

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 8, August 2019

Experimental Study on Stabilization of Black Cotton Soil Using Steel Slag

Shadakshari gowda M S¹, Prashanth T R²,

Assistant Professor, Department of Civil Engineering, Tirumala Engineering College, Hyderabad, India

ABSTRACT: Expansive nature of black cotton soil generates lot many problems in pavement construction. It drastically affects the performance and life of the pavement. Thus for good performance and long life of road it is important to improve the properties of black cotton soil. This study deals with improving the properties of black cotton soil through addition of locally available industrial wastes as Foundry Sand, Steel Slag. Laboratory tests were conducted on various proportions of mixes of black cotton soil and industrial wastes 0% to 40% at the interval of 8%. The soaked CBR value untreated soil is 2.44%. The soaked CBR value of mix soil: Foundry sand in the proportion of 40:60 is 5.663% which is increased by 43.087% in comparison with untreated soil.

KEYWORDS: Stabilization, Black cotton soil, Index properties, CBR value

I. INTRODUCTION

Expansive soils also called as Black soils or Black cotton soils and Regur soils . In India expansive soils cover about 0.8×10^6 km² area approximately 20% of surface are. These soils are mainly found over the Deccan lava tract (Deccan Trap) including Maharashtra, Madhya Pradesh, Gujarat, Andhra Pradesh, Northern Karnataka. But in Karnataka these soils are widely prevalent in many parts of northern Karnataka, particularly Belgaum, Bijapur, Bagalkot and Gadag Districts of Karnataka.

Expansive soils expand due to the clay content. Expansive soils have a relatively high percentage of clay minerals and are subject to changes in volume with changing moisture conditions. The mineral for most expansive clay soil damage includes steatite and montmorillonite (along with Bentonites and elite) which can swell up to 40 times its own size. The soil under a house swells and shrinks with the seasons. This movement is not a problem as long as it is uniform or not great enough to damage the foundation and/or house. Damage to the house may appear and disappear on a regular basis as the seasons change. Significant defects occur when the movement is uneven or localized. Expansive soils contain clay or other minerals that cause them to expand when absorbing water. These soils often expand by 10 per cent or more during a rainfall. When the soils dry out, they shrink back to their original size.

II. LITERATURE SURVEY

Sanjeev tanaji jadhav, Sushma shekhar kulkarni (2014) carried laboratory investigations on the characteristics of black cotton soil by using foundry sand.

The addition of foundry sand decreases the liquid limit upto 40% by 33.82%, and the maximum dry density of soil increases upto 40% and then decreases. The CBR value also increases upto 40% by addition of foundry sand. From this investigation they conclude that the addition of foundry sand improves the drainage properties of soil by reducing liquid limit, and MDD increment helps us to provide good stable working platform mainly during rainy seasons, CBR value helps to increase the stability of the soil. So from this study the utilization of foundry sand is economical for stabilisation of subgrade soil.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 8, August 2019

Brajesh mishra,Assistant engineer U P(2014) presented the stabilisation of clayey soil using foundry sand

In percentage of 0 to 40% with an increment of 10%.According to the study,increase in percentage of foundry sand the MDD and CBR value of the soil foundry sand mixture initially increases upto certain value but on further addition of foundry sand in soil the values of MDD andCBR shows the decreasing trend,it conclude that there exist a optimum % of foundry sand which is responsible for increasing the sterngth of soil.On the basis of this study it can also conclude that foundry sand is used for stabilisation of weak soil subgrade material to improove the strength of soil and hence increase in CBR value will result in reduced crust thickness of road resulting in saving of construction cost.

Kiran B Biradar,U Arun kumar,Dr PVV Satyanarayana from Vizag(AUCOE)AP presented a comparative study on Influence of Steel slag and Fly ash on the strength properties of clayey soil.

