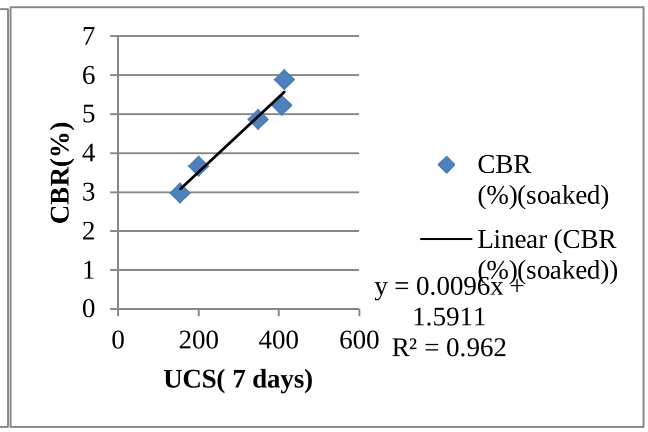
Figure 4.17 Correlation of soaked CBR with OMC

Water in the soil acts both as a lubricant and as a binding agent among the soil particle there by influencing the structural stability and strength of soil geologic materials. The correlations between CBR and MDD was found significant ,CBR values are higher when the compacted densities are high and when clay content liquid limit and plasticity index are low. Both figure shows significant increase as the MDD increases. The correlation statistically indicating that as the OMC Increases CBR decreases this is due to the maximum absorption of moisture in the 4 days of soaking. But the value of R- square shows the good relationship between the both values of laboratory test.

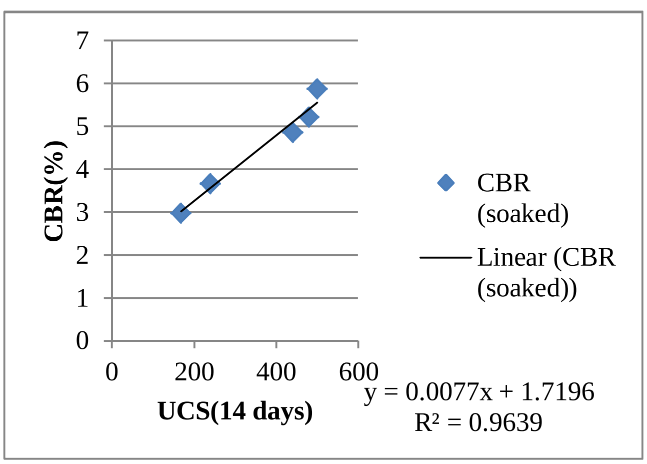
C. Correlation between UCS and Soaked CBR



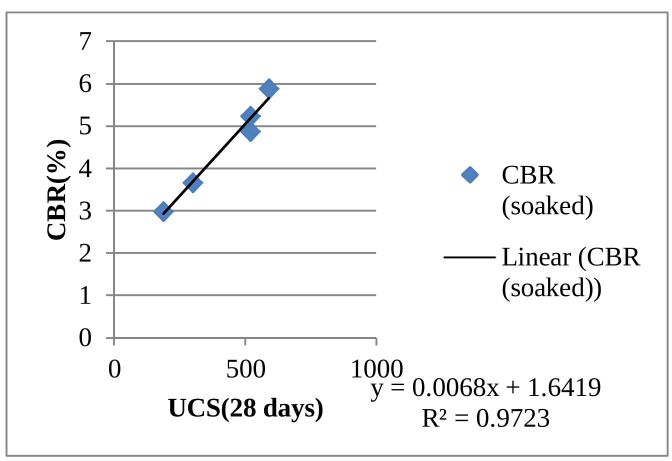
Correlation of soaked CBR with unsoaked UCS(0 days)



Correlation of soaked CBR with unsoaked UCS(7 days)



Correlation of soaked CBR with unsoaked UCS(14 days)



Correlation of soaked CBR with unsoaked UCS(28 days)

V. CONCLUSIONS

A. It is observed that by using the chemical stabilizer the property of soil is improved, the use of $CaCl_2$ can be better option for the improvement of structures, road pavement.

B. The CBR value of laterite soil has been increased. The use of chemical concentration at 1.5% gives the effective stabilization result and therefore it is used as stabilization of soil.

C. The R – square values of all the experiments is greater than 50% which indicates the good relationship between properties of soil.

D. Using data analysis tool for comparing the laboratory test result and predicted values gives the good explainations.

E. Use of $CaCl_2$ can be done as the alternative for the traditional stabilizers ,because of their cost and time saving nature.

