STRENGTH PROPERTIES OF BLAST FURNACE SLAG MIXED WITH ALLUVIAL SOIL

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Abstract: Alluvial soil is formed by accumulated sediments transferred by the rivers and lakes. The texture of the deposit depends on the energy of the water body. We can get strength properties of Blast Furnace Slag mixed with alluvial soil. When iron melts during the melting process of making steel which residue product are collected in the end of process it is known as blast furnace slag. The chemical compositions are similar to that of cement. It contains following metal such as chromium 0.034mg/l, cadmium .0004mg/l and nickel .0027mg/l. Blast furnace slag does not contain lead. These are materials found in blast furnace slag within the range of permissible value. Soil stabilization means that change properties of soil and can improve engineering characteristics and performance of a soil used to industrial waste materials such as blast furnace slag. Utilization of blast furnace slag may be improve alteration of modification of soil properties .It is a cost effective and ecofriendly method .In this paper were consistent assess the stability of blast furnace slag in soil stabilization.

Keywords: Blast furnace slag (BFS), Alluvial Soil, Direct Shear strength.

INTRODUCTION

In now days, growth of civilization is increasing rapidly due to this reason the engineer's to use the site which is not suitable for geotechnical engineering. In these sites, the weak soil condition often create problems to engineers associated with the foundation design and construction works of civil engineering structures such as buildings, highways, railways, airfields, embankments, dams, storage tanks, car parks and temporary working platform. In such poor sites creates problem due to excessive settlement and low bearing capacity of the soil. It is really a challenging task for the engineers to improve such site conditions. Soil Stabilization means that every physical – chemical operation applied to make a soil suitable for its required engineering purpose. Soil stabilization is a regulated process to improve the soil structures by other additive materials.

There are different types of ground improvement techniques can be used to improve the strength of the soil, to improve the strength of the soil, to reduce the settlement and to minimize the construction cost & construction time. The selection of specific techniques depends upon the site condition, engineering properties of soil, availability of required material in sufficient amount, environmental impact, and energy consumption.

Blast furnace slag is a type of industrial waste. Industrial waste materials have little or no production cost .Waste materials utilization is not only the promising solutions for disposal problem, but also saves construction cost. Blast furnace slag is produced as a by-product during the manufacture of iron in a blast furnace.

It has a rough surface giving good frictional properties and a good hire fire resistance. It has relatively high water absorption, due to its high porosity. Blast furnace slag is used in many fields because it has unique characteristics. The major use of BFS is in the construction Industry. BFS is a recycled material that can reduce impacts on the environment due to its resource-conservation and energy-saving effects. BFS is used to make durable concrete structures in combination other pozzolanic materials.

. Blast-furnace slag is defined by the American Society for Testing and Materials (ASTM) as "the nonmetallic product consisting essentially of silicates and alumino-silicates of calcium and other bases that is "developed in a molten condition simultaneously with iron in a blast furnace."

The GBS is basically inorganic in nature. It contains mainly inorganic constituents. According to Working Group on Cement Industry for the 12th Plan (reference, Indian Bureau of Mines) approximately 10 million tones BFS is currently generated in the country from iron & steel industry. Since the outset of industrial revolution the greatest challenge before the processing and manufacturing industries is the disposal of the residual waste products. Waste products which are generally toxic, ignitable, corrosive or reactive pose serious health and environmental consequences.

Over recent years, studies have been carried out to reuse waste materials such as construction waste, blast furnace, coal fly ash for construction of embankment, road, pavement, foundation and building materials.

Industry of metal produced slag, mine stone and mining waste are suitable for recycling or reuse. These solid wastes are transforming from one form to another form, to be reused either by the same production unit or by different work.

I. MATERIAL USED

1. ALLUVIAL SOIL

Alluvial Soil was collected from village Narahi in Gorakhpur district of Uttar Pradesh. The soil sample was collected from a depth of about 0.3 to 0.4 below the ground surface.

2. BLAST FURNACE SLAG

Blast Furnace Slag (BFS) was collected from Gallant Ispat Limited in Gorakhpur district Uttar Pradesh. On visual inspection the blast furnace slag appeared dark grey colour.

