

Laboratory Study of Black Cotton Soil Blended With Copper Slag and Fly-Ash

P.Rajendra Kumar¹, P.Suresh Praveen Kumar², G.Maheswari³

Assistant Professor, Department of Civil Engineering, KSRM College of Engineering (Autonomous), Kadapa,
A.P., India¹.

Assistant Professor, Department of Civil Engineering, KSRM College of Engineering (Autonomous), Kadapa,
A.P., India².

M.Tech Scholar, Department of Civil Engineering, KSRM College of Engineering (Autonomous), Kadapa,
A.P., India³.

ABSTRACT: Expansive soil is one of the major soil deposits in India they exhibit high swelling and shrinkage when exposed to changes in moisture content and hence have been found to be most troublesome from engineering considerations. So there is a need to stabilize these soils when they are used for construction. In this regard, the expansive soil properties are found out. To this soil, as a first consideration, stabilized with copper slag adding at an interval of 5% reaching up to 30%. In second consideration, fly-ash is selected as a stabilizing agent to stabilize the expansive soil at an interval of 2%, reaching up to 10%. In the last consideration, sample of expansive soil with 30% copper slag is taken to be stabilized with fly-ash at an interval of 2% reaching up to 10%. Finally regression analysis for these test results is carried out.

KEYWORDS: black cotton soil, Copper slag, Fly-Ash, CBR.

I. INTRODUCTION

Soil stabilization is the process in improving the engineering properties of soils and thus making it more stable. It is essential when the soil accessible for construction is not suitable for the anticipated purpose. In its broadest sense, stabilization included compaction, reconsolidation, drainage and many other such process. However, the term stabilization is generally restricted to the processes which alter the soil material itself for improvement of its properties a cementing material or a chemical is added o a natural soil for the purpose of stabilization. Is to improve the natural soils for the construction of foundations, highways and airfields. Soil stabilization is used to reduce the permeability and compressibility of the soil mass n earth structures and to increase its shear strength. Soil stabilization is of stab required to increase the bearing capacity of foundation soils. However, the main use of the principles of soils stabilization are used for controlling the grading of soils and aggregates in the construction of bases and sub-bases of the foundations, highways and airfields. Soils stabilization is also used to make an area trafficable within a short period of time for military and other emergency purpose. Sometimes, soil stabilization is used for city and suburban streets to make them more noise-absorbing. The expansive soil is a very problematic soil these soils occur in up to 3.7m depth on average in India. The black soil is occupying nearly 30% of area. The black soils contain various sever our problem just like more shrinkage more swelling less strength and stability and having volumetric change. Based upon the seasonal change to avoid these problem used. Admixtures like poly propylene, polyethylene etc, the waste material occur from manufacture process these material are create not only environment problem but also create the hazardous and disposal problem that why to avoid this problem these waste material are used in the strengthens soils s admixtures are stabilization in the form of admixture. These are available in less cost or free of cost.

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II. REVIEW OF LITERATURE

1. **Prof. Jinka Chandrasekhar and Timir A Chokshi (2015)** discussed that Copper slag is one of the waste materials that are being used extensively in the civil engineering construction industry. Copper producing units in India leave thousands of tonnes of copper slag as waste every day. Large quantities of the accumulated slag is dumped and left on costly land, causing wastage of good cultivable land. Based on U.S. environmental protection agency regulations, governing solid waste characteristics, copper slag can be classified as a non-hazardous material. Granulated copper slag is more porous and, therefore, has particle size equal to that of coarse sand. In this paper, a review of the previous research studies carried out by various researchers on utilization of copper slag in geotechnical applications is discussed and presented.
2. Nalbantoglu et al. (2001) found that addition of fly ash decreases swelling potential in expansive soils. The hydraulic conductivity of treated soils was also found to increase with increasing lime or fly ash and with increasing curing time.
3. According to Pandian et.al, (2002) The addition of fly ash to BC soil increases the CBR of the mix up to the first optimum level due to the frictional resistance from fly ash in addition to the cohesion from BC soil. Further addition of fly ash beyond the optimum level causes a decrease up to 60% and then up to the second optimum level there is an increase.
4. filled area is greater

III. OBJECTIVE

The main objective of the present work is to study the physical and geotechnical properties of Expansive soils available at Pendlimari, Kadapa to study the strength properties of soil by addition of Copper Slag, Fly-Ash with water at different percentages i.e., 10%, 20%, 30%, 40% & 50% and Fly-Ash 2%, 4%, 6%, 8%, 10%.

