Effects Of Blast Furnace Slag On Black Cotton Soil

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Abstract- *Many experiments have been conducted on Black cotton soil for reducing its problematic properties and stabilising it. In this connection many ingredients have been tried for blending the Black cotton soil to neutralize its harmful properties. Through the present study it is proposed to blend the Blast furnace slag in different proportions with Black cotton soil and to determine the variation /improvement in the geotechnical properties. To safeguard environment, efforts are being made for recycling different industrial wastes and utilizing them in value applications. The utilization of industrial waste for the improvement of engineering properties is cost-effective and eco-friendly, since it helps in reducing the problem of waste disposal of the industrial wastes. The main objective of this study is to contribute to the understanding of improvement in the characteristics of Black Cotton soil mixed with the Blast Furnace slag in different proportions range from 0%, 5%, 10%, 15%, 20%, 25%.*

Keywords- BCS,BFS,CBR,FSI.

I. INTRODUCTION

The object of this experimental study is to study the improvement in the geotechnical properties of black cotton soil mixed with lime and BFS. The BFS is a non- metallic by product obtained in the process of iron and steel manufacturing. Produce by quenching of molten iron slag from a blast furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a fine powder. The lime and BFS is used in varying percentage for the improvement of geotechnical properties of black cotton soil. The lime content is kept constant 5%, for all the samples prepared with different percent of BFS such as 0%, 5%, 10%, 15%, 20% and 25%. The samples were prepared by mixing oven dried lime stabilized black cotton soil and oven dried BFS by weight, then the prepared dry mix is blended with water to attain homogeneity as per the requirement of test, and testing is done on the samples.

II. METHODOLOGY

This explains about the works carried out in this study. The effect of industrial wastes such as Blast Furnace slag under different proportioning with soil.

A. Soil sample collection

The soil sample for this study was collected from a construction site in Jabalpur.

B. Material collection

The industrial waste Blast Furnace slag for this study was collected from the disposal site of Bhilai Steel plant, Bhilai, Chattisgarh

C. Test on materials

The tests were conducted in the Geotechnical laboratory of Civil Engineering department, Jabalpur Engineering College with the collected soil sample to classify the soil, to evaluate its physical and engineering properties and to study the compaction characteristics. Proctor's compaction tests, UCS tests, CBR tests were conducted on samples under different proportioning with 0%, 5%, 10%,15%, 20%, 25% with 5% lime as stablizer. The Standard Proctor's Compaction tests were conducted on the soil sample to evaluate the OMC and MDD of samples. UCS test were conducted on soil samples to determine the unconfined compressive strength, which is then used to calculate the unconsolidated undrained shear strength of the soil under unconfined conditions. The sample were also analyzed for the CBR value. Results obtained were compared. Conclusions were made based on the results obtained.

III. LABORATORY INVESTIGATION

This chapter explains the various physical and engineering properties of Black cotton soil namely moisture content, specific gravity, liquid limit, plastic limit, shrinkage limit, grain size distribution, optimum moisture content, MDD, UCS and CBR along with the mineral composition of Blast Furnace slag. All the tests were carried out as per IS codes.

A. Properties of soil

The properties of Black cotton soil were determined by conducting various laboratory tests and the results are presented in Table.1

Table.1 Properties of Black cotton soil

S no.	Particulars	Observation
1.	Specific Gravity	2.2
2.	Liquid Limit	51
3.	Plastic Limit	29.63
4.	Plasticity Index	21.37
5.	Shrinkage limit	14.56
6.	Passing 75µ sieve	98 %

IV. RESULTS AND DISCUSSIONS

The experimental study involves Free Swell Index, Optimum Moisture Content, Plasticity Index, California Bearing Ratio tests on soil sample with varying percentage of Blast Furnace slag and fixed percentage of lime as stablizer.