Properties of soil and BFS are determined as per the Indian Standard (IS). Properties of soil are showed in Table 1. Table 2 shows the properties of BFS. Table 3 shows the concentration of heavy metal in BFS. Heavy materials such as Chromium, Cadmium, and Nickel are materials found in blast furnace slag within the range of permissible value

3. METHODOLOGY

Classification tests were test performed on the soil samples. The soil samples were mixed with the stabilizer at OMC. Steel slag was added to the soil samples in 2, 6,10,14,22 and 26 % by weight of the samples. Table 5 Engineering properties were determined to understand the effects of steel slag as stabilizing agent.

Table 1: Engineering properties of soil

Properties	**Value**
Maximum dry density g/cc	1.34
Optimum moisture content	17.5%
Specific gravity	2.70
Plastic limit	16
Liquid limit	27
Plastic index	18
CBR value	1.68
Sand size Particles	41%
Silt size Particles	29%
Clay size Particles	30%

Table 2: Engineering properties of BFS

Properties	Value
Maximum dry density g/cc	1.86
Optimum moisture content	15%
Specific gravity	2.57
Atterberg's limit	NP

Table 3: Chemical properties of BFS

S. No.	**Property**	**Percentage**
1	SiO_2	37.60
2	Al_2O_3	14.21
3	Fe_2O_3	0.98
4	MgO	10.12
5	CaO	32.61
6	Na_2O	0.42
7	K_2O	0.76
8	SO_3	0.99

(Source: sivrikaya et al 2014)

Table 4: Concentration of heavy metal in BFS

S.No.	Heavy metals	value (mg/l)
1	Chromium	.0034
2	Cadmium	.0004
3	Nickel	.0027
4	Lead	NIL

Table 5: Combinations of additive with soil

S No.	Additive BFS%
1	2%
2	6%
3	10%
4	14%
5	22%
6	26%

II RESULT AND DISCUSSION

DIRECT SHEAR STRENGTH TEST

Direct shear tests were carried out in the laboratory using a standard direct shear testing machine as per the IS code. This helped us to understand how the C and ϕ values of the mix change when different a proportion of the mix is taken. Different percentage of blast furnace slag was mixed with soil .From the table 6 it is clear that dry density of the mixture increases with the increases in blast furnace slag.

Table 6: Variation in OMC and MDD with BFS %

ADDITIVE	OMC (%)	MDD(g/cc)
0	17.5	1.34
2	24	1.51
6	21.5	1.54
10	20.8	1.56
14	19.1	1.59
22	18	1.61
26	16.5	1.63

The data of Table 6 is plotted as Figs 1 and 2. From the Figs 1 and 2, it is showed that OMC decreased and MDD increased with increasing percentage of BFS.

