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Effect on CBR Value of Soil by Using Steel Slag

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ABSTRACT: Soil stabilization is nothing but the modification of soils to enhance their physical and mechanical properties to improve theshear strength and load carrying capacity of the subgrade and to reduce the shrinkage property of soil. Black cotton soil is alwaysknown for its high fertility rate but when it comes to the construction it becomes the matter of concern. In order to utilize the industrialwaste, an attempt is made to stabilize the black cotton soil by adding steel slag. This project work aims to evaluate the effect of additionofsteelslagwithvariouspercentagestostabilizetheblackcottonsoilandtoverifyitssuitabilitytobeusedasaconstructionmaterialfor road, embankment and structural fills. In the first phase, the physical engineering properties of the black cotton soil samples werestudied by conducting CBR test on plain black cotton soil whereas in the second phase of the test, black cotton soil was mixed with 5%,10% and 15% of steel slag as percentage of dry weight of black cotton soil. It is found that the properties of black cotton soil mixed withsteel slag are suitably improved.

Index Terms - BC soil, soil stabilization, CBR, Steel slag.

I. INTRODUCTION

Now a day, large acres of land is occupied by industrial waste which not only creates landfilling problem but also leads to adverseimpact on the environment. Steel slag is one of the industrial waste which is generates from steel and iron industry as it's byproduct.Asitisaresiduematerialitisbeingdumpedopenlyonthelargerscalewhichmaybeoneofthereasonsforsoilpollution.So, in spite of dumping slag into the ground it can be used as a soil stabilizer. Soils vary throughout the globe and engineeringproperty of soils are equally variable. Black cotton (BC) soil is inorganic clays of medium to high compressibility and acquiresmajor soil group in India. They possess high swelling and shrinkage properties and because of these properties of BC soil, itbecomeschallengeforstructuralengineerstoworkinsuchterrain.Soit'sbecomeverynecessarytofindoutany suitableingredientor material which can strengthen all engineering properties of BC soil to make the structure more firm. There are so manystabilizingmaterialsavailablebutsteelslagisoneofthematerialswhichnotonlyprovidebetterstabilitytoBCsoilbutalsomakesthe structure more economical. In the present study properties of BC soil are evaluated by replacing soil by various percentage ofsteelslag.ItisfoundthatpropertiesofBCsoilshowncnsiderableimprovementafterthepartialreplacementbysteelslag.

1.1 OBJECTIVE OF STUDY

1. TO ENHANCE THE PROPERTIES OF BLACK COTTON SOIL BY USING STEEL SLAG.
2. TO EVALUATE STABILITY OF BC SOIL BY PARTIAL REPLACEMENT BY STEEL SLAG AT VARIOUS PERCENTAGE.
3. TO DETERMINE OPTIMUM AMOUNT OF STABILIZER REQUIRED TO STABILIZE THE BC SOIL AND MAKE THE STRUCTURE ECONOMICALWITH THE GREATER STRENGTH AND STABILITY.

1.2 Material to be used

I. 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 changesin moisture content and hence have been found be most troublesome from engineering consideration. The rate of montmorilloniteis more in black cotton soil which causes expansiveness and crack occurs in soil without any warning which is dangerous forconstruction. Black cotton soils are formed by lava basaltic rocks. Hence they are very dark in color. They develop cracks duringdry period and swell if got moisture, hence they are self-tilling in nature, that's why they are fertile and can hold water for longtime. Black cotton soils are generally

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clayey, deep and impermeable. These soils expand and become sticky during rainy seasonand contract during the dry season causing deep cracks into the soil.

