EFFECT OF BLAST FURNACE SLAG ON INDEX PROPERTIES OF BLACK COTTON SOIL

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ABSTRACT: *In India, the black cotton soil covers an area of about 0.8 million sq. km. which is about 20% of the total land area. It is considered as problematic soil due to detrimental volume changes with variation in moisture content. When it comes in contact with water it shows immense swelling whereas it shrinks with the decrease in water content and develops cracks on drying. The properties of black cotton soil can be modified by stabilizing the soil with the use of additives or by mechanical means. This study briefly describes the suitability of the blast furnace slag (BFS) to be used in the steel industry in a way to minimize the amount of waste to be disposed to the environment causing environmental pollution. In this present study, different amount of BFS are added separately i.e. 10,20,30,40 and 50% by dry weight of soil are used to study the stabilization of soil. In this thesis the soil are stabilized by blast furnace slag (BFS). The use of by-product materials for stabilization has environmental and economic benefits. Blast furnace slag (BFS) material is used in the current work to stabilize soil (clay). The main objectives of this research were to investigate the effect of BFS on the index property (plastic limit, liquid limit, plasticity index and DFS) of the black cotton soil. Test results indicated that liquid limit, plasticity index and DFS of expansive soil decreased with increase in BFS percentage.*

***KEYWORDS*: Expansive Soil, Blast furnace slag, Index Properties, DFS, Soil stabilization.**

1. INTRODUCTION: One of the main environmental problems in this century is the storage of solid waste materials such as municipal waste, industrial waste, hazardous waste and low-level radioactive waste. Waste utilization is an attractive alternative to disposal in that disposal costs and potential pollution problems are reduced or even eliminated along with the goal of resource conservation. Iron and steel slag is broadly divided into blast-furnace slag (BFS) and steel slag. BFS may be either blast-furnace slag (BFS), a glass form that is quenched or air-cooled slag, which is cooled in the atmosphere. During the production of iron, BFS and steel slag are formed as by-products. BFS is a non-metallic by-product during the manufacture of pig iron in a blast furnace.BFS consists primarily of silicates, alumina-silicates, and calcium-alumina-silicates. The color of BFS is whitish.

Many researchers have worked on improving properties of black cotton soil with the help of GBFS, results of some are as; **Ashish Kumar Pathak, et.al. (2014);** Investigated the effect of GGBS on the engineering property of the soil and determine the engineering properties of the stabilized. GGBS are added from 0% to 25% by dry weight of soil. The addition of GGBS resulted in a dramatic improvement within the test ranges covered in the program. The maximum dry density increased and the optimum moisture content decreased with increasing GGBS content and at 25% we got the maximum value of dry density. **Laximanth Yadu (2013);** Investigated that the liquid limit and plasticity index values decrease and the plastic limit values increase with increasing GBFS content up to 50% for all the stabilized samples of both the low-plasticity and high plasticity clays. The unit weights of a particle for the stabilized clayey soil sample increases with an increase of the content of GGBFS. Thus indicates that the stabilized clayey soil sample is heavier than that of its natural conditions. **Dayalan, et.al (2016)**; Studied the effect of stabilization of soil with GGBS and Fly Ash and found that the values of liquid limit and plastic limit decreases with increasing percentage of GGBS. The plasticity index decreases with increase in percentage of GGBS. It is concluded that the optimum value for fly ash is 15% and GGBS is 20% respectively.
In this study use of black cotton soil with varying percentage(10,20,30,40, and 50%) of blast furnace slag and show the index properties i.e. increase the percentage of BFS and decrease the liquid limit, plasticity index, DFS value of black cotton soil.

2. MATERIALS:

2.1 BLACK COTTON SOIL: The soil is selected for this study is black cotton soil collected from sagda railway station, sagda Jabalpur (M.P.). Coordinates of this site work are: $23^0 8'30"$N and $79^0 51'53"$E.