From the results of his study shows the marked reduction of liquid limit and plasticity index of the clay for increase in the % of Steel slag and Fly ash. Increase in Steel slag(40%) reduces the OMC by 39.24% and also density of soil is increases upto 9.20% for (50%).The value of CBR is increases from 1.82% to5.20% with increase in steel slag upto 50%.

Conclusion from Literature survey:

From the above literature review, for our case the percent of foundry sand is varied accordingly to the literature survey as 8% , 16%,24% , 32% and 40% , correspondingly the steel slag sand is varied as 8% , 16%,24% , 32% and 40%.for each percent mix of steel slag sand with soil.

III.MATERIALS AND METHODOLOGY

GENERAL

Soil is one of the most important engineering materials. Determination of soil conditions is the most important first phase of work for every type of civil engineering facility. Soil properties are determined by both field and laboratory test methods. In this chapter, we will discuss the several laboratory tests that are performed to determine different properties of soils. These properties are essential for the design of foundation and earth structures.

MATERIALS FOR STUDY

For this experimental investigation black cotton soil is used as representative weak soil and steel slag as admixture.

BLACK COTTON SOIL

A black cotton soil procured from Kowshika Village, Hassan is used as a representative soil in the present study. This soil was collected from an open excavation, at a depth of 1m to 1.5m below the natural ground surface

Geo technical properties of Black Cotton soil

SL NO	PROPERTIES	RESULTS	RELEVANT IS CODE
1	Grain Size Distribution (%)	Gravel-0	IS 2720 Part 4
		Sand-10	
		Silt and clay-25&65	
2	Specific Gravity (G)	2.644	IS 2720 Part 3
3	Liquid Limit (WL) (%)	56	IS 2720 Part 5

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 8, August 2019

4	Plastic Limit (WP) (%)	28.57	IS 2720 Part 5
5	Plasticity Index (IP) (%)	36	IS 2720 Part 5
6	Optimum Moisture Content (O.M.C) (%)	18	IS 2720 Part 8
7	Maximum Dry Density (M.D.D) (G/cc)	1.627	IS 2720 Part 18
8	Unconfined compression strength (U C S)(KN/m ²)	113.4	IS2720 Part10
9	California Bearing Ratio (C.B.R) (%)	2.44	IS 2720 Part 16

STEEL SLAG

Steel slag can be used as a lightweight fill and in engineered fill applications to find new ways of utilizing them in construction industry. In the current research work the steel slag is used as a replacement material for soil. The replacement for soil by steel slag is done from 10 to 40 percent by weight of soil. This method is followed to maintain the balance between the utilization of natural available soil and industrial waste product. The waste steel slag procured from **JSW Bellary district** was used in the present work.

Physical properties of waste foundry sand and waste slag sand are as tabulated

SL NO	PROPERTY	VALUE OF SLAG SAND
1	Colour	White ,light grey
2	Sp gravity	2.6235
3	Liquid limit	-
4	Plastic limit	-
5	Cu	2.64
6	Cc	1.25

TEST CONDUCTED ON BLACK COTTON SOIL

The purpose of this investigation is to study the physical and engineering properties of the black cotton soil. The following tests were conducted on black cotton soil:

1. Grain size analysis.
2. Specific gravity test
3. Atterberg's limits
4. Standard proctor compaction test
5. California bearing ratio test [CBR test]

