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Stabilization of Black Cotton Soil with Red mud and formulation of Linear Regression between properties of the mixes

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Abstract – *The present paper deals with the investigation on the properties of black cotton soil, it is observed that, its strength properties are very low. In order to construct any foundation one such soil, we need to stabilize the black cotton soil. Red mud is material produced by aluminum industries, which, now a days creating so many problems when we dump it on open space. To beat both the criteria red mud is used as a stabilizer. Number of mixes is proposed here and experiments are done on the same. Black cotton soil was stabilized with red mud by varying the % of mix from 15% to 30% with 1% interval Gypsum is also used in the mixes in order to give better binding between the particles. It is observed that results obtained at the mix proportions 0% to 25% is increasing. Optimum of 25% of red mud replacement gives better results. After obtaining the test results as stated above, another attempt has been made to understand the interrelation (linear) between the parameters; regression analysis is made. This regression analysis is made using Microsoft Excel 2010; regression summary output is also discussed in this study.*

Key Words: Gypsum, Regression, Red mud, Strength, Soil. Stabilization

1. INTRODUCTION

Day by day construction activities are increasing rapidly. It is an Engineers task to take of the every steps of the construction activity should run safely. In particularly, construction activities on black cotton soil brings challenging tasks to him to handle. When the civil structures are needed to construct over the soils, which are unable to provide the desired properties to civil structures for the construction in such cases stabilization is the only method to get the desired properties of soil.

1.1) Stabilization

Stabilization can be defined as it is a process of changing the soil properties by changing the gradation by mixing with other soils, changing the density of soil by compaction, or replacing the soil with the granular materials. This process may change both engineering as well as index properties of soil.

Stabilization can be carried out by using different types of materials and techniques based on the cost, type of structure to be constructed and also the climatic conditions. Materials like rice husk ash, disposal of solid wastes, lime, cement, fly ash, copper slag, etc.

1.2) Theory of Regression

Regression can be defined as it is a statical measure used in finance, investing and many other disciplines that attempts to determine the actual relationship between one dependent variable(denoted by Y) and a series of other fluctuating variables (called as independent variable).

2. MATERIALS AND PROPERTIES

2.1) Black cotton soil

Black cotton soils are the major form of soil groups found in India, and cover approximately 20% of the total area and found in most of the places. Most commonly founded in the central and western parts of India this includes the Maharashtra, Madhya Pradesh, Gujarat, Andhra Pradesh and some part of Karnataka.

In this research the soil sample is collected from local area of Belagavi, and tested for their index and engineering properties, results are shown in table-1

2.2) Red Mud

Industrialization and urbanization are the two overall wonders. In spite of the fact that these are the need of the general public and are for the most part inescapable, one has to investigate their negative effects on the worldwide condition and social life. The real sick impact of these worldwide procedures is the generation of huge amounts of modern squanders and the issues related with their sheltered administration and transfer. Second issue is the shortage of land, materials and assets for on-going formative exercises, including framework.

Red mud sample for the research is collected from the HINDALCO Industry located in Belagavi, and tested for their index and engineering properties; results are shown in table-1

2.3) Gypsum

Gypsum is chemically also known as "calcium sulphate dehydrate," it is an abundant mineral and takes forms including alabaster – a material used in decoration and construction as far back as ancient Egypt, and till now in modern methods of construction.

It is a non-toxic mineral helpful to humans, plant life as well as for environment.

Table-1: Index and Engineering properties of Black cotton soil and Red mud.