IV. MATERIALS AND METHODOLOGY

Following are the materials which are used in the present study:

A. EXPANSIVE SOIL:

In this study, the investigation is carried out on soil samples which are collected at Pendlimari village near KADAPA which in black in colour with high moistures content. The following table shows the various soil properties obtained

Table 1 Expansive Soil Properties:

S.No	Property	Soil
1	Gravel (%)	10
2	Sand (%)	32
3	Clay (%)	58
4	Liquid Limit (%)	86
5	Plastic Limit (%)	39.71
6	Plasticity Index (%)	46.39
7	I.S.Classification	CH
8	Free Swell Index (%)	140
9	C.B.R (Soaked) (%)	1.80
11	Specific Gravity	2.34
12	Maximum Dry Density (kN/m ³)	1.46
13	Optimum Moisture Content (%)	30

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B. COPPER SLAG:

Copper slag is an industrial waste by product obtained by the manufacture process it is mettle smelting and reefing of copper. Present it is used in sand blasting, rail road ballast and also in cement and concrete industries. the copper slay is used for replacement of fine aggregated in concrete as in up to 15% by weight of copper slay is used as fly ash replacement together with up to 1.5% . The multiple extraction leading tests indicate that the elements present in the slag are stable and are not leachable even through repetitive leaching under acid rain in a natural environment the highest concentration of all the elements is for below the prescribed limits .It has been estimated that approximately 24.6million tons of slay are generated from the world of copper industry. Although copper slag is widely used in the sand blasting in and in the manufacturing of abrasive tools, the reminder is disposed of without any further reuse or reclamation. Copper slag possesses mechanical and chemical character to the copper slays C Copper slag procured from sterlite industries, tuticorin, and tamilnadu. The physical & chemical properties of the copper slag as provided by the manufacture are presented n the below tables respectively.

Table No 2 Physical Properties of Copper Slag

Property	Value
Colour	Black , glassy
Grain shape	Angular , multifaceted
Grain size	0.2-2.4mm
Bulk density	1.87g/cc
Moisture content	<0.1%

Table No 3 Chemical Properties of Copper Slag

Constituent	%weight
Silica SiO_2	26-30
Free silica	<0.5
Alumina Al_2O_3	1-3
Iron oxide Feo	42-48
Calcium oxide Cao	0.8-1.5
Magnesium oxide Mgo	0.8-1.5
Copper oxide cuo	0.6-0.7

C. FLY-ASH:

Large quantities of coal are being burnt in thermal power stations to meet the ever increasing demand for thermal power. Combustion of coal results in a residue consisting of inorganic mineral constituents and organic matter which is not fully burned. The inorganic mineral constituents from ash: about 80% of these ash sis fly ash. Environmentally safe disposal of large quantities of ash is not only tedious but also expensive. To reduce the problems of disposal, great efforts are being made to utilize fly ash.

Table No 4 Chemical Composition of the Fly-Ash

Name of the chemical	% by weight
Silica (SiO_2)	56.88
Alumina (Al_2O_3)	27.65
Ferric oxide (Fe_2O_3)	6.23
Titanium Di Oxide (TiO_2)	0.31
Calcium oxide (cao)	3.60
Magnesium oxide (Mgo)	0.34
Sulphate (SO_4)	0.27
Loss on Ignition (LOI)	4.46

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Table No 5 Properties of the Tested Fly-Ash

Property	Value
Specific gravity	2.12
Maximum dry density	13.5 kN/m ³
Optimum moisture content	20.7%
C B R value (unsoaked)	10.50%
C B R value (soaked)	3.15%

V. RESULTS AND DISCUSSION

The experimental tests are conducted on black cotton soil collected by using various percentages of Copper Slag and Fly-Ash.

A series of tests for untreated and treated soils using Copper Slag and Fly-Ash as a stabilizer are determined. The tests such as compaction, CBR, are done. The results are shown below for various tests:

A compaction test

Compaction is a mechanical process. While compacting it densities the soil by expulsion of voids from soil. OMC and MDD values are obtained by compaction. The results obtained are given below:

Table No: 6 MDD Values for Different Percentages of Copper Slag

Copper Slag (%)	0	5	10	15	20	25	30	35
M D D Values	1.46	1.54	1.68	1.79	1.89	1.94	2.06	1.80

CBR TEST:

Table No 7: Unsoaked and Soaked CBR Values For Various Percentages of Copper Slag

Copper Slag (%)	0	5	10	15	20	25	30	35
C.B.R (Un Soaked)	1.84	1.86	2.21	3.46	4.95	5.38	6.66	5.21
C.B.R (Soaked)	1.80	1.80	2.01	3.11	4.21	5.12	6.32	5.03