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 8, August 2019

IV.RESULT AND DISCUSIONS

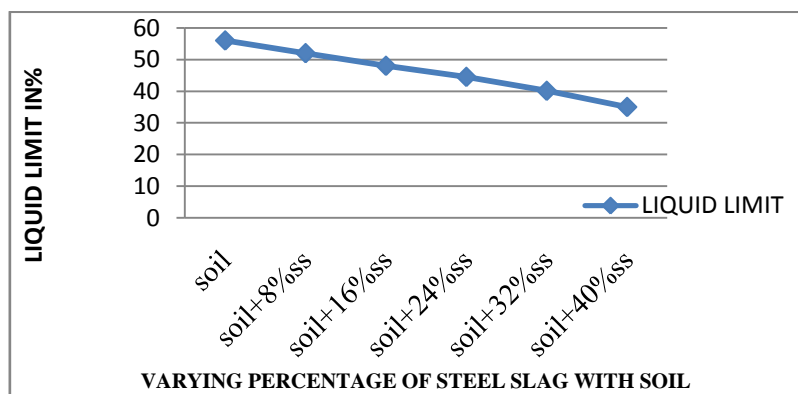
GENERAL

The test results obtained from liquid limit, plastic limit, compaction, California bearing ratio's for representative soil and soil treated with varying percentage of foundry sand and steel slag are discussed with aid of graphical representation are presented .

LIQUID LIMIT

The liquid limit for all the samples were obtained by Cone Penetration device IS 2720, Part 5, 1985

INFLUENCE OF STEEL SLAG ON LIQUID LIMIT

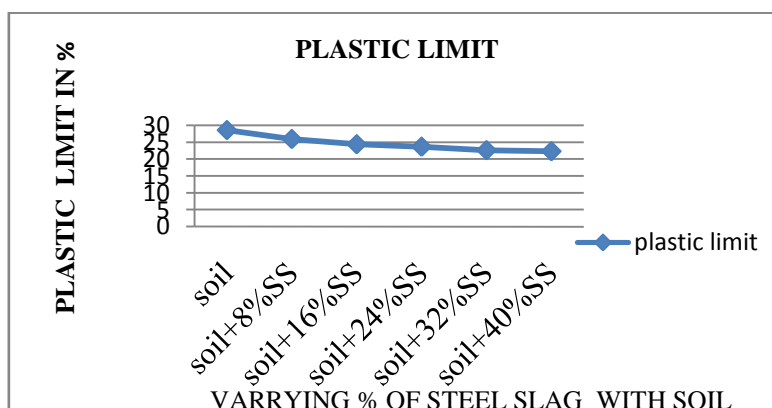


(NOTE: The addition of steel slag and foundry sand to the unmodified soil reduces the clay content and thus increases the percentage of coarser particles; in turn reduce in the liquid limit.)

PLASTIC LIMIT

The plastic limit of the various samples determined by Standard method test for determination of plastic limit of soil IS 2720 (part5)1985.

INFLUENCE OF STEEL SLAG ON PLASTIC LIMIT



International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

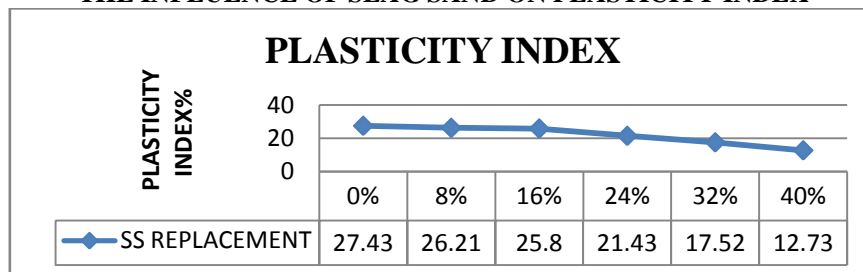
Visit: www.ijirset.com

Vol. 8, Issue 8, August 2019

(NOTE: The addition of steel slag to the unmodified soil reduces the clay content and thus increases the percentage of coarser particles; in turn reduce in the plastic limit.) ' steel slag reduces the liquid limit then other admixture due to non plastic nature of steel slag over other admixture