Table-1: Physical Properties of Black Cotton Soil

S.NO.	PROPERTIES	VALUES
1.	SOIL CLASSIFICATION	CH
2.	SPECIFIC GRAVITY	2.45
3.	LIQUID LIMIT	61.34%
4.	PLASTIC LIMIT	25.51%
5.	PLASTICITY INDEX	35.83%
6.	DFS	70%
7.	OPTIMUM MOISTURE CONTENT	16.1%
8.	MAXIMUM DRY DENSITY(g/cc)	1.82
9.	CBR Value (%)	2.37

2.2 BLAST FURNACE SLAG: Blast furnace slag is produced as a by-product during the manufacture of iron in a blast furnace. Molten blast furnace slag has a temperature of 1300-1600°C and is chilled very rapidly to prevent crystallization. The granulated material thus produced is known as granulated blast furnace slag. Blast furnace slag has a glassy, disordered, crystalline structure which can be seen by microscopic examination which is responsible for producing a cementing effect. The blast-furnace slag (BFS) samples were collected from the *Monnet Ispat & energy limited Distt. Raigarh (Chhattisgarh).* Black cotton soil used in this study was replaced with Blast furnace slag in different proportions i.e. 10, 20, 30, 40, and 50% by weight of the soil to obtain the optimum amount for stabilization.

Table-2: Physical properties of BFS

S.NO.	PROPERTIES	VALUES
1.	SOIL CLASSIFICATION	ML
2.	SPECIFIC GRAVITY	2.8
3.	LIQUID LIMIT	33.5%
4.	PLASTIC LIMIT	0
5.	PLASTICITY INDEX	NP

6.	DFS	0%
7.	OPTIMUM MOISTURE CONTENT	15.8%
8.	MAXIMUM DRY DENSITY(g/cc)	2.08

3. METHODOLOGY: The following tests were conducted on black cotton soil and BFS mixes as per relevant IS codes of practice:

- Specific gravity test
- Liquid limit
- Plastic limit
- Plasticity index
- Differential free swell (DFS) Test
- Wet Sieve Analysis

4. MIX PREPARATION: Following mix has been prepared with different percentage of Lime.

- Soil Sample + 0% BFS (CB0)
- Soil Sample + 10% BFS (CB10)
- Soil Sample + 20% BFS (CB20)
- Soil Sample + 30% BFS (CB30)
- Soil Sample + 40% BFS (CB40)
- Soil Sample + 50% BFS (CB50)

5. RESULTS AND DISCUSSION:

Liquid limit and plastic limit both decreases with increasing percentage of blast furnace slag. Variation of plasticity index with various percentage of blast furnace slag is shown in Fig 3, it was inferred that plasticity index decreases with increasing percentage of blast furnace slag DFS value also decrease with increasing percentage of BFS in black cotton soil. These may be due to the soil type, the associated exchangeable cations and the relative amount of silicate clay mineral in the samples. This effect is mainly attributed to the hydration reaction of Blast furnace slag were the pores are filled by crystalline growth.

Table-3: Test results of Black Cotton Soil with BFS (%)

S.NO	SAMPLE TYPE	LL (%)	PI (%)	DFS (%)
1.	CB0	61.34	35.83	70
2.	CB10	59.8	34.5	64
3.	CB20	57.6	33.4	57
4.	CB30	54.4	30.5	46
5.	CB40	49.1	26.3	34
6.	CB50	44.2	23.1	27

