



STABILIZATION OF BLACK COTTON SOIL USING RED MUD FOR PAVEMENT CONSTRUCTION

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ABSTRACT

Soil stabilization improves various engineering properties e.g. bearing capacity, compressibility, strength, and various other properties of soil. In this study the impact of Red Mud to improve the strength of soil. The soil was stabilized with Red Mud in stepped concentration of 10%,20%,30% and 40% by dry weight of the soil individually. The test results indicate that the addition of red mud enhances the strength. The investigation on the properties of black cotton soil, we observed that, the strength properties of black cotton soil is very low. Before any foundation work one such soil, we need to stabilize them.

1. INTRODUCTION

Industrialization and urbanization are the two worldwide phenomena. Though these are the necessity of the society and are mostly inevitable, one has to look into their negative impacts on the global environment and social life. The major ill effect of these global processes is the production of large quantities of industrial wastes and the problems related with their safe management and disposal. Second problem is the scarcity of land, materials and resources for ongoing developmental activities, including infrastructure.

Soil stabilization is a process used to enhance the physical properties of the soil. Soil stabilization improves the shear strength of the soil and it controls shrink-swell behavior of soil. Black cotton soil is found mainly in Maharashtra, Madhya Pradesh, Andhra Pradesh and Karnataka. Developing countries like India experience various challenges due to the presence of Black cotton soil during the development of infrastructure projects. To improve the sub grade, it is stabilized by using chemical additives or biopolymers. Strength and bearing capacity of the soil is mainly considered to transfer the loads to the below layers effectively without any failure. Therefore, to improve the desired properties of the soil it needs stabilization. In many sectors soil stabilization is used namely, roads, landfills, industries, slope protection, dam cores, etc.

Red Mud is produced during the process for alumina production. Depending on the raw material processed, 1–2.5 tons of red mud is generated per ton of alumina produced. In India, about 4.71million tons/annum of red mud is produced which is 6.25% of world's total generation. It is the insoluble product after bauxite digestion with sodium hydroxide at elevated temperature and pressure. It is a mixture of compounds originally present in the parent mineral bauxite and of compounds formed or introduced during the Bayer cycle. It is disposed as slurry having a solid concentration in the range of 10-30%, pH in the range of 10-13 and high ionic strength. The main aim this project work is to stabilize the waste Red Mud obtained from alumina plant by mixing it with Black Cotton Soil which is subsequently be utilized for various geotechnical and highway engineering applications such as filling of embankments, construction of highways, replacement of poor sub grade soil etc.

2. OBJECTIVES

The main objectives of our experimental project include the following.

1. To study the effect of red mud on the index properties and consistency limit on black cotton Soil.
2. To study effect of red mud on compaction.
3. To study petrographic characterization of red mud for utilizing In soil stabilization.
4. To study swelling and shrinkage behavior, California bearing ratio of red mud on black cotton soil.

3. SCOPE OF THE PROJECT

1. In developing countries like India, America, Spain, Ukraine which are having black cotton soils are problematic in nature to the construction of various structures over them.

2. Construction of pavement over black cotton soil is possible but it requires more capital for the construction as the thickness of base and sub base increased; similarly different challenges are now being faced by the foundation engineers during the construction of structures over Black cotton soil.
3. For any construction work soil having low bearing soil has to be strengthening by the stabilization process.

4. MATERIALS

Materials Used For The Research:

- **Black Cotton Soil**

Black cotton soil was procured from Raichur district from 1m depth of original ground level. Black cotton soil was procured manually and are carried out efficiently. From depth of 1m below natural ground level Black cotton soil is removed later soil lumps are crushed into small pieces, broken and dried. In clean and moisture free area soil is stored. Black cotton soil are expansive in nature. with change in the moisture content, it will show swell and shrink behavior. It has high volume change behavior and comparatively less strength than other soils. Structures built on this type of soil experience large settlement.

- **Red Mud (Bauxite Residue)**

Industrial waste Red-mud. Red mud is a waste produced in the formation of alumina in aluminum industries. 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.

5. METHODOLOGY

These are the experiments conducted on black cotton soil with or without Red Mud.

1. Specific Gravity
2. Atterberg's Limits
 - i) Liquid limit
 - ii) Plastic limit
 - iii) Plasticity Index
3. Standard Proctor Compaction Test
4. Unconfined Compressive Test
5. California Bearing Ratio

6. RESULTS

The tests conducted on Black cotton soil as per specified IS codes for each test.