PLASTICITY INDEX

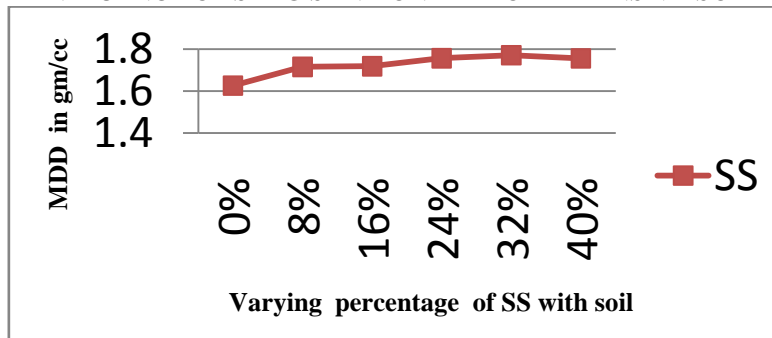
THE INFLUENCE OF SLAG SAND ON PLASTICITY INDEX



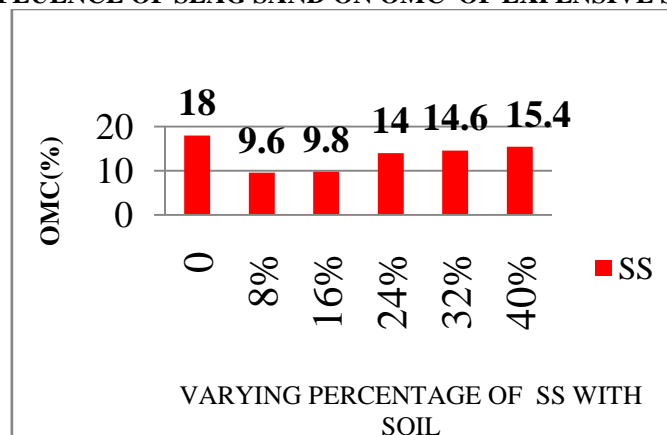
(Note) Addition of SS to the BC soil reduces the clay content of soil & then increase in % of coarser particles thus reduces the LL,PL&PI.

STANDARD COMPACTION

INFLUENCE OF SLAG SAND ON MDD OF EXPENSIVE SOIL



INFLUENCE OF SLAG SAND ON OMC OF EXPENSIVE SOIL



International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

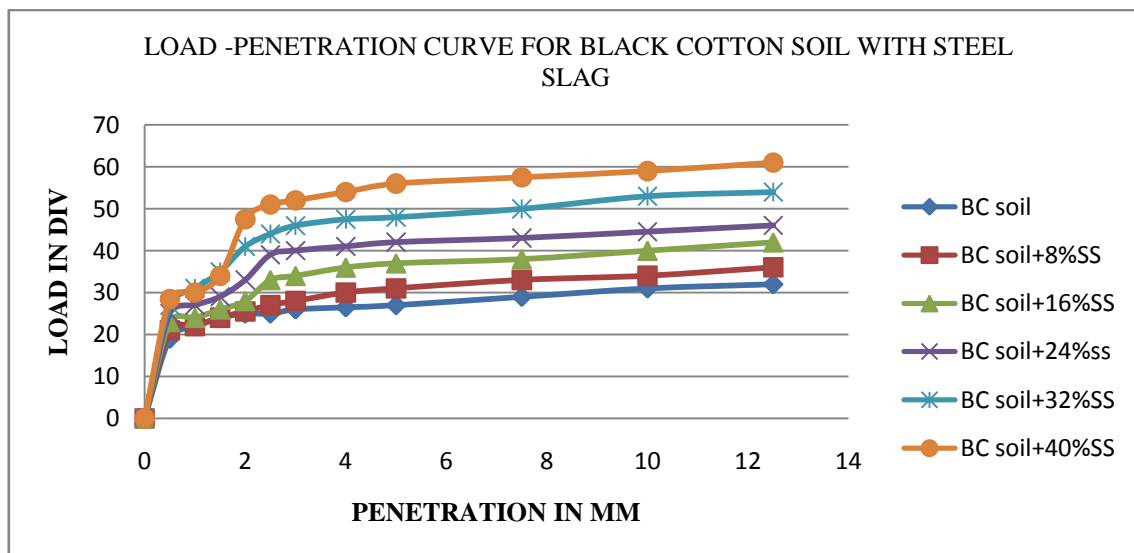
Vol. 8, Issue 8, August 2019

(Note) Generally addition of silt or sand to fine grained soil decreases the OMC and increases the MDD. Decrease in OMC mainly due to increase in size of the particles is coarser than BC soil, addition of coarser particle reduces the water holding capacity due to reduction of clay content.