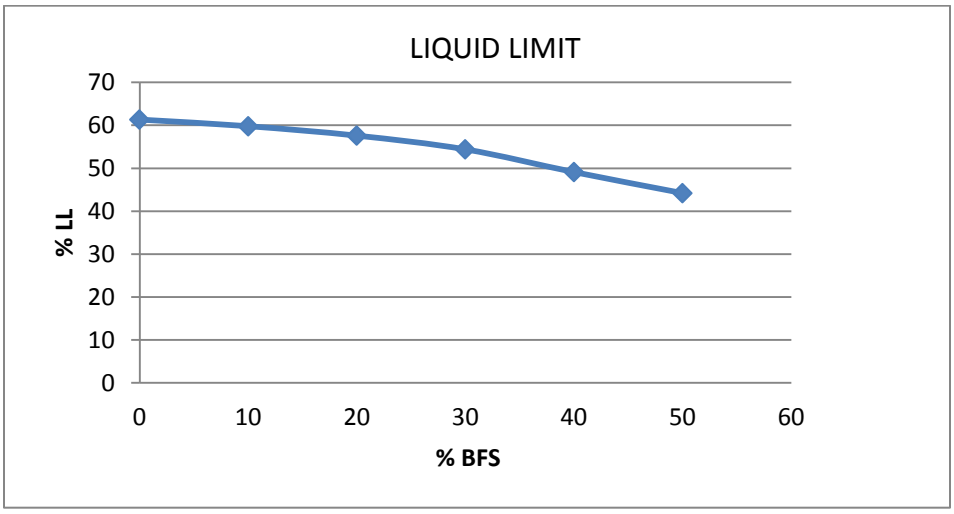

Fig-1: Variation in LL with increase in BFS content

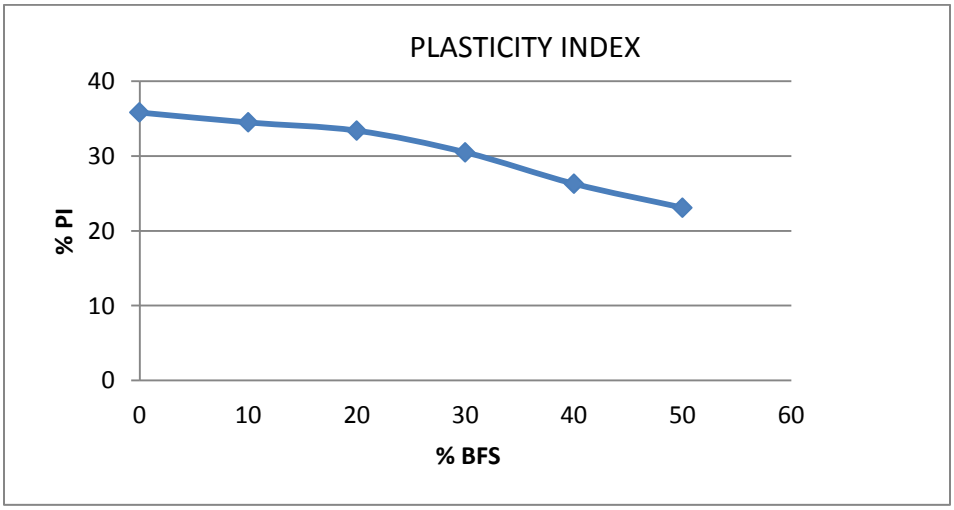

Fig-2: Variation in PI with increase in BFS content

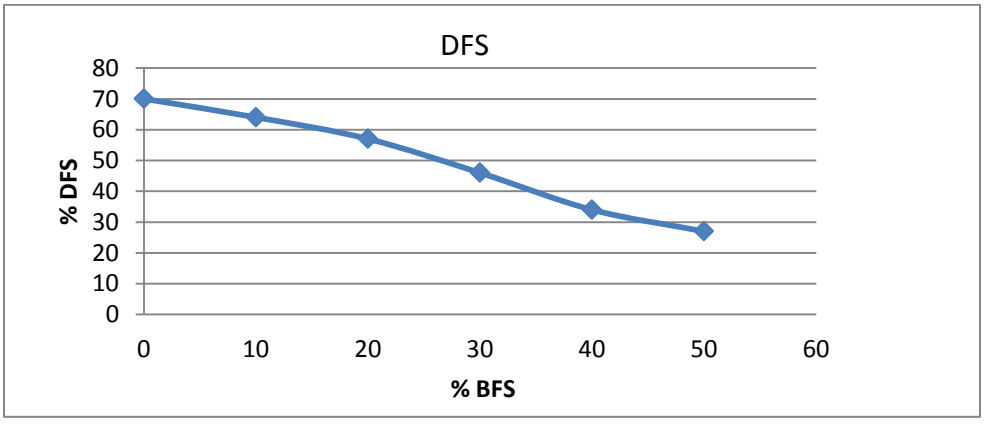

Fig-3: Variation in DFS with increase in BFS content

6. CONCLUSIONS:

From the results of investigation following conclusions can be drawn.

- Liquid limit of soil decreases from 61.34% to 44.2% with increase in percentage of BFS.
- Plasticity index of soil decreases from 35.83% to 23.1% with increases percentage of BFS.
- Differential free swell decreases from 70% to 27% with increase in percentage of BFS. This study has revealed that the use of BFS waste material has the potential to modify the properties of clays in order to decrease their swelling potential, and therefore positively affect the stabilized soil samples.

Above results shows that the liquid limit, plastic limit, plasticity index and swelling characteristics of soil get reduced and result are found best at an 50% BFS by weight of dry soil.

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