A. Free Swell Index

Free Swell Index Test is conducted as per IS: 2720(Part 40)-1977 on soil sample. Two samples passing 425µ IS sieve is taken; both the samples are poured in 100 ml capacity graduated glass cylinder. Distilled water is poured in on cylinder and kerosene in the other one as shown in picture 3.15. Remove the entrapped air by stirring with glass rod. Allow attainment of equilibrium state for 24 hrs. Final volume of soil in each cylinder shall be read out. This process continues for different proportion of soil and BFS ranging from 0% to 25% . The F.S.I. value is reported in Table.2.

Table.2 Free Swell Index of soil with BFS

S.no	% BFS + Stablizer	F.S.I. (%)
1.	BCS	38.63
2.	0	18.2
3.	5	-1.82
4.	10	-3.76
5.	15	-4.3
6.	20	-8.0
7.	25	-8.6

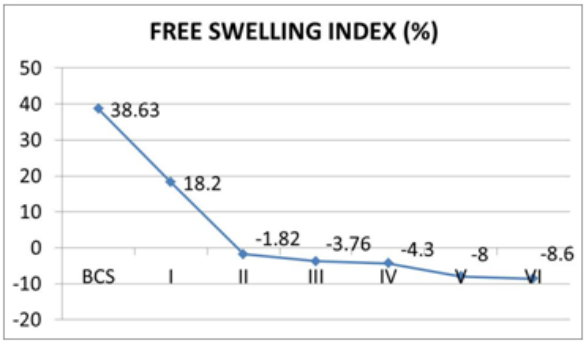

Fig.1 Variation of Free Swelling Index with addition of Lime/BFS

B. Standard Proctor's Test

Standard Proctor's Compaction tests is conducted on soil samples under different proportioning with 0%, 5%, 10%, 20%, 25% of Blast Furnace slag with 5% lime as stabilizer to determine the optimum moisture content and maximum dry density of soil sample. The optimum moisture content and maximum dry density of soil sample under different proportioning of BFS and Lime are reported in Table.3

Table.3 Standard Proctor's Compaction tests results of soil with BFS

S.no	% BFS + Stablizer	OMC (%)	MDD (gm/cc)
1.	BCS	28.71	1.395
2.	0	26.5	1.42
3.	5	25.2	1.430
4.	10	24.1	1.469
5.	15	23.43	1.471
6.	20	23.43	1.513
7.	25	20.93	1.54

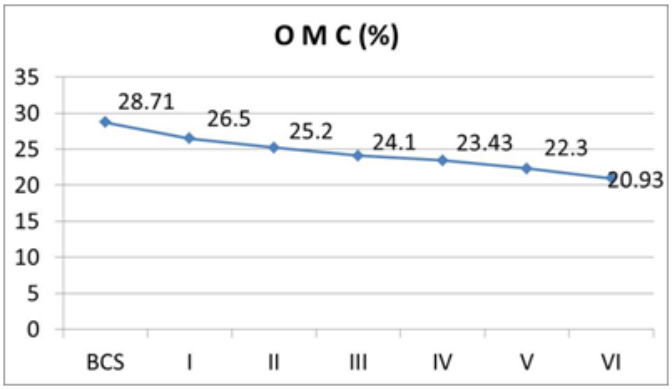

Fig.2 Variation of Optimum Moisture Content with addition of Lime/BFS.

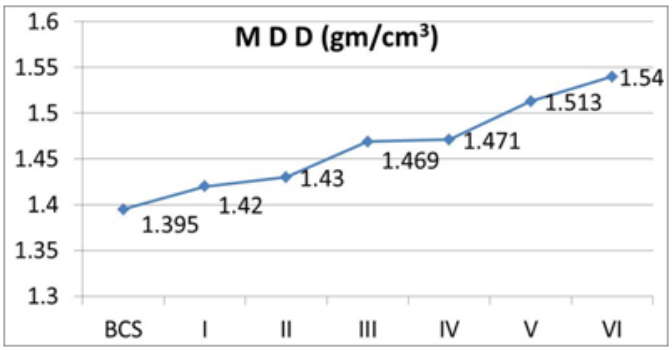

Fig.3 Variation of Maximum Dry Density with addition of Lime/BFS

C. California Bearing ratio test

The CBR tests were conducted as per IS 2720(Part 16) – 1987. It is the ratio of force per unit area required to penetrate a soil mass with standard circular piston at the rate of 1.25 mm/min. to that required for the corresponding penetration of a standard material. The California Bearing ratio test was performed on soil sample mixed with varying amount of Blast Furnace slag such as 0%, 5%, 10%, 15%, 20% and 25% . From this test the strength characteristics of the soil sample are studied by determining California Bearing ratio value which are listed in Table.4.

