A Study On Stabilisation Of Clayay Soil Using Ggbs And Bauxite Residue

Archana
PG student, Department of Geo-Technical Engineering
Bheemanna khandre Institute of Technology, Bhalki
Bidar, Karnataka, India

Mallikarjun Honna
Asst. Professor, Department of Civil Engineering
Bheemanna khandre Institute of Technology, Bhalki
Bidar, Karnataka, India

Dr. Vageesh S Mathada
Asst. Professor, Department of Geo-Technical Engineering
Bheemanna khandre Institute of Technology, Bhalki
Bidar, Karnataka, India

Sharan Kumar
Asst. Professor, Department of Geo-Technical Engineering
Bheemanna khandre Institute of Technology, Bhalki
Bidar, Karnataka, India

***Abstract*— Black cotton soil most problematic soil for civil engineers for several challenges. Therefore this type soil is considered as potential hazard naturally; this can be cause the damage in structures due to extension if it is not treated properly. The purpose of the study is to increase its capacity and to control the swelling properties. The properties can be modified mechanically and chemically. The selection of this modification depends on the availability and applicability for the soil. For decrease the effect of cost and environmentally free method several industrial waste materials are utilized for improving the soil characteristics. And also another concern is to reduce the consumption of natural materials like aggregates, sand etc… It can be reduced by selecting this methods, it helps to reduce the quantity or thickness of sub-base in road construction and also reduces the area of footing in residential buildings. In this point of view, the utilization of bauxite residue and GGBS in this study is chosen which will help the environment. The soil Stabilised with different percentage of Bauxite residue (red mud 15%, 25% & 35%) and with 5% GGBS are added found variation in the original strength of the soil. Based on the results at optimum Bauxite residue (25%) found the maximum increase in the CBR value as 4.7% when compared to other mixes. By observing these results, at Mix2 (80% black cotton soil + 25% of bauxite residue+ 5%GGBS) 1.46N/mm2 UCS is higher than other mixes. Liquid limits is decreases with increase in the Bauxite residue quantity.**

***Keywords*— Black_Cotton_soil,GGBS,Bauxite,CBR,UCS**

I. INTRODUCTION

Soil is a complex material and the study of its properties is very important for a civil engineer to execute the construction work. For a superstructure, foundation is very important which is constructed on Soil. Soil properties changes depending on the geographical location, it may be silt, clayey, gravel soil. If soil is weak the construction cost hikes due to the foundation area required to support the super structure is large. By any means the properties of soil can be altered is through stabilization. The stabilization methods started in early 70's.The purpose of the study is to increase its capacity and to control the swelling properties. The properties can be modified mechanically and chemically. The selection of this modification depends on the availability and applicability for the soil.In developing country like India, the major concern is to recycle the marginal materials or by products. So in this study the chemical like GGBS which is a marginal material is used and properties have been modified chemically. And also another concern is to reduce the consumption of natural materials like aggregates, sand etc… It can be reduced by selecting this methods, it helps to reduce the quantity or thickness of sub-base in road construction and also reduces the area of footing in residential buildings. The study is required more in developing countries because of over exploitation of raw materials which leads to change in topography due to quarry, and also it leads to change in weather conditions, fertility of the soil. Various researches have been conducted to reuse the marginal materials in the engineering projects. In this point of view, the utilization of bauxite residue and GGBS in this study is chosen which will help the environment.

II. EXPERIMENTAL DETAILS

A. Materials Used

In this study three material are used clayey soil; Bauxite residue and GGBS.

1) Black Cotton Soil: Collection of soil was done at Hedger, open pit of depth 1meter below ground level was excavated. Soil obtained was black in texture and color of soil, soil collected have moderate infiltration characteristic.

