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Stabilization of Black Cotton Soil by Using Red Mud and Sodium Silicate

Nitin Mane[1], Prof M. S. Rajashekhar[2],

[1]*P. G Student, Department of Civil Engineering, Jain College of Engineering, Belagavi, VTU Belagavi, Karnataka, India*
[2]*Assistant Professor, Department of Civil Engineering, Jain College of Engineering, Belagavi, VTU Belagavi, Karnataka, India*

Abstract – *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. By studying the properties of black cotton soil, it is observed that, its strength properties such as UCS and CBR are very low. In order to construct any foundation on the same soil, we need to stabilize the black cotton soil. Black cotton soil was stabilized with red mud by varying the % of mix from 10% to 40% with 2% interval sodium silicate 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 10% to 30% is increasing. Optimum of 30% of red mud replacement gives better results. Along with this 6% of sodium silicate replacement gives better results. The sodium silicate content increased CBR values got increased up to 8% of sodium silicate. Later as the percentage of sodium silicate increased, CBR values got decreased. The maximum value of CBR being 3.9%, which is obtained for D308 combination.*

Key Words: Red mud, Sodium Silicate, Strength, Soil. Stabilization

1. INTRODUCTION

Now a day's, the population of the world is rapidly increasing, which indeed resulting in to reduction of good land availability for construction purposes. Thus the reduced availability of land, causing construction of more buildings and other many civil engineering structures needs to be constructed on weak, unsound or soft soil, which is not good and safe for construction of structures. It has been noted that most of the civil engineering structures becomes unsuccessful due to the presence of weak and unsound underlying soil strata. For e.g. construction of various buildings, water retaining structures, and under water structures etc. Generally the black cotton soil contains clay's or very fine silts which have a special typical property for volume change such as swelling to softening or shrinking to dry cracks, which depends on the saturation moisture content in black cotton soil. The movements caused by swelling and shrinking in expansive soils have previously undergone number of problems because of unexpected movement of structures upward and down words and thus it results into cracks in pavements, which are resting on them. The property of swelling and shrinkage of soil creates depression cracks and swelling of construction on it. Therefore, there is a requirement to upgrade or improve the engineering properties of inefficient soils in advance to put the respective soil in construction views.

1.1) Stabilization

Soil stabilization is the process of changing the soils to improve their physical properties, shear strength of soil and thus improving the load bearing capacity of a sub-grade to support pavements and foundation by blending and mixing with other materials.

A few common types of stabilization of soil are listed as below:

a) Stabilization of soil by Cement.
b) Stabilization of soil by Bitumen.
c) Stabilization of soil by using Lime.
d) Stabilization of soil chemical.
e) Stabilization of soil by salt.

2. MATERIALS AND PROPERTIES

2.1) Black cotton soil

In India, a region around one-sixth is involved by black cotton soil. The area cover mainly the Deccan Trap plateau, between 73˚80' East longitude and 15˚ to 24˚ north latitude. Along these line, vast majority of soil in and around Mumbai, Madras, Gwalior, Khandwa, Indore, Pune and even some on the steam bank is black cotton soil. That implies these soils are prevalent in Deccan trap level locale i.e. in conditions of Andhra Pradesh, Western Madhya Pradesh, Maharastra, northern Karnataka and Tamilnadu.

The soil sample is collected in this research is from the local area of Belagavi, and tests were carried out for their engineering properties and index properties.

2.2) Red Mud

Despite the fact that the presence of aluminium was first settled in the year 1808, it took right around 46 years to make its creation financially reasonable. The exploration work of quite a long while brought about extricating the aluminium from the mineral, by the bayer's process the alumina is extracted from bauxite and we got red mud as by product or waste product, per annum 15 MT of aluminium is extracted in all over the world. To extract 30 MTPA aluminium it requires 50 MTPA of bauxite, from this 30 MTPA of red mud is given.

2.3) Sodium Silicate

The compound sodium silicate is belonging to the family of sodium Meta silicate. It is usually experienced as water glass or liquid glass. Crystal state of the chemical is usually seen but aqueous solution is popular in market. Usually the powder form of the sodium silicate is used in the stabilization process. The formula for the name is given as (Na2Sio2)O.