Table.4 California Bearing ratio tests results of soil with BFS

S.no.	% BFS + Stablizer	CBR Value (%)
1.	BCS	1.54
2.	0	3.315
3.	5	3.39
4.	10	3.42
5.	15	3.6
6.	20	4.9
7.	25	4.82

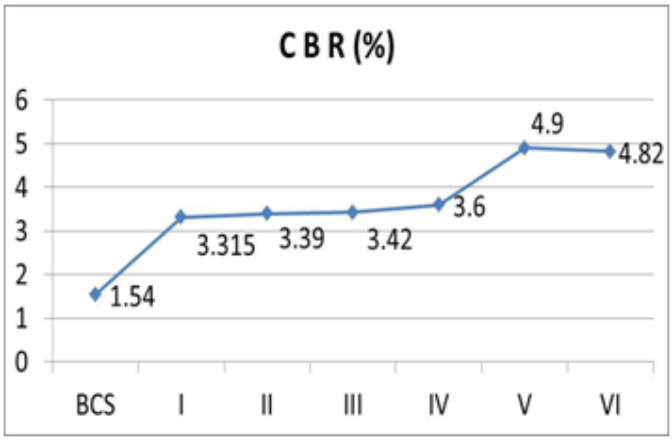

Fig.4. Variation of California Bearing Ratio with addition of Lime/BFS.

D. Plasticity Index

Plasticity index test were conducted as per IS2720 Part VII 1980/87. The plasticity index (PI) is a measure of the plasticity of a soil. The plasticity index is the size of the range of water contents where the soil exhibits plastic properties. The Pasticity Index test was performed on soil sample mixed with varying amount of Blast Furnace slag such as 0%, 5%, 10%, 15%, 20% and 25%. The value are listed in Table.5

Table.5 Plasticity Index tests results of soil with BFS

S.no	% BFS + Stablizer	Plasticity Index (%)
1.	BCS	21.37
2.	0	13.92
3.	5	9.2
4.	10	7.6
5.	15	2.78
6.	20	1.0
7.	25	0.79

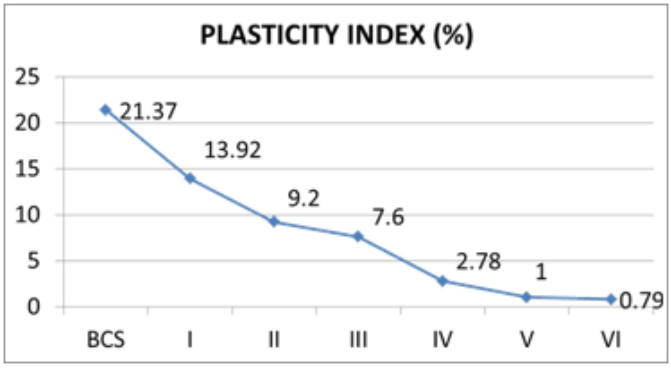

Fig.4. Variation of Plasticity Index with addition of Lime/BFS

V. CONCLUSION

The experimental work is carried out to study the use of Blast Furnace Slag in the improvement of swelling and shrinkage characteristics of Black Cotton Soil and also enhancement in shear strength and CBR values.

From the results, the following conclusion are warranted.

A. The Plasticity Index is gradually decreased with the increasing percentage of Blast Furnace Slag.
B. The CBR of the soil increases with the increasing percent of Blast Furnace slag.
C. Maximum Dry Density of Black cotton soil samples are increasing, with the increasing percentage of Blast furnace Slag.
D. Optimum Moisture Content is decreasing with the increase in percentage of Blast Furnace Slag in the soil samples.

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