

# International Journal of Innovative Research in Science, Engineering and Technology

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## Stabilization of Black Cotton Soil by Using Steel Slag

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**ABSTRACT:** In modern days, the disposal problem of industrial waste is rapidly increasing. Such, hazardous waste is affecting the environment as well as land. To protect the land and environment from industrial waste we utilized that waste for the construction purpose. Currently the world annual production of steel slag is estimated in between range 90-135 million metric tonnes. Therefore steel slag used for stabilizing the black cotton soil and for minimizing the waste. The use of steel slag improves the bearing capacity and the strength of black cotton soil and indirectly it saves the construction cost. Different percentage of 5%, 10%, 15% and 20% steel slag have been used to stabilize the black cotton soil and to verify its suitability for using it as a construction material for road. The steel slag collected from Kalika Steel, Jalna and the black cotton soil collected from Himayatbaugh, Aurangabad. The overall program was conducted in 2 phases. In first phase all necessary test such as Atterberg limit, C.B.R and standard proctor compaction test on plain soil were being performed to analyse the maximum dry density (maximum dry density) and optimum moisture content (Optimum Moisture Content). And in 2 phase the black cotton soil was mixed with 5%, 10%, 15%, 20 % of steel slag.

**KEYWORDS:** steel slag, black cotton soil, bearing capacity, Maximum Dry Density, Optimum Moisture Content, Standard Proctor, CBR.

### I. INTRODUCTION

Stabilization of soil is modification in the properties of the soil for improving its engineering properties by adding admixture such as lime, cement, fly ash, steel slag etc. Soil stabilization is mostly used in the connection with road pavement construction. Black cotton soil has property of plasticity when it comes in contact with moisture. It is hard and brittle at dry state. So it creates problem on work. To solve this problem some admixtures are used to stabilize this soil. Steel slag is a by-product produced during the conversion of iron ore or scrap iron to steel. Various tests are performed on the black cotton soil with the addition of various percentage of steel slag. It improves the engineering properties of the soil in terms of volume stability, strength and durability. The addition of this waste in the stabilization technique makes the proper use of waste and solves the problem of disposal.

### II. OBJECTIVE OF THE STUDY

#### THIS EXPERIMENTAL WORK FOCUSED ON

- 1) To improve the engineering properties of black cotton soil.
- 2) To reduce the plasticity of the locally available black cotton soil.
- 3) To determine the strength by using standard proctor test and CBR test.
- 4) To find out strength characteristic for different percentage.

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## III. LITRATURE SURVEY

Kiran B. Biradar et al (1) he describe the properties of clayey soil with the addition of fly ash and steel slag. Fly ash and steel slag are blended with unmodified soil in varying percentage to obtain the optimum percentage of admixture required for the soil stabilization. Saurabhkumar et al (2) the aim of his study to improve the engineering properties of clayey soil using steel slag. Specimen are prepared to know the properties of soil with percentage of 4%, 8%, 12%, 16% and 20% steel slag mixture passed through 180 micron and 300 micron sieve. Kayal Rajkumaran et al (3) The stabilization of expansive soil assessed by the presence of different percentage of steel sag and fly ash on the expansive soil is evaluated using index properties test, permeability test, compaction test and unconfined compressive strength test. Based on this performance tests, optimum amount of steel slag and fly ash on expansive soil is determined. Laximikant yadu et al (4) evaluate the performance of GGBS with fly ash modified soils using compaction and California bearing (CBR) test based on these performance test, optimum amount of GGBS with fly ash was determined 3% fly ash + 6% GGBS. Reasonable improvement has been observed for unsoaked and soaked CBR value of soils with this optimum amount. optimum moisture content increase and maximum dry density decreased with the addition of fly ash + GGBS mixture to the soft soil.

## IV. PROPOSED METHODOLOGY

### Material Used

#### Black cotton soil

Black cotton soil is one of major soil deposits of India. They exhibit high rate of swelling and shrinkage when exposed to changes in moisture content and hence have been found be most troublesome from engineering consideration.



Fig. No. 1

Fig. No. 1 shows the collected black cotton soil sample. These soil sample collected form Himayatbaugh, Aurangabad.

### Steel Slag

Steel slag is produced at steel melting shop during steel manufacturing. To produce steel, removal of excess silicon and carbon from iron is achieved through oxidation by adding limestone and coke. The steel slag contains higher amount of iron and its physical characteristics are similar to air-cooled iron slag.

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Fig. No. 2

Fig. No. 2 shows the steel slag sample which is used for stabilization of soil. The steel slag collected from Kalika Steel, Jalna. This steel slag sample used for soil stabilization.