CBR TEST

CBR test was conducted on both untreated and treated BC of soil. BC soil was treated with varying percentages of Steel slag. The SS added was 8%, 16%, 24%, 32%, 40% and 48%. And CBR test was conducted as per IS 2720 (part 16).

It was found CBR value at 2.5 mm penetration is higher than the CBR value at 5mm penetration. Hence the CBR is taken as penetration at 2.5mm only.



CBR CURVES FOR BC SOIL TREATED WITH DIFFERENT DOSAGES OF STEEL SLAG

V.CONCLUSION

The BC soil was initially tested for the basic properties ,basic properties of BCS are very weak ,then after the addition of admixtures FS and SS wastes for BCS gave considerable improvement in the geo technical properties of BCS.

With those geo technical properties test results the conclusions are drawn

- The basic laboratory test results showed that the soil belongs to clayey soil with high plasticity, low permeability, low strength & undergo high volume changes.
- The addition of SS (40%) reduces the LL from 56% to 35%, and PL from 28.57% to 22.27% . Reduction of LL & PL improves the drainage properties of soil sub grade.
- The addition of SS increases the MDD upto 32% from 1.627 to 1.7695 then decreases with further addition, it concludes that there exist a optimum % of SS which is responsible for increase in strength of soil. The increase in MDD helps to provide good stable working platform, mainly in rainy seasons.
- Addition of SS (40%) increases the CBR value of the BCS from 2.4 to 4.895 for SS. thus improves the bearing strength of soil.

On the basis of this study it conclude that SS is used for stabilization of weak soil sub grade material to improve the strength of soil & hence increase in CBR value will results in reduced crust thickness of road, resulting in saving of construction cost.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 8, August 2019

REFERENCES

- 1) Yan Liang, Wei Li, Xinghua Wang, "Influence of Water Content on Mechanical Properties of Improved Clayey Soil Using Steel Slag," in *SPRINGER, Geotech Geol Eng (2013) 31:83-91*.
- 2) Babita Singh, Amrendra Kumar and Ravi Kumar Sharma, "Effect of Waste Materials on Strength Characteristics of Local Clay", International Journal of Civil Engineering Research Volume 5, Number 1, pp. 61-68, 2014.
- 3) IS 2720: Part 5: 1985 Methods of Test for Soils- Part 5: Determination of Liquid and Plastic limit.
- 4) IS 2720: Part 7: 1987 Methods of Test for Soils- Part 7: Determination of water Content and Dry Density Relation Using Light Compaction.
- 5) Pankaj R. Modak, Prakash B. Nangare, Sanjay D. Nagrale, Ravindra D. Nalawade, Vivek S. Chavhan, "Stabilisation of Black Cotton Soil Using Admixtures," in (*IJEIT*) Volume 1, Issue 5, May 2012.
- 6) Saranjeet Rajesh Soni, P. P. Dahale, R. M. Dobale, "Disposal of solid waste for black cotton soil Stabilization", International journal of advanced engineering sciences and technologies Vol No. 8, Issue No. 1, pp. 113 – 120
- 7) E.A. Meshida, G.L.Oyekan, A.O.Ogundalu, "Effects of Steel Mill Dust on the Strength Characteristics of Black Cotton Clay Soils", International Journal of Scientific & Engineering Research, Volume 4, Issue 5, pp. 2242-2246, May-2013.