Table 4.1 Basic Test Results on Black Cotton Soil

SI NO	TESTS	RESULTS
1	SPECIFIC GRAVITY	2.321
2	LIQUID LIMIT %	77.97

3	PLASTIC LIMIT %	42.17
4	PLASTICITY %	35.8
5	COMPACTION FACTOR MDD % OMC %	1.65 24
6	UNCONFINED COMPRESSIVE STRENGTH kn/m ²	87.27

BLACK COTTON SOIL IS CHARACTERISTICS WHEN STABILIZED WITH RED MUD

BCS=BLACK COTTON SOIL RM=RED MUD

SAMPLE 1	BCS (100%)
SAMPLE 2	BCS+10%RM
SAMPLE 3	BCS+20%RM
SAMPLE 4	BCS+30%RM
SAMPLE 5	BCS+40%RM

LIQUID LIMIT TEST: Results of liquid limit test.

SAMPLE	LL (%)
S1	77.97
S2	57.8
S3	54.96
S4	53.21
S5	51.87

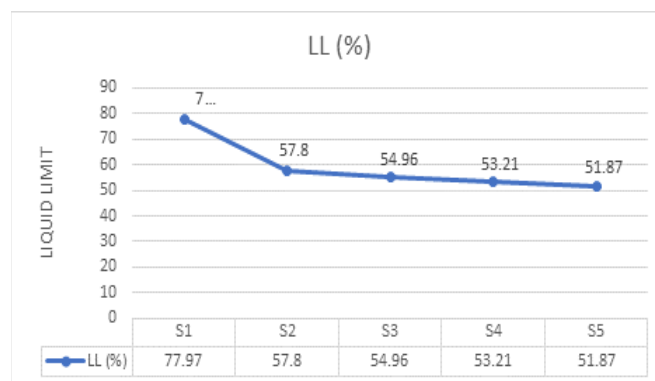
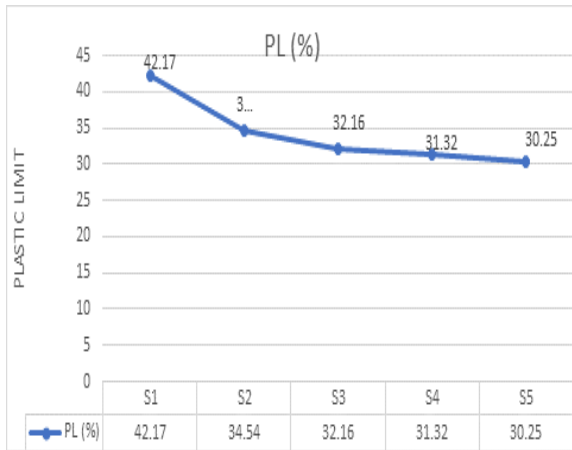


Fig:1 LIQUID LIMIT

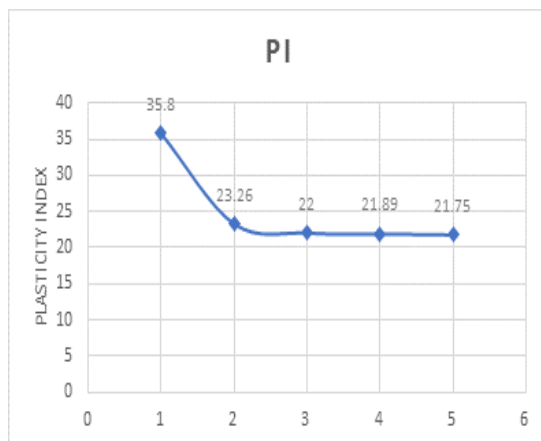
PLASTIC LIMIT TEST: Results of plastic limit test.



SAMPLE	PL (%)
S1	42.17
S2	34.54
S3	32.16
S4	31.32
S5	30.25

Fig:2 PLASTIC LIMIT

PLASTICITY INDEX: Results of plasticity test.