TABLE I. SHOWS PHYSICAL PROPERTIES OF SOIL

SL.N0	Properties	B.C soil
1	Specific gravity	2.39
2	*Liquid* limit	65.2%
	Plastic limit	33%
	Plasticity limit	32.2%
	Shrinkage limit	18.1%
	Free swell index	14
4	IS soil classification	CH

5	MDD (g\cc)	1.657
6	OMC (%)	19.4%
7	CBR (%)	1.65
8	UCS	0.69kg/m2

2) RED MUD (bauxite residue): Red mud a byproduct evolved while extraction of alumina from bauxite. Red mud is a insoluble material which generate when bauxite digest with sodium hydroxide at some temperature and pressure. It was procured from Belgaum Karnataka, which is a byproduct of Bayer process.

TABLE II. SHOWS PHYSICAL PROPERTIES OF BAUXITE RESIDUE

SL.N0	Properties	Bauxite Residue
1	Specific gravity	2.9
2	Liquid limit Plastic limit Free swell index	42% 31% No swell
3	Appearance	Fine material
4	OMC	1.43
5	MDD	30%

3) Geo-polymer: GGBS (ground granulated blast Furnace slag-generated from quenching molten iron slag from blast furnace in steam). The GGBS Was procured from JSW vendor.

TABLE III. GEO-POLYMER

Composition	Percentage
Sio2.	30-34%
Al2O3.	12-20%.
Cao	42-50%

III. RESULTS AND DISCUSSIONS

A. *Wet sieve analysis*

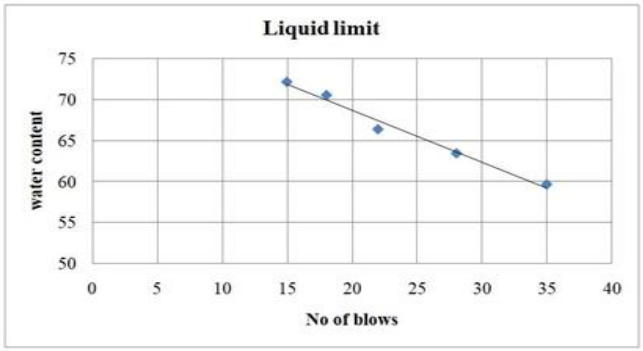
The test was conducted on selected soil as per IS-2720 (part 4); 1983. The oven dried sample weighing 1kg is taken and soaked in water for 24hrs and then soil is washed in 75micron sieve and the remaining soil is oven dried. Test was conducted on oven dried sample.

TABLE IV. WET SIEVE ANALYSIS

SI NO.	TEST	RESULT
1	Gravel	1.1
2	Sand	8.1
3	Fines	90.8

B. *Atterberg limit*

The atterberg limit for the soil sample and the stabilized sample is tested as per IS-2720 (part 5); 1985.Results for clayey soil were found to be Liquid limit: 65.2% using casagrande apparatus. Plastic limit: 33%Plasticity Index: 32.2%.



Graph-5.2 Liquid limit for Black cotton soil obtained from graph is 65.2%.

The tests were also conducted on stabilized soil samples and shown in table.

TABLE V. THE TESTS RESULS ON STABILIZED SOIL SAMPLES

Admixture	Stabilizer		
GGBS	5%		
Bauxite residue	15	25	35
Liquid limit	51.2	39.4	32.1
Plastic limit	31.1	26	25.1
Plasticity index	20.1	13.4	7

TABLE VI. THE TESTS RESULS ON STABILIZED SOIL SAMPLES

SL NO.	Description	Liquid limits
1	Natural soil	65.2
2	80%black cotton +15%bauxite residue +5%GGBS	51.2
3	70%black cotton +25%bauxite residue +5%GGBS.	39.4
4	60%black cotton +35%bauxite residue +5%GGBS	32.1