Table No 8: Unsoaked and Soaked Values for Various Percentages of Copper Slag and Fly ash

Copper Slag (%)	0	30% C.S+2% F.A	30% C.S +4% F.A	30% C.S+6%F.A	30% C.S+8 %F.A	30% C.S+ 10% F.A
Unsoaked	1.86	15.11	23.65	38.46	46.98	46.24
Soaked	1.80	14.74	23.31	35.90	45.56	31.05

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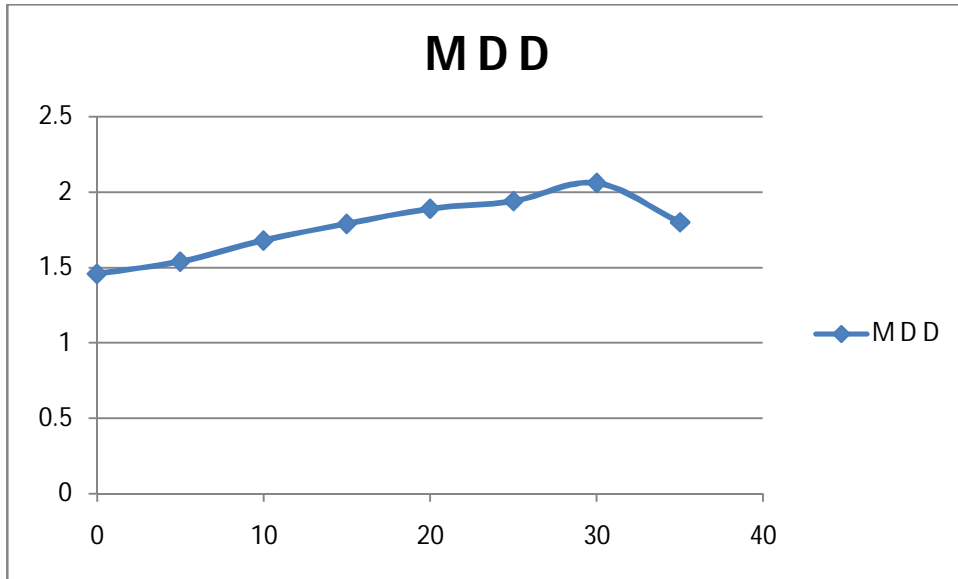


Fig No 1: Variations in the MDD Values of Soil for Various % of Copper Slag

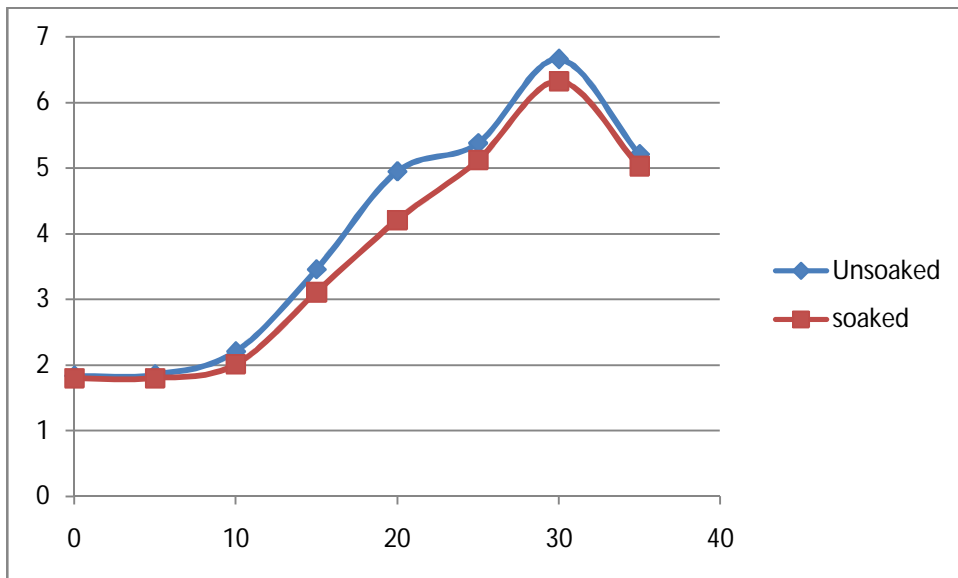


Fig No 2: Variation in the Unsoaked CBR Values of Soil for Various % of Copper Slag

