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Index Property of Expansive Soil with Blast Furnace Slag

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ABSTRACT

The stability of any structure depends on the soil on which it is constructed. As we are Civil Engineer we are well aware of that. To stabilize soil so many technique were used. The by-product from industrial waste which produce during production is also hazardous for environment. Therefore in present time these industrial waste product were used to enhance the stability of soil. The Blast Furnace slag is also an industrial waste. The Blast Furnace slag is a non-metallic by product produced in steel manufacturing plant. Blast Furnace slag consists of silicates, alumina silicates, calcium alumina-silicates and ash from coke. The total production of slag from the steel industries in India is about 10.0 million tonne and the obtained slag is a waste by product during production of steel. Generally, admixing techniquehas an dominant improvement in the soil properties. Therefore, the present experiment describes the behavioral aspect of black cotton soil mixed with Blast Furnace slag. The main objectives of the present experiment is to find the index and engineering poperties of black cotton soil with addition of lime and Blast Furnace slag ranging from 0% -25% .

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Keywords: BCS, BFS, LL, PL

1 Introduction

The Black cotton soil is considered as treacherous soil by practising engineers due to its high shrinkage and swelling properties. Black cotton soil when come in contact with water, it shows immense swelling but when the water dries out, it shrinks and cracks are developed. In worst areas the cracks may sometimes extent to severe limits like 10 cm wide and 3.0m to 3.5m deep. Swelling of soils is generally observed in the unsaturated clays which contain clay minerals such as illite, kaolinite, montmorillonite. Such soil have high capacity for water absorption, thus they absorb water meanwhile their volume increases.
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

2 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.

2.1Soil sample collection

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

2.2Material collection

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

2.3 Test on materials

The tests were conducted in the Geotechnical laboratory of Civil Engineering , 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.

3 LABORATORY EXPERIMENT

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.

3.1 Properties of soil

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

Table1 - 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

3.2 *Properties of Blast furnace slag*

The properties of Blackcotton soil were determined by conducting various laboratory tests and the results are presented in Table 2.

Table 2 - Properties of BFS

S no.	Particulars	Observation
1.	Specific Gravity	2.705
2.	Passing 12.5mm sieve (Gradation)	98 %
3.	Type	Granular

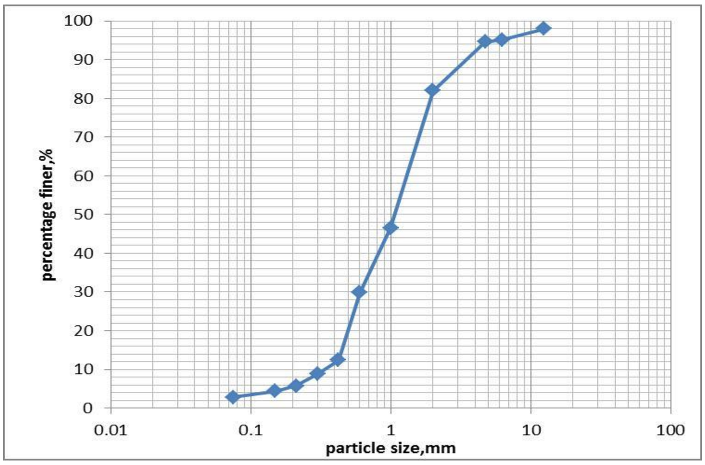

Fig.1Particle size Distribution of BC Soil

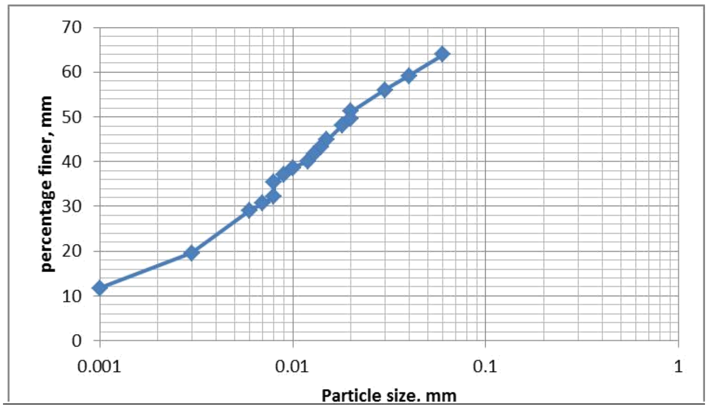

Fig.2Particle size Distribution of BFS

4 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.