Table-1: Properties of Sodium Silicate

Sr. No.	Particulars	Values
1	Totally Alkaline (Na_2O_3)	11.03%
2	Silicate (SiO_2)	28.57%
3	Ratio by weight Na_2O, SiO_2	1 to 2.43%
4	Molecular ratio Na_2O, SiO_2	1 to 1.66%

3 LITERATURE REVIEW

Many investigations are carried out on black cotton soil for the stabilization. Moayedi et.al. (2011), K.V.Madurwae et.al. (2013), Oluyemi-Ayibiown et.al. (2015), Pramod Kilabanur et.al. (2016), studied about the stabilization of black cotton soil by using sodium silicate. Aswathy M. et.al. (2016), studied about the stabilization of black cotton soil by using red mud. Pankaj R. modak et.al. (2012), studied about the stabilization of black cotton soil by using lime and fly ash.

4 METHODOLOGIES

4.1 Stabilization

Stabilization of Black Cotton soil was done by using Red mud and Sodium Silicate. Table 2 gives the detail about Percentages addition of stabilizing materials to black cotton soil.

Table-2: main combinations of red mud and sodium silicate in percentages; clay as a main component

Serial No.	Combinations	Name
1	BC+0RM+0SS	A0
2	BC+10RM+2SS	A102
3	BC+20RM+2SS	A202
4	BC+30RM+2SS	A302
5	BC+40RM+2SS	A402
6	BC+10RM+4SS	B104
7	BC+20RM+4SS	B204
8	BC+30RM+4SS	B304
9	BC+40RM+4SS	B404
10	BC+10RM+6SS	C106
11	BC+20RM+6SS	C206
12	BC+30RM+6SS	C306
13	BC+40RM+6SS	C406
14	BC+10RM+8SS	D108
15	BC+20RM+8SS	D208
16	BC+30RM+8SS	D308
17	BC+40RM+8SS	D408
18	BC+10RM+10SS	E1010
19	BC+20RM+10SS	E2010
20	BC+30RM+10SS	E3010
21	BC+40RM+10SS	E4010

(Note: - BC+0RM+SS Indicates, BC indicates the black cotton soil 0RM Means 0% red mud and SS indicates sodium silicate %, in the mix proportions, A0, A102, A202….E4010 are the names of the combinations)

5 TEST RESULTS AND DISCUSSIONS

5.1 By Stabilization

Table-3: Unconfined compression test values

Sl.no	Name of combinations	load applied in kg	corrected area	UCS in kg/cm²
1	A0	12.20	22.19	0.548
2	A102	13.50	20.66	0.553
3	A202	12.00	20.45	0.587
4	A302	12.00	20.45	0.587

5	A402	10.50	20.34	0.516
6	B104	16.50	20.77	0.694
7	B204	18.60	20.92	0.889
8	B304	08.40	20.19	0.816
9	B404	12.00	20.44	0.587
10	C106	22.50	21.22	1.060
11	C206	10.80	20.36	1.130
12	C306	06.30	20.05	1.314
13	C406	08.40	20.19	1.216
14	D108	10.80	20.36	0.630
15	D208	05.40	20.00	0.770
16	D308	07.20	20.11	0.880
17	D408	03.00	19.83	0.751
18	E1010	06.60	20.07	0.528
19	E2010	03.00	19.83	0.551
20	E3010	02.40	19.79	0.621
21	E4010	07.50	20.13	0.573

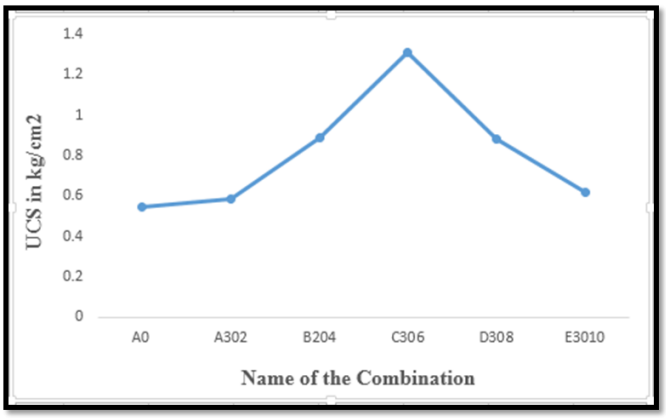

Chart -1: Relationship between combinations and UCS values for the maximum results.

