"Experimental Investigation on Properties of Black Cotton Soil By Adding Iron Slag"

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Abstract - This work presents the results of laboratory tests conducted on black cotton soil mixed with iron slag. Different proportions of iron slag, I.E.10,20 and 30 % mixed with the black cotton soil to improve soil characteristics. The improvement in the characteristics of stabilized soil was assess by evaluating the changes in the physical and strength parameters of the soil, namely, the Atterberg limits, free swell, the CBR Value, compaction parameters and unconfined compressive strength. The mixing of iron slag decreases the liquid limit, plasticity index and optimum moisture contents (OMC) of the soil. The swelling potential of the soil is reduced from medium to very low.

I. INTRODUCTION

Expansive soils cover a considering part of various countries including India. These soils are also called as black cotton soil because of their black color which is a result of high iron, humus and magnesium minerals derived from trap and basalt. It is mostly found in Maharashtra, Madhya Pradesh, Gujarat, Tamilnadu, Andhra Pradesh, and Karnataka states of India and covers almost 22 % of total land cover of the country. Swelling and shrinkage are the main characteristics of these soils which cause threats to the foundations, structures, roadways, railways and various other life lines. BC soils swell and shrink, respectively, with the increase and decrease in the water content. In the rainy season, clay minerals attract water and due to the swelling and softening of soil whereas in the summer season, after evaporation of water, soils gets shrink and produce cracks on it. After absorption of water, soils become compressible and it leads to decrease in strength of the soil.Black cotton soil has proved itself as a source of damage to the property and economical loss. Expansion and contraction of this soil causes various problems to the civil engineers not only at the time of construction but also throughout the life of structures. Uneven contraction and swelling reduce the serviceability of the structures. It causes the emergence of hairline cracks, differential settlements, and sometimes even severe cracks, which may initiate the collapse of structures, railway lines and roadways. Decrease in the availability of suitable soil for construction has forced researchers to search for an appropriate method to improve the performance of locally available problematic soil. During the last four decades, lots of researches have been conducted on black cotton soil to reduce its expansion and contraction, and to save a lot of resources.

In our project we are introducing the modern way to study and improving the properties of black cotton soil by adding iron slag, Fly ash, crush lime stone etc. Material which can effectively increase them and make suitable and best base for construction purpose possibly for small case of hosing or such type of small case project and even for major projects also.

1.1 Problem Statement: Due to their peculiar nature Black Cotton soils are challenge for engineers everywhere in the world, and more so in tropical countries like India because of wide variation in temp and because of distinct dry and wet seasons, leading to wide variations in moisture content of soils. The following problems occur in black cotton soil –

1. High Compressibility: Black Cotton soils are highly plastic and compressible, when they are saturated. Footing, resting on such soils under goes consolidation settlements of high magnitude.

2. Swelling: A soil structure built in a dry season, when the water content is less shows differential movement as result of soils during subsequent rainy season. This is due to structures supported by such swelling soils to lift up and getting crack. Some restriction on having developed swelling pressures making the structure suitable.

3 .Shrinkage: A structure built at the end of the rainy season when the natural water content is high, shows settlement and shrinkage cracks during subsequent dry season. Therefore Black cotton soil construction of foundation on that soil is not possible without any treatment otherwise settlement of whole structure will be takes place after some time.

***1.2 Objectives of the study*:** The main purpose of experimental investigation of Black cotton soil is as follows :

1. To increase safe bearing capacity of soil.
2. To increase shear strength of soil.
3. To reduce swelling potential of Black cotton soil
4. To reduce permeability of Black cotton soil.

1.3 Scope of the project work

In our project we are introducing the modern way to study and improving the properties of black cotton soil by adding iron slag, Fly ash, crush lime stone etc. Material which can effectively increase them and make suitable and best base for construction purpose possibly for small case of hosing or such type of small case project and even for major projects also. Decrease in the availability of suitable soil for construction has forced researchers to search for an appropriate method to improve the performance of locally available problematic soil.

Therefore we are investigating black cotton soil in this project to make it suitable for construction purpose by adding various materials like iron slag, steel slag, fly ash, etc.

II. MATERIALS TO BE USED IN PROJECT

***A) Iron Slag*:** In many developed countries, concern over waste production, resource preservation and reduced material cost have focused attention on reusing solid waste materials. Waste materials when proper processed meet various design specifications in the construction industry. So recovering the useful materials from wastes not only offers environmental gains, but also helps to preserve natural resources. Therefore It has become necessary that the research efforts in using various types of solid wastes need greater attention . Slag is a by-product of the iron and iron making process. Iron cannot prepare in the blast furnace without the production of its by-product blast furnace slag. Similarly, iron cannot be prepared in the Basic Oxygen Furnace (BOF) or in an Electric Arc Furnace (EAF) without making its by-product, iron slag.