VI. ACKNOWLEDGMENT

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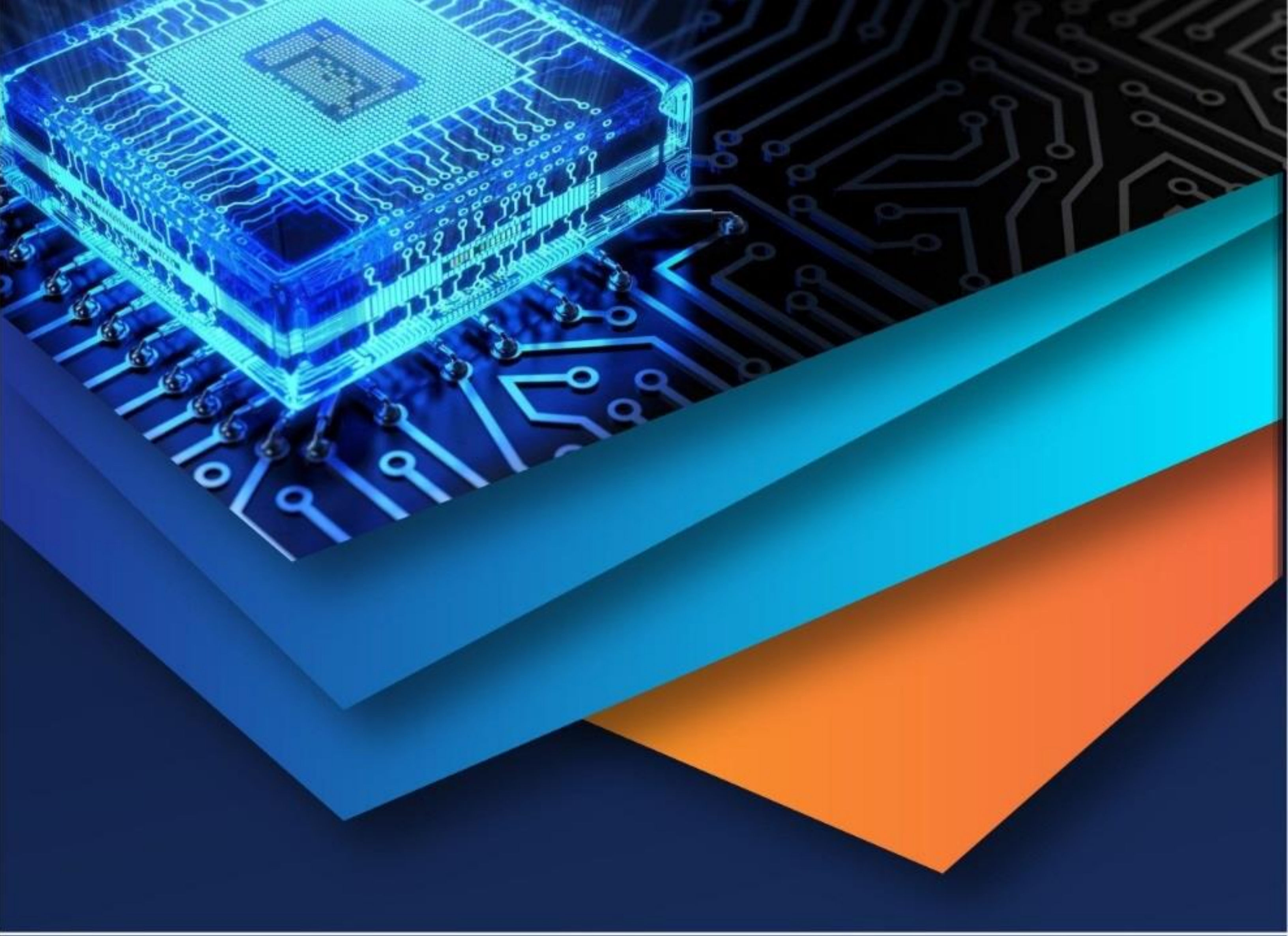
REFERENCES

[1] A.A. Amadi, A .Okeiyi , Use of quick and hydrated lime in stabilization of lateritic soil.(2017)
[2] Afeez Adefemi Bello ,Stabilisation of Lateritic Soils with coconut Husk Ash(2015)
[3] Aginam , C. H,Chidolue,C.A,Geotechnical Properties of Lateritic Soils from Northern Zone of Anambra State,Nigeria.(2014)
[4] Ankit singh Negi ,Stabiliation of Expansive soil using Lime.(2013)
[5] Anuar Kasa,Zamri Chik studied" Stabilisation of silty clay soil using chloride compounds.
[6] Bairwa Ramlakhan ,The effect of the lime and fly ash on some basic engineering properties of Black cotton soil.(2013)
[7] B.M Das ,Principle of Geotechnical Engineering.
[8] Duotone ,T.O Akinmusuru,Effect of Common Salt On the Engineering Properties of Expansive Soil.(2016)
[9] George Rowland Otoko,Use of Salt Compounds for the stabilization Of Nigerian Laterites.(2014)
[10] Gyanene Takhelmayun,Laboratory study on Soil Stabilization Using Fly ash.
[11] Habiba Afrin,Stabilization Of Clayey Soils Using Chloride Components(2017)
[12] J.M Raut,Stabilization Of Expansive Soil Using Fly ash and Murrum. ". International Journal of innovative Research in Science,Engineering and Technology,vol.3, issue , June 2004.
[13] J.R. Oluremi, Stabilization of Lateritic Soil With Casava Peels Ash.(2015)
[14] J.B Oza, Stabilization of Black Cotton Soil using 1. Cement Dust 2. Cement Dust + Lime Powder 3. Lime Powder.(2013)
[15] Krishanu Bhaumik ,V.Janani,Effect of strength Characteristic on Lateritic Soil by using Lime and Sugarcane Baggase Ash.(2016)
[16] K.V. Manoj Krishna1and Dr. H.N.Ramesh," Strength and F O S Performance of Black Cotton Soil Treated with Calcium Chloride" IOSR Journal of Mechanical and Civil Engineering (IOSRJMCE) ISSN: 2278-1684 Volume 2, Issue 6 (Sep-Oct 2012)
[17] N.Gangadhara Reddy ,Evaluating the influence of additives on Swelling characteristics of expansive soil.



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