Table-4: Soaked CBR test values

Sl. No	Name of combinations	CBR value in %
1	A0	2.1
2	A102	2.6
3	A202	2.9
4	A302	3.1
5	A402	2.8
6	B104	2.25
7	B204	2.6
8	B304	3.1
9	B404	2.8
10	C106	2.6
11	C206	3.1
12	C306	3.6
13	C406	3.5
14	D108	3.5
15	D208	3.7
16	D308	3.9
17	D408	3.6
18	E1010	2.7
19	E2010	2.9
20	E3010	3.6
21	E4010	3.4

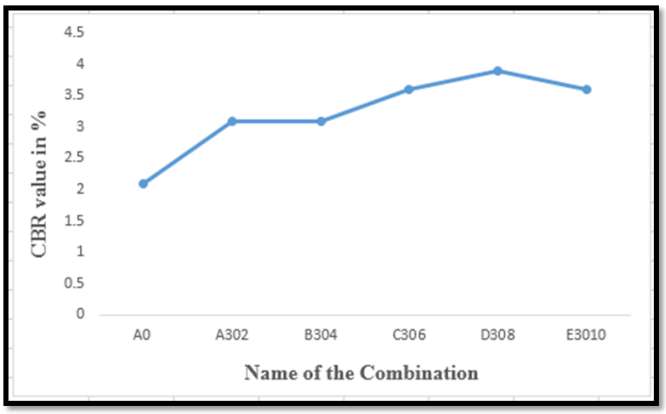

Chart-2: Relationship between combinations and Soaked CBR values for the maximum results

Table -1 The bond between Red mud and Black Cotton soil was tabled up to 30% later as the red mud content increases, the bond strength may get reduces, so influences on reduction of UCS strength. Here, one can note that, as the sodium silicate content increased UCS values got increased up to 6% of sodium silicate. Later as the percentage of sodium silicate increased, UCS values got decreased.

Chart -1 shows the maximum value of UCS being 1.3.14 kg/ sq.cm, which is obtained for C306 combination.

Table -2 The bond between Red mud and Black Cotton soil was tabled up to 30% later as the red mud content increases, the bond strength may get reduces, so influences on reduction of CBR strength. Here, one can note that, as the sodium silicate content increased CBR values got increased up to 8% of sodium silicate. Later as the percentage of sodium silicate increased, CBR values got decreased.

Chart -2 shows the maximum value of CBR being 3.9%, which is obtained for D308 combination.

6 CONCLUSIONS

Following are the conclusions made after the experimental investigation

1. Index properties and engineering properties of the Black cotton soil and Red mud was determined, found that black cotton soil is week to use as foundation soil as well as subgrade soil.
2. To improve the strength of Black cotton soil, Red mud is used from 10% to 40% with 10% increment and Sodium Silicate was used from 2% to 10% with 2% increment.
3. For series of mix designs UCS and CBR tests were conducted.
4. When 2% of Sodium silicate is used maximum value of UCS was found to be 0.587kg/sq.cm with 30% of Red mud.
5. When 4% of Sodium silicate is used maximum value of UCS was found to be 0.889kg/sq.cm with 20% of Red mud.
6. When 6% of Sodium silicate is used maximum value of UCS was found to be 1.314kg/sq.cm with 30% of Red mud.
7. When 8% of Sodium silicate is used maximum value of UCS was found to be 0.88kg/sq.cm with 30% of Red mud.
8. When 10% of Sodium silicate is used maximum value of UCS was found to be 0.621kg/sq.cm with 30% of Red mud
9. Ultimate value of UCS is being 1314kg/sq.cm was observed for the combination C306.
10. When 2% of Sodium silicate is used maximum value of CBR was found to be 3.1% with 30% of Red mud.
11. When 4% of Sodium silicate is used maximum value of CBR was found to be 3.1% with 30% of Red mud.
12. When 6% of Sodium silicate is used maximum value of CBR was found to be 3.6% with 30% of Red mud.
13. When 8% of Sodium silicate is used maximum value of CBR was found to be 3.9% with 30% of Red mud.
14. When 10% of Sodium silicate is used maximum value of CBR was found to be 3.6% with 30% of Red mud.
15. Ultimate value of CBR is being 3.9% was observed for the combination D308.

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