The objective of this study was to investigate the use of by-product iron slag aggregates (SSA) as a stabilizer. Large quantities of iron slag are produced daily in Ahmednagar from iron manufacturing processes. Currently, by-product iron slag material is dumped randomly in open areas. If not recycled or disposed in properly designed landfills, the toxic elements such as Cr, Ni, and Zn may migrate to and pollute the surface water and groundwater and affect the human life and the environment. In addition to that, the very fine particles of by product iron slag are expected to pollute the air.

The investigation of this work focused on the engineering properties of a stabilized clay soil as a sub-grade material used in road pavement and

foundation. The investigation considered the effect of SSA on plasticity, swelling behaviour, compressibility, shear strength and California bearing ratio (CBR) of the treated clay soil.

Fig: Iron slag

B) Black cotton soil : Black cotton soil possesses great threat for the construction of the buildings due its less characteristics shear strength and high swelling characteristics. In order to control the behavior, the cohesive soils have to be suitably treated with chemicals or any other available materials which can alter its engineering behavior. The Black cotton soil used in the study is collected from Coimbatore near Ganapathy area. Laboratory tests carried out to find out the index and engineering charactoristics of unmodified soil. Based on the results, from the Indian standard classification the soil sample is designated as clay of intermediate plasticity.

Fig: B.C. Soil

III. EXPERIMENTAL STUDY

1. Determination of compaction properties of soil by standard proctor test
2. Determination of Moisture content
3. Sieve analysis of soil.
4. Specific gravity by pycnometer.
5. Unconfined compressive test.
6. Differential free swell test.
7. Vane shear test.
8. Direct shear test.
9. Permeability by constant head method.

A) Black Cotton Soil

Soil for the work was collected from A.nagar city. Tests were carried out to determine the various properties of soil and results are tabulated in table given below:

Sr No	B.C. Soil Property	Value
1	Specific Gravity	2.66
2	Liquid limit	66.26%
3	Plastic limit	25.07 %
4	Plasticity index	36.19 %
5	Free swell index	31.1%
6	Max Dry density	1.498 g/cm3
7	Optimum moisture content	20.52 %
8	California bearing ratio	1.27

Add of B.C. soil + Iron slag(Slag10%,20%, 30%)

Sr. no	Name of experim-ents	10% of Iron slag	20% of Iron slag	30% of Iron slag
1	water content by Oven drying	16.29%	14.35%	12.89%
2	compaction properties of soil by standard proctor test.	MDD-1.71gm /cc OMC-40.53%	MDD-1.64gm/cc OMC-39.69%	MDD-1.58gm/cc OMC-38.29%
3	Sieve analysis of soil.	Gravals-28.8% Sand-60.5% Fines-0.73%	Gravals-25.4% Sand-53.9% Fines-0.8% %	Gravals-23.2% Sand-46.5% Fines-0.5%
4	Unconfined compressive test.	45.8 N/mm^2	49.59N/mm^2	54.72N/mm^2
5	Differential free swell test.	29%	27.5%	24.5%
6	Specific gravity by pycnometer.	2.95	3.36	3.88
7	Vane Shear Test.	9.10 N/mm^2	10.3N/mm^2	11.6N/mm^2
8	Direct shear test	3.5 N/mm^2	4.32N/mm^2	5.12N/mm^2

IV. CONCLUSION

1. Safe bearing capacity of soil is increase by 40% after adding 30% (by vol.)Iron slag and after well compaction.

2. Shear strength of soil is increase by 29.87% after adding 30% (of vol.) of iron slag.

3. Swelling potential of B.C.soil is decrease by 24.44% after adding 30% (of vol.) of iron slag.

4. Permeability of B.C. soil is also reduce by 21.50% after adding 30% (of vol.) of iron slag.

5. This changes in properties of B.C soil allows you to construction on B.C. ground. But it has it's own limitations.

- Limitation on multi story building.
- Utilization of Iron slag on site must done properly.
- Experts supervision and advice is very important.

V. REFERENCES

- VikasRameshraoKulkarni,Ganesh Keshavrao Patil "Expermental Study of Stabilization of B.C.Soil by Using Slag and Glass Fibers" Volume 1, No. 2; Aug, 2014 pp. 107-112.
- Ashutosh Rawat, Rajesh Jain "Effect Of Blast Furnace Slag on Index Properties of Black Cotton Soil" Vol: 04 Issue: 01 | Jan -17.
- K.V.Manjunath, H Shekhar, Manish Kumar, Prem Kumar and Rakesh Kumar "Stabilization of B C Soil by using Ground Granulated Blast Furnace Slag" 21st– 23rd June 2012 aper ID GET114, Volume. 1.
- Rajesh Prasad Shukla, Niraj Singh Parihar "Stabilization of Black Cotton Soil by using Micro-fine Slag" ISSN 2250-2149 Volume 97Number 3J. Inst. Eng. India Ser. A (2016).
- Brajesh Mishra"A Study on Engineering Behavior of Black Cotton Soil and its Stabilization by Use of Lime" Volume 4 Issue 11, Nov 2015.