4.1 Liquid Limit

The casagrande apparatus is used to determine the liquid limit of the soil. The liquid limit (LL) is the water content at which a soil changes from plastic to liquid behaviour. Soil is placed into the metal cup of the device and a groove is made down its center with a standardized tool of 13.5 millimetres width. The cup is repeatedly dropped 10mm onto a hard rubber base at a rate of 120 blows per minute, during which the groove closes up gradually as a result of the impact. The number of blows for the groove to close is recorded. The moisture content at which it takes 25 drops of the cup to cause the groove to close over a distance of 13.5 millimetres is defined as the liquid limit.

Table3–Liquid Limit of BCsoil

No. of Blows		32	18	8
Container no.		23	51	38
Container wt.	(M_1)	10.18	10.82	9.59
Wt.of cont.+ wet soil	(M_2)	39.15	42.03	31.81
Wt.of cont.+ dry soil	(M_3)	29.55	31.17	23.70
Wt. of moisture	(M_2-M_3)	9.60	10.86	8.11
Wt. of dry soil	(M_3-M_1)	19.37	20.35	14.11
Water content	$\frac{(M_2-M_3)}{(M_3-M_1)}$	49.60 %	52.87 %	57 %

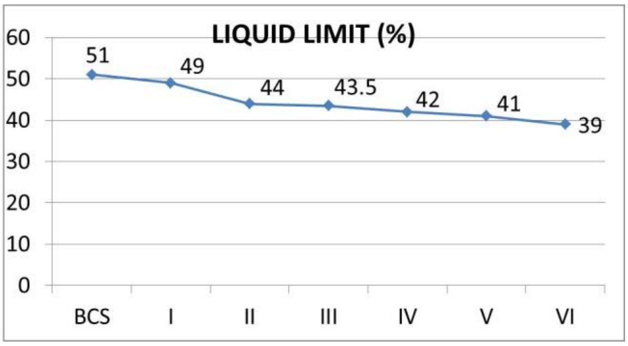

Fig.3 Variation of Liquid limit with addition of Lime/BFS.

4.2 Plastic Limit

The plastic limit is determined by rolling out a thread of the fine portion of a soil on a flat, non-porous surface. If the soil is plastic, this thread will retain its shape down to a very narrow diameter. The sample can then be remoulded and the test repeated. As the moisture content falls due to evaporation, the thread will begin to break apart at larger diameters. The plastic limit is defined as the moisture content where the thread breaks apart at a diameter of 3 mm.

Table4–Plastic Limit of BCsoil

Container no.		58	46	25
Container wt. (gm)	(M_1)	9.55	10.43	8.77
Wt.of cont.+ wet soil (gm)	(M_2)	16.61	23.93	24.33
Wt.of cont.+ dry soil (gm)	(M_3)	19.84	20.88	20.90
Wt. of moisture (gm)	(M_2-M_3)	10.29	10.45	12.13
Wt. of dry soil (gm)	(M_3-M_1)	3.23	3.05	3.43
Water content	$(M_2M_3)*100\ (M_3-M_1)$	31.40 %	29.20 %	28.30 %

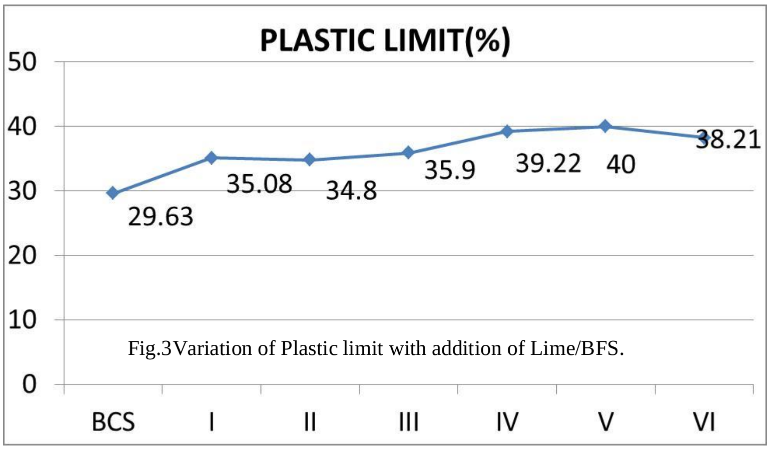

Fig.3Variation of Plastic limit with addition of Lime/BFS.