Particulars	Black cotton soil	Red mud
Sp. Gr	2.,nm665	3.19
LL in %	75	42
PL in %	39	0
OMC in %	22	15
MDD	1.495	1.75
Engineering properties		
UCS in kg/cm2	0.55	0.79
SOAKED CBR in %	2.1	11

3 LITERATURE REVIEW

Various researches are carried out for the stabilization of black cotton soil and to predicate the equation CBR using soil properties. Rajashekhar Malagihal(2014), Mishra et al(2014), modak et al(2012), are studied about the stabilization of black cotton soil by using stabilizing materials such as red mud, granite dust and fly ash respectively. Hind et al (1999), Deelwal et al, studied about the physical and characteristic properties of red mud. Ramasubbarao et al (2013), Srinivasa R. H et al (2016), studied the soil properties and established the regression equations to predict the CBR values.

4 METHODOLOGIES

4.1 Stabilization

Stabilization of Black Cotton soil was done by using Red mud and Gypsum. Percentages of addition of stabilizing materials are tabulated in the table 2.

After getting results of the stabilized B.C. soil, regression analysis is carried out by using Microsoft Excel 2010, and obtained the linear relation between the properties said in the article 4.2

Table-2: Mix combinations for the stabilization

Serial No.	Combinations	Name
1	C+0RM+0G	C0
2	C+15RM+1G	C15
3	C+16RM+1G	C16
4	C+17RM+1G	C17
5	C+18RM+1G	C18
6	C+19RM+1G	C19
7	C+20RM+1G	C20
8	C+21RM+1G	C21
9	C+22RM+1G	C22
10	C+23RM+1G	C23
11	C+24RM+1G	C24
12	C+25RM+1G	C25
13	C+26RM+1G	C26
14	C+27RM+1G	C27
15	C+28RM+1G	C28
16	C+29RM+1G	C29
17	C+30RM+1G	C30

(Note: - C+0RM+0G Indicates, 0RM Means 0% red mud and 0G Means 0% gypsum, in the mix proportions)

4.2Regression analysis

Regression analysis is carried out for the following parameters

1) Regression between CBR and UCS
2) Regression between CBR, LL AND PL
3) Regression between CBR AND PI
4) Regression between UCS, LL AND PL