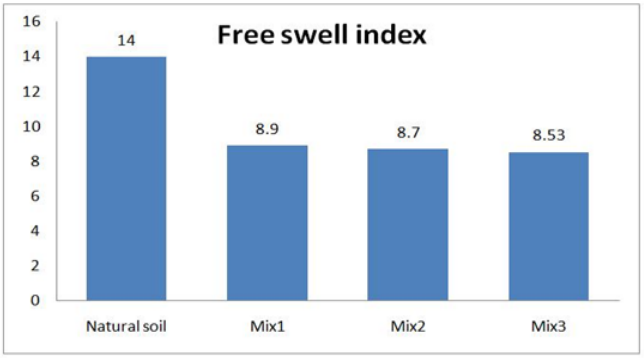
The Liquid limit by using black cotton soil treated with bauxite residue and GGBS of different percentage i.e. 15%, 25% & 35% are 51.2, 39.4 & 32.1 respectively. By observing these results, as the percentage of material increases the Liquid limit will be decreases.

C. *Free Swell Index*

The test conducted was conformed to IS-2720 (part XL) and the test results given below.

TABLE VII. FREE SWELL INDEX

	Natural soil	Stabilized soil		
Proportion	-	Mix1	Mix2	Mix3
FSI	14	8.9	8.7	8.53



Graph: 5.7 Free swell index

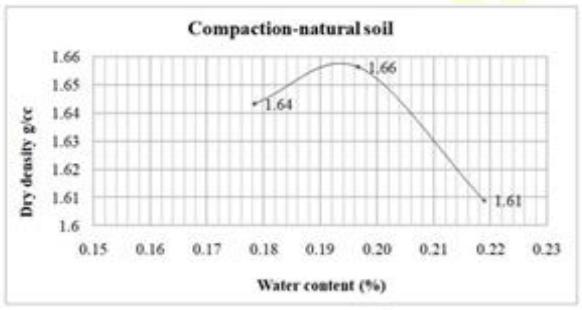
The Free swell index by using black cotton soil treated with bauxite residue and GGBS of different percentage i.e 15%,25% & 35% are 8.9,8.7&8.53 respectively . By observing these results, as the percentage of material increases the free swell index will be decreases.

D. Compaction Test

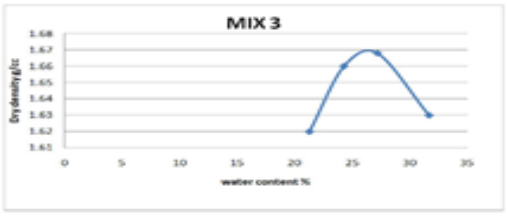
The test was conformed to IS-2720 (part VII), conducted on both natural and stabilized soil to arrive with maximum dry density and optimum moisture content. Results are shown below.

TABLE VIII. COMPACTION TEST

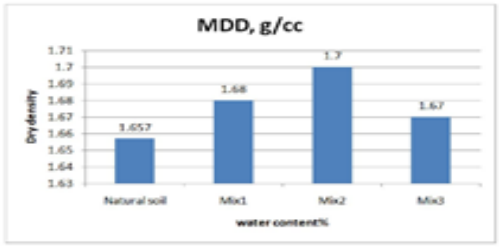
	Natural soil	Stabilized soil		
Proportion	-	Mix1	Mix2	Mix3
MDD, g/cc	1.657	1.68	1.7	1.67
OMC,%	19.4	22.1	24.4	26.8



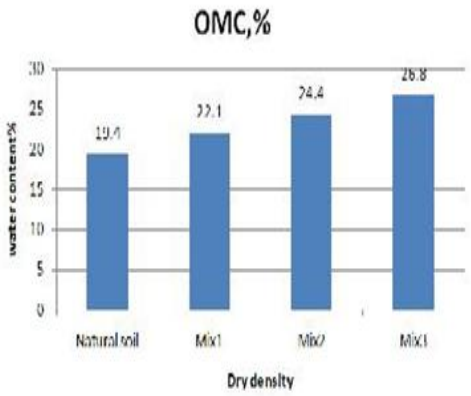
Graph-5.6 MDD and OMC of graph plotted for natural soil.



Graph-5.7 MDD and OMC of graph plotted for (60% Black cotton + 35%Bauxite residue + 5%GGBS) soil.