4.3 Shrinkage limit

The shrinkage limit (SL) is the water content when the water is just sufficient to fill all theof the soil and the soil is just saturated. The volume of soil does not decrease when the water content is reduced below the Shrinkage limit

Table5–Plastic Limit of BCsoil

Shrinkage dish no.		07
Weight of shrinkage dish (gm)	M_1	17.48
Weight of shrinkage dish + wet soil pat (gm)	M_2	91.61
Weight of shrinkage dish + dry soil pat (gm)	M_3	59.66
Weight of dry soil pat (gm)	(M_3-M_1)	43.78
Weight of water (gm)	(M_2-M_3)	31.05
Water content	$(M_2-M_3) / (M_3-M_1)$	70.94 %
Volume of wet soil pat		
Weight of mercury filling shrinkage dish (gm)		652.86
Volume of wet soil pat	V	48.01
Volume of dry soil pat		
Weight of mercury displaced by dry soil pat (gm)		317.33
Volume of dry soil pat	V_d	23.33

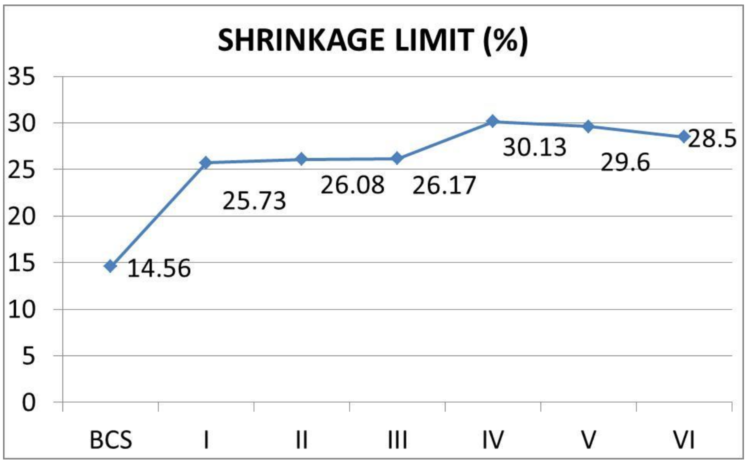

Fig 4 Variation of Shrinkage limit with addition of Lime/BFS

4.4 *Unconfined compressive Strength*

The primary purpose of this test is to determine the unconfined compressive strength, which is then used to calculate the unconsolidated undrained shear strength of the clay under unconfined conditions. The unconfined compressive strength (qu) is defined as the compressive stress at which an unconfined cylindrical specimen of soil will fail in a simple compression test. The testing is done by extruding the soil sample from the sampler. The ratio (L/d) should be approximately between 2 and 2.5.The value are listed in Table.6.

Table.6UCS of soil with BFS

S.no	% BFS + Stablizer	UCS (KN/m^2)
1.	BCS	110
2.	0	119
3.	5	121
4.	10	178
5.	15	188.8
6.	20	196.6
7.	25	236.4

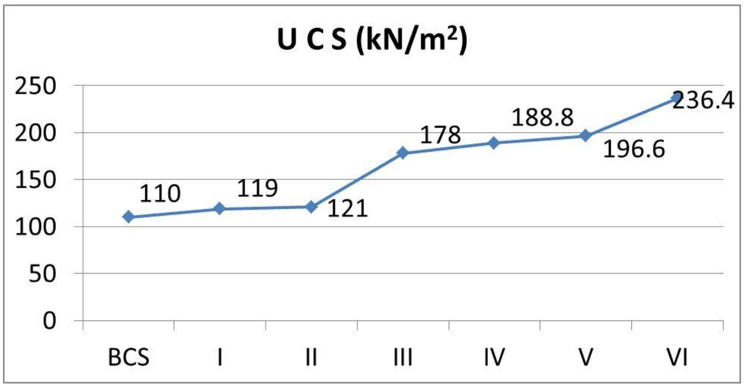

Fig 5. Variation of Unconfined Compressive Strength with addition of Lime/BFS

5.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 conclusions are warranted.

5.1 The Liquid limit values of the samples are decreasing with increase in the amount of Blast furnace slag

5.2 Shrinkage limit is increasing with the increase in the percent of Blast furnace slag.

5.3The Black Cotton Soil mix with Blast Furnace Slag increases Unconfined Compressive Strength of BC Soil.

5.4 Plastic Limit of Black Cotton Soil is decreasing with the increase in percentage of Blast Furnace Slag.

5.5 The study presents an effective method for improvement of problematic black cotton soil by utilizing an industrial waste blast furnace slag.

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