## Test Carried Out

### Plastic Limit

The plastic limit is determining plastic limit of the red soil. The plastic limit is defined as the moisture content where the thread breaks apart at a diameter of 3 mm. Plastic limit is Compute the average of the water contents obtained from the three plastic limit tests. The plastic limit (PL) is the average of the three water contents.

### Liquid Limit

The liquid limit is most commonly performed of the Atterberg Limits along with the plastic limit. These 2 tests are used internationally to classify soil. The liquid limit is defining the moisture content at which soil begin to behave as a liquid material and soil begins to flow. The liquid limit is determine in the labs the moisture content at which the two sides of a groove shaped in soil come simultaneously and touches a distance of 2 inch after 25 blows. it is very tricky to get this to occur value exactly, we will run the test repeatedly until the groove closes 1/2 inch with over 25 blows. We can plot these results as no. of blow versus moisture content and interpolate the moisture content at 25 blows from the graph.

### Specific Gravity Test

Specific gravity is defined as the relative amount of the weight in air of a given volume of a material at a specified high temperature to the weight in air of a same volume of distilled water at a specified temperature. The reason of the test is to characterize the specific gravity of black cotton soil passing the 4.75 mm sieve by density bottle method. 50g of sample of black cotton soil and steel slag is taken in each 3 bottles and added water then weight of the water + bottle is taken. Then all the 3 bottles are subjected to sand bath, heating is done up to air bubbles are seen in the bottle. This is done to remove the entrapped air in the mixture; the bottle is kept for around 15min so that the temperature comes to 27 °C.

### Proctor Compaction Test

Proctor compaction test is a laboratory method of test is to define the optimal moisture content at which a given soil type will specifically. To determine the optimum water content at which soil be able to get to its maximum dry density. The soil is then located and compacted in the Proctor compaction mould in three different layers where each layer receives 25 blows of the standard hammer.

### California Bearing Ratio Test (CBR)

The California bearing ratio is a penetration test for evaluation of the mechanical strength of road sub grades and base-courses. The test is performed by measuring the pressure required to penetrate soil sample with a plunger of standard area. The measured pressure is then divided by the pressure required to achieve an equal penetration on a standard

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crushed rock material. 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.

**Table no.1 Calculated Properties of black cotton soil**

Sr. no.	Property	Values
1	Specific Gravity	2.65
2	Plastic limit (%)	31.94
3	Liquid limit (%)	52.63
4	Plasticity Index (%)	20.69
5	Proctor/Compaction test	
	a) Maximum Dry Density (g/cc)	1.57
	b) Optimum Moisture content (%)	20.1
	c) California Bearing Ratio (%) (Un-soaked)	4.29

The soil sample is mixed with steel slag with variable percentage like 5%, 10%, 15%, 20%, etc. The standard proctor test is performed on these combinations. The result is plotted as following.

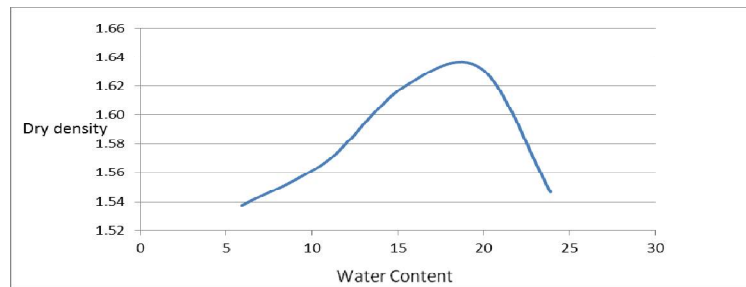


Fig. No. 3

Fig. No. 3 shows Influence of Steel Slag 5% on optimum moisture content and maximum dry density. The optimum moisture content is reduced to 19.9 % and maximum dry density is increased to 1.64 gm /cc by the addition of 5% steel slag

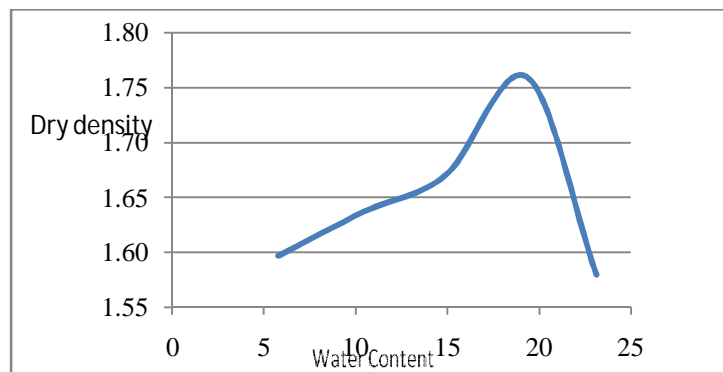


Fig. No. 4

Fig. No. 4 shows Influence of Steel Slag 10% on optimum moisture content and maximum dry density. The optimum moisture content is reduced to 19.3 % and maximum dry density is increased to 1.76 gm/cc by the addition of 10% steel slag.