SAMPLE	PI (%)
S1	35.8
S2	23.26
S3	22
S4	21.89
S5	21.75

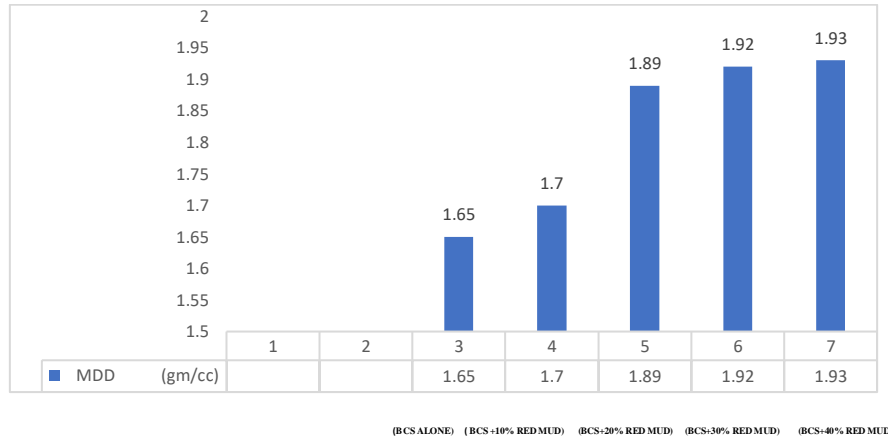
Fig:3 PLASTICITY INDEX

COMPACTION TEST: Results of compaction test.

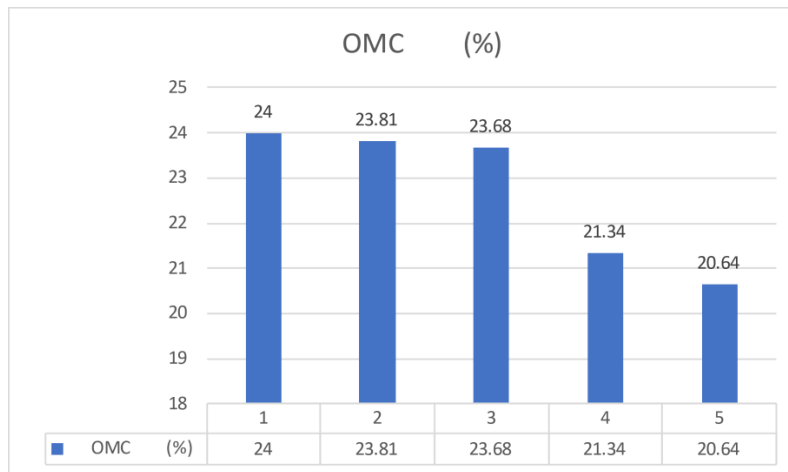
PARTICULARS	COMPACTION TEST	
	MDD (gm/cc)	OMC (%)
BCS ALONE	1.65	24
BCS+10 % RED MUD	1.70	23.68

BCS+20 % RED MUD	1.89	23.81
BCS+30 % RED MUD	1.92	21.34
BCS+40 % RED MUD	1.93	20.64

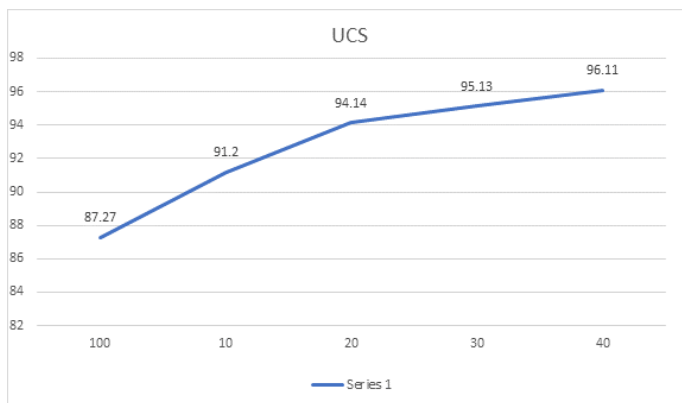
MDD GRAPH



OMC GRAPH



Unconfined Compressive Strength Test: Results of UCS test.



PARTICULARS	UCS VALUE
BCS (100%)	87.27Kn/m ²
BCS+10%RM	91.20Kn/m ²
BCS+20%RM	94.14Kn/m ²
BCS+30%RM	95.13Kn/m ²
BCS+40%RM	96.11Kn/m ²

7. CONCLUSION

1. The specific gravity of Soil is 2.67 and Specific gravity of Red Mud is 3.05 which is very high as compared to conventional soil, so the density and strength of Red mud is more.
2. As we have seen from the graphs and tables the plasticity characteristics of soil decreases while increasing the percentage of red mud in the soil sample.
3. As the plasticity of the sample decreasing would results in decreasing the swelling behavior of sample so therefore it can be used as a filling material in embankment.
4. Black cotton soil is treated with different percentages of red mud. which MDD increased from 1.65g/cc to 1.93g/cc and OMC decreased to 24% to 20.64%.
5. UCS is value increased when increasing the percentages of red mud from 87.27Kn/m² to 96.11Kn/m².
6. CBR is also good. which the red mud is used for filling embankments, road construction etc.

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