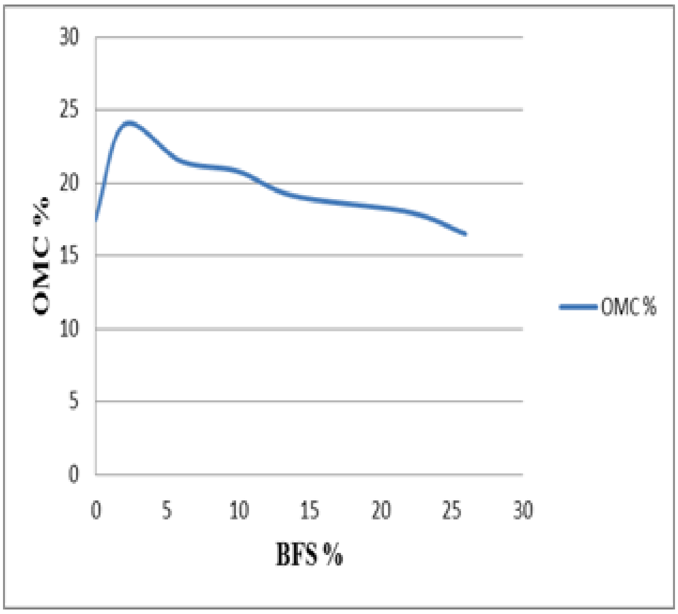

Fig -1: Variation of OMC with BFS%

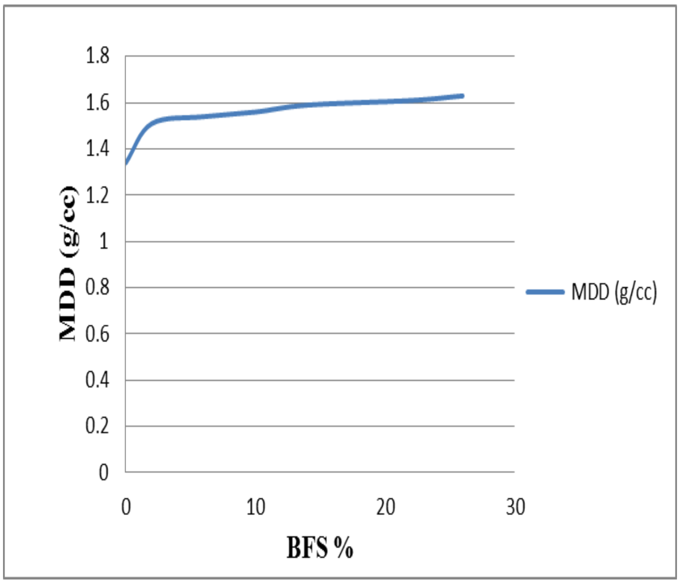

Fig -2: Variation of MDD with BFS%

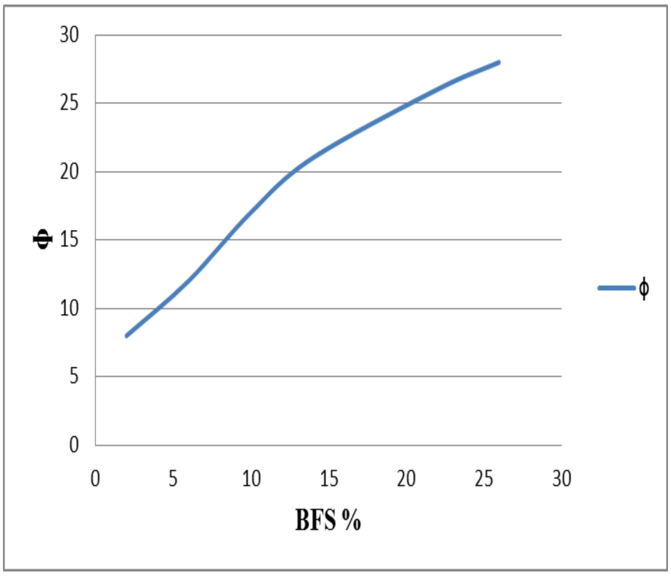

Fig -3: Variation of ϕ values with BFS%

Table 7 presents the Cohesion (C) and angle of internal friction (ϕ) of "BFS + Soil" mix.

Table 7: C and ϕ of "BFS + soil" mix

S.No.	Soil+BFS%	C kN/m²	ϕ⁰
1	98%+2%	.041	8
2	94%+6%	.055	12
3	90%+10%	.066	15
4	86%+14%	.088	23
5	78%+22%	.138	25
6	74%+26%	.167	28

The data of Table 7 is plotted as Figs 3 and 4.Figures shows, gradually increasing value of cohesion and internal friction respect to BFS.

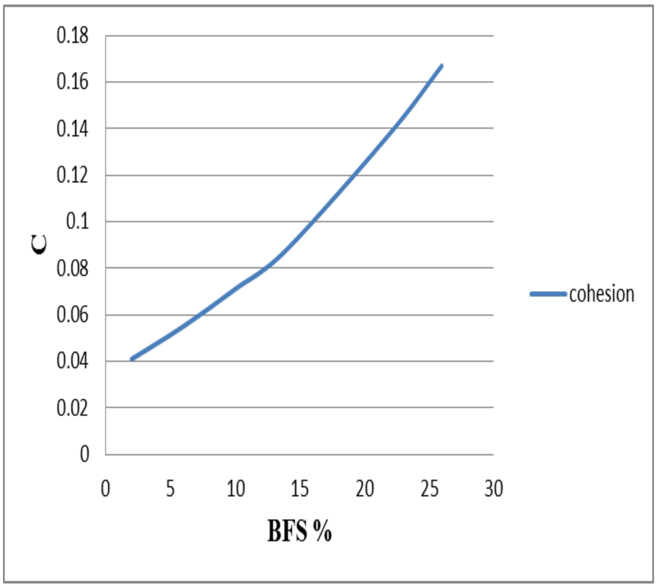

Fig -4: Variation of C values with BFS%

III. CONCLUSION

Based on the experimental results the following conclusion can be drawn:

1) OMC decreased and MDD increased with the addition of blast furnace slag to the soil.

2) The combination of BFS and soil mixed for the study that the angle of internal fraction increased corresponding to shear strength.

3) It was noticed that the cohesion of the soil increased by with the addition of alluvial soil.

4) 26% of BFS may be considered as optimum percentage of BFS to be mixed with alluvial soil.

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