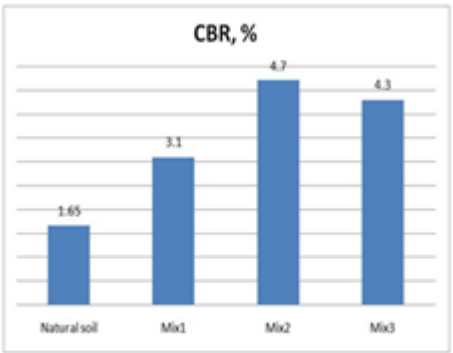


Graph: 5.8 MDD graph for comparing with natural soil, Mix1, Mix2 & Mix3.



Graph: 5.9 OMC graph for comparing natural soil, Mix 1, Mix 2 & Mix 3.

The CBR by using black cotton soil treated with bauxite residue and GGBS of different percentage i.e. 15%, 25% & 35% are 3.1, 4.7& 4.3 respectively. By observing these results, at Mix2 (80% black cotton soil + 25% of bauxite residue+ 5%GGBS) 4.7% CBR is higher than other mixes.



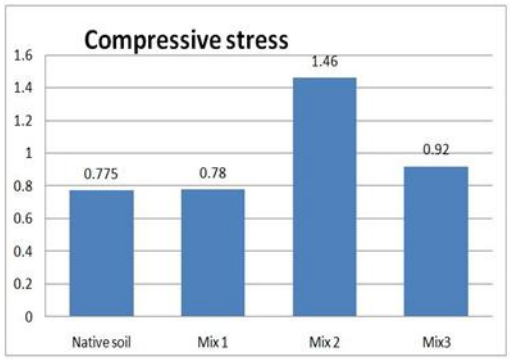
Graph: 5.10 CBR for natural soil, Mix1, Mix 2 & Mix 3

E. Unconfined compression test (UCS)

This test was conducted on specimen having 3.8cm diameter and 7.6m height standard moulds. The samples were cured for 7 and 28days and results are shown in table.

TABLE IX. UNCONFINED COMPRESSION TEST

Compressive stress (N/mm2) 7 days			
Native soil	Mix 1	Mix 2	Mix 3
0.775	0.78	1.46	0.92



Graph: 5.14 Compressive stresses for natural soil, Mix 1, Mix 2 & Mix 3.

The UCS by using black cotton soil treated with bauxite residue and GGBS of different percentage i.e. 15%, 25% & 35% are 0.78, 1.46, 0.92 respectively. By observing these results, at Mix2 (80% black cotton soil + 25% of bauxite residue+ 5%GGBS) 1.46N/mm2 UCS is higher than other mixes.

IV. SCOPE OF THE PRESENT WORK

- To reduce the consumption of natural materials by replacing it by byproducts.
- To continue the study on using marginal materials to improve the properties of silty and clayey soil.
- Field applicability is necessary to understand the performance
- The impact of the waste materials on environment can be reduced
- The bad impact on agriculture has to be studied when these marginal materials are used to stabilize the soils.

V. SUMMERY AND CONCLUSION

- Based on above test outcome and perception made, the conclusion are as per the following.
- From this study it is observed that there was an improvement in the properties of soil as the admixture was added to the soil
- From the observed results, the Mix 2(Soil 70% + GGBS 5% + Bauxite residue 25%) was a better proportion to use to modify the weak soil.
- Mix 2 shall is used to stabilize the clayey soil for highways or road construction and building construction, by providing proper drainage.
- Mix 1 and Mix 3 shall be used in sub-grade layer to strengthen; thereby it will reduce the thickness of pavement layer in highway construction and also the area of footing in building construction.
- In present study the marginal materials used will help environment by implementing the sustainable development concept i,e... by reducing the waste material by using it as a construction material.
- From the results, the CBR of Mix 3 was less than Mix2; it helped us to know the maximum bauxite residue that can be used to stabilize soil is between 25% and 35%.
- From the free swell index results, it was observed that the free swell index values was decreased which will help the structures to be stable and durable.

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