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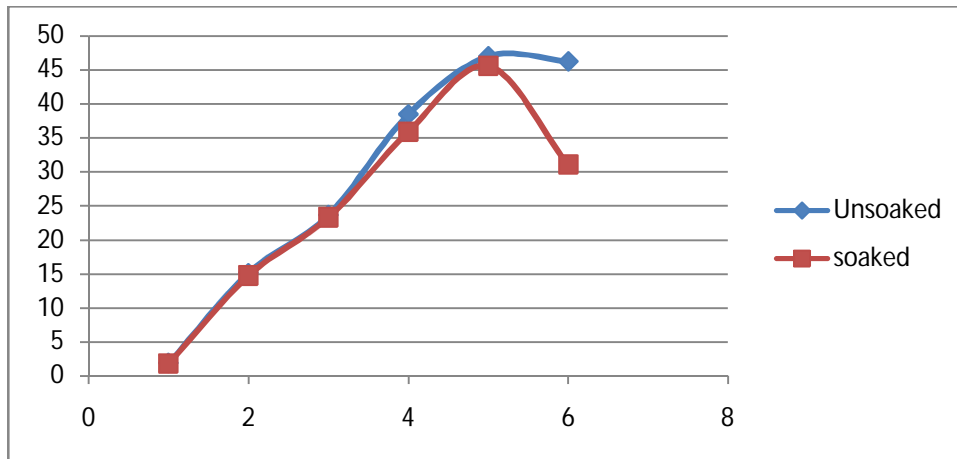


Table No: 9 CBR (%) of BCS and BCS Treated with 30% Copper Slag and Various Percentages of Fly Ash

S.No	Description	C.B.R (Unsoaked)	C.B.R (Soaked)
1	Soil	1.86	1.80
2	Soil+30% copper slag+2% fly-ash	15.11	14.74
3	Soil+30% copper slag+4% fly-ash	23.65	23.31
4	Soil+30% copper slag+6% fly-ash	38.46	35.90
5	Soil+30% copper slag+8% fly-ash	46.98	45.56
6	Soil+30% copper slag+10% fly-ash	46.24	31.05

Fig No 10: Variation in the Soaked CBR Values of Soil for 30% Copper Slag and Various Percentages of Fly-Ash

S.No	Description	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index I _p	Free Swell Index	O.M.C	M.D.D	C.B.R (Unsoaked)	C.B.R (Soaked)
1	Soil	86.1	39.71	46.39	140	30%	1.46	1.86	1.80
2	S+5% C.S	80.23	37.22	43.01	120	29.12%	1.54	1.84	1.80
3	S+10% C.S	76.34	35.62	40.72	100	28.91%	1.68	2.21	2.01
4	S+15% C.S	69.43	31.33	38.31	80	26.32%	1.79	3.46	3.11
5	S+20% C.S	56.32	29.24	27.08	60	24.82%	1.89	4.95	4.21
6	S+25% C.S	48.44	27.63	20.81	50	23.51%	1.94	5.38	5.12
7	S+30% C.S	38.22	24.81	13.41	30	20.52%	2.06	6.66	6.32
8	S+35% C.S	33.5	21.92	16.43	20	28.32%	1.80	5.21	5.03

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Table No 11: Regression Analyses

S.No	Formulas
1	$L.L = -1.6959L.L + 91.414$
2	$F.S = -3.3571F.S + 132.86$
3	$M.D.D = 0.0121M.D.D + 1.5729$
4	$C.B.R = 0.149C.B.R + 1.2543$
5	$C.B.R = 0.1451C.B.R + 1.04$
6	$C.B.R = 4.2795C.B.R + 8.411$
7	$C.B.R = 2.7435C.B.R + 13.651$



VI. CONCLUSION

Based on the test results finally concluded that:

- With increase in 5% to 30% of Copper Slag, Dry density increases from 1.46 to 2.06. The % increase in dry density is 48%.
- With increase in % of Copper Slag, Unsoaked CBR value increases from 1.86 to 16.66 indicating the increase of CBR value up to 495%.
- With increase in % of Copper Slag, Soaked CBR value increases from 1.80 to 6.32 indicating the increase of CBR value up to 67%.
- Addition of 30% Copper Slag is common with increase in % of Fly-Ash from 2% to 10% , Unsoaked CBR value increases from 6.66 to 46.24 indicating the increase of CBR value up to 395%
- Addition of 30% Copper Slag is common with increase in % of Fly-Ash from 2% to 10% , Unsoaked CBR value increases from 6.32 to 45.56 indicating the increase of CBR value up to 247%

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