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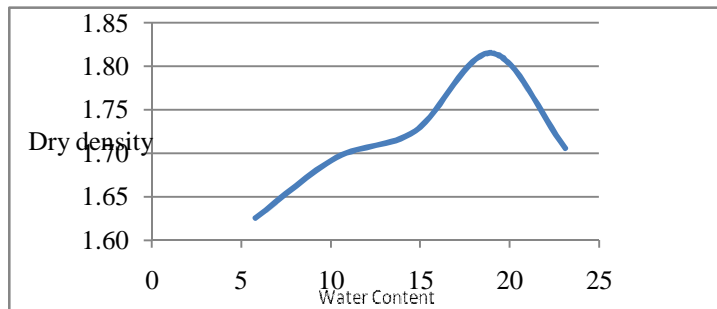


Fig. No. 5

Fig. No. 5 shows Influence of Steel Slag 15% on optimum moisture content and maximum dry density. The optimum moisture content is reduced to 19 % and maximum dry density is increased to 1.82gm/cc by the addition of 15% steel slag.

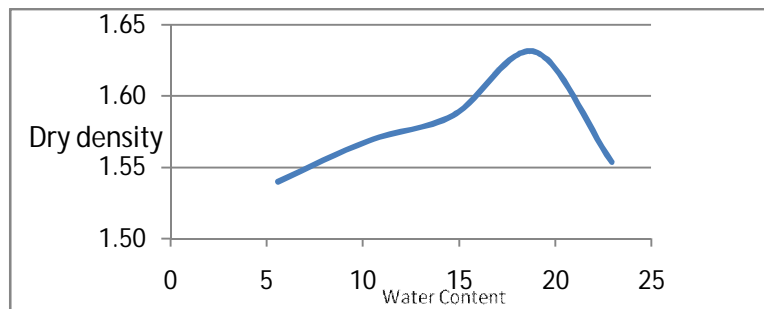


Fig. No. 6

Fig. No. 6 shows Influence of Steel Slag 20% on optimum moisture content and maximum dry density. The optimum moisture content is reduced to 18.9 % and maximum dry density is decreased to 1.63 gm/cc by the addition of 20% steel slag.

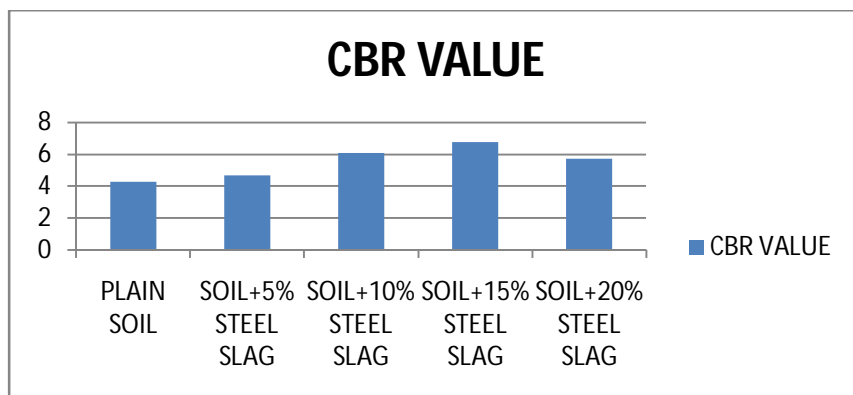


Fig. no.7

Fig. no.7 shows Effects of Steel Slag on unsoaked CBR test of black cotton soil. As the percentage of steel slag is added in black cotton soil the CBR value is increased up to 15%. The further increasing the addition of steel slag the CBR value is decreases.

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## V. CONCLUSION

In this project, strength characteristics of black cotton soil with steel slag have been studied. The following conclusions can be made based on the result. In geotechnical engineering application steel waste may be feasible. By the addition of steel waste in the poorly graded soil may improve the bearing capacity of soil. Also by using waste as an admixture it can reduce the cost of stabilization process and also due to use of waste it does not affect the environment.

- The liquid limit for black cotton soil is 52.63%
- With the addition of steel slag percentage in the maximum dry density in increasing in order and the optimum moisture content start decreasing.
- The CBR values is maximum with addition of 15% of steel slag afterwards the CBR values decreases with further addition of steel slag.

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