5 TEST RESULTS AND DISCUSSIONS

5.1 By Stabilization

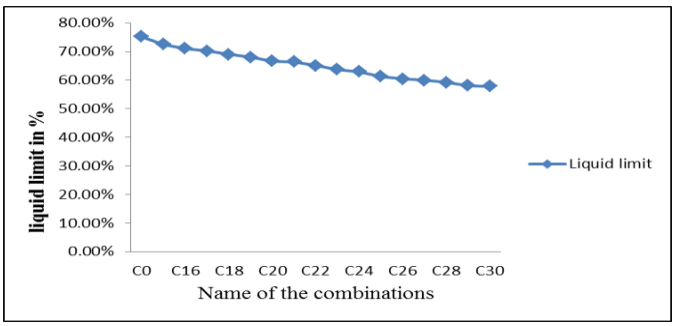

Chart -1: Above chart shows the relation between combinations and liquid limit

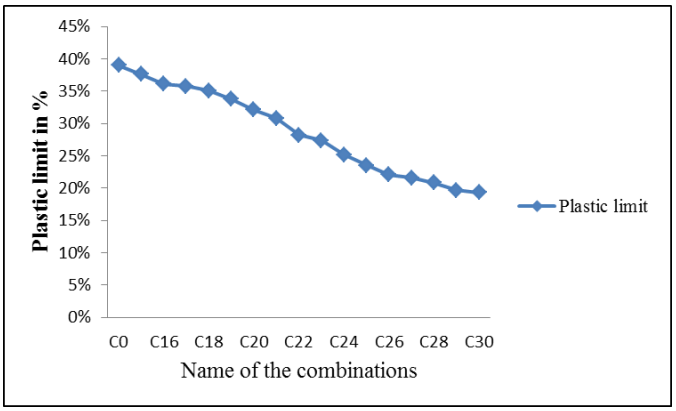

Chart -2: Above chart shows the relation between combinations and plastic limit

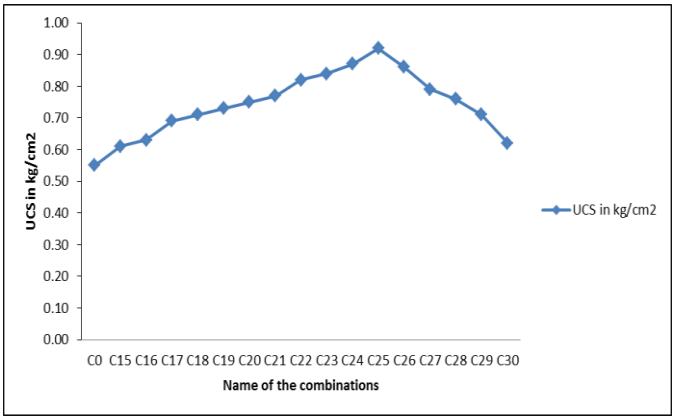

Chart -3: above chart shows relationship between combinations and UCS values of the mix designs

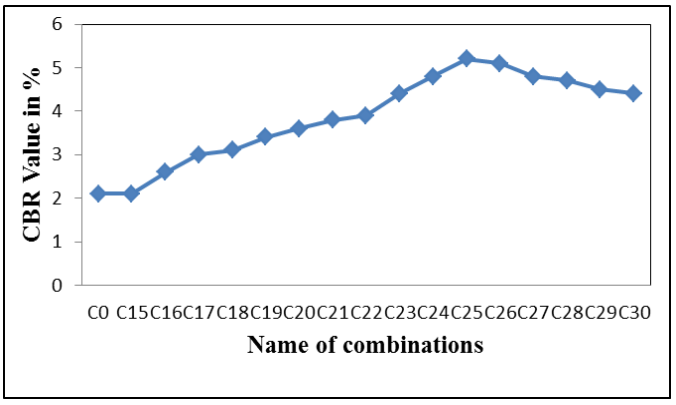

Chart -4: Above chart shows the relationship between combinations and CBR values of the mix designs.

Chart -1 show there is continuous decrement in liquid limit with increase in the combination of mixes from C0 to C30
Chart -2 shows there is continuous decrement in plastic limit to as of liquid limit from C0 to C30

Chart -3 shows there is increase in the value of UCS from C0 to C25 and gradual decrement is observed in UCS values from C25 to C30.
Chart -4 shows increase in the value of CBR from C0 to C25 and decrement is observed in CBR values from C25 to C30

5.2 By Regression

Following are the linear relationships obtained between the parameters explained in article 4.2

1. Regression between CBR and UCS
   CBR= -3.0272 + 8.8105 ×UCS ……formula
   For C0 –C25
   CBR= 2.49864 + 2.943 × UCS…..formula
   For C26-C30
2. Regression between CBR, LL AND PL
   CBR=14.8482–9.3851×PL- 12.324×LL…
   ……formula for C0-C25
3. Regression between CBR AND PI
   CBR= -12.462 +44.7794×PI…..Formula for C0-C30
4. Regression between UCS, LL AND PL
   UCS=2.5922+0.00047×PL - 2.7383×LL…formula for C0-C25

6 CONCLUSIONS

1. Black cotton soil was stabilized with red mud by varying the % of mix from 15% to 30% with 1% interval Gypsum is also used in the mixes in order to give better binding between the particles.
2. Maximum unconfined compressive strength and CBR values obtain was 0.96 kg/cm^2 and 5.2 % respectively for the 25 % of red mud and 1% of gypsum replacement.
3. To understand the flow characteristics of the mix, liquid limit and plastic limit tests are done, these values gradually decreased as the red mud content increased. Maximum value of liquid limit for black cotton soil being 75.25% and the same of the minimum being 57.88%. Corresponding maximum and minimum plastic limit being 39% and 19.30% respectively.
4. Later in order to obtain the linear relation between these parameters regression analysis is carried by Microsoft excel 2010. And following are the relations obtained.

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