Fig -1: Dry Black Cotton Soil

Blackcottonsoiliscomparativelypoorforconstructionpurposethananyothersoils.SomeofthebasicpropertiesofBCsoilsampletakenforthestudyarementionedinTableNo.1

Sr. No.	Properties	Soil
1.	Liquid limit (%)	59.79
2.	Plastic limit (%)	36.8
3.	Plasticity index (%)	22.19

Table -1: Properties of BC Soil

II. STEEL SLAG

Steel slag is produced at steel industry during steel manufacturing. To produce steel, removal of excess silicon and carbonfrom iron is achieved through oxidation by adding limestone and coke. The steel slag contains higher amount of iron and itsphysical characteristics are similar to air-cooled iron slag. The fines are utilized in sinter making and lumps are charged in theblast furnace(BF). Theiron contentis the majorbasic differencebetween BF slagand steelslag.InBFslag,FeOisaround0.5%,whereas,incaseofsteelslag,totalironcontentvariesfrom16to23%.

Fig -2: Steel slag

III. METHODOLOGY

During the laboratory experiments, The BC soil sample was crumbled, and then it is finely sieved in order to remove otherimpuritieslikebigstonesandvegetation.Aftergetinggentlesoilsampleitsoakedinwaterfor24hours.Afterdryinginoven,thevariousspecimenofBCsoil wasthentestedwithoutadding steelslagfortheAtterberg'slimits,accordingtoasperIS:2720(Part5)1985.Afterperformingliquidlimit,plasticlimitandplasticityindextests,Californiabearingratio(CBR)testwasconductedonplainsoilspecimens.Afterconductingtestonplain BCsoilspecimenthesoilsamplewerepartiallyreplacedbyvariouspercentageofsteelslag.Comparisonoftestresultsobtainedforplainsoilsampleandsamplewiththepercentageofsteelslagisdemonstratedintheresultsanddiscussion.

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1.1 CALIFORNIA BERAING RATIO TEST

TheCaliforniabearingratioisapenetrationtestforevaluationofthemechanicalstrengthofroadsubgradesandbase-courses.The test is performed by measuring the pressure required to penetrate soil sample with a plunger of standard area. The measuredpressureisthendividedbythe pressure required to achieve an equal penetration on a standardcrushedrockmaterial.Itistheratioofforceperunitarearequiredtopenetrateasoilmasswithstandardcircularpistonattherateof1.25mm/min.tothatrequiredforthecorrespondingpenetrationofastandardmaterial.

CBR(%)=(Pressureonplunger/StandardPressure)X 100

Fig -3: CBR Test Mould

IV. RESULTS AND DISCUSSION

a) CBR Test on plain BCsoil

Table -2: Penetration and Load value for CBR

Penetration (mm)	Dial GaugeReading	LoadKg
0	0	0
0.5	27	12.03
1	69	19.65
1.5	109	26.47
2	145	31.38
2.5	171	34.80
3	182	41.29
3.5	206	48.87
4	226	54.83
4.5	232	61.05
5	244	66.23
5.5	265	70.89
6	279	73.96
2.5 mm CBR	**25.40%**	

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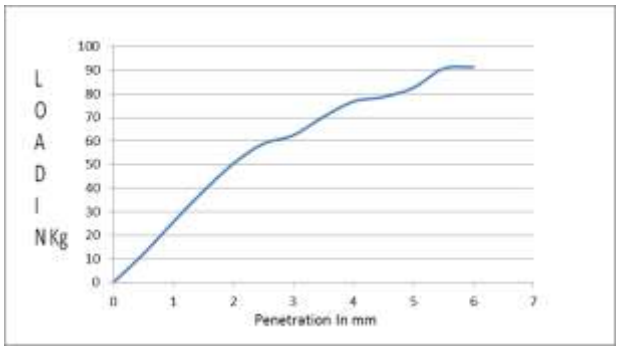

Chart -1: Penetration Vs Load in Kg

Inthetableno.2valueofloadandrespectivepenetrationareobtainedforplainblackcottonsoilsample.TheCBRvalueobtainedfromthetableis4.14%whichshowstheBCsoilpossessthelesserstrengthandstabilityagainsttheshearfailure.

b) CBR TEST ON PLAIN SOIL + 5% STEELSLAG

Table -3: Penetration and Load value for CBR

Penetration (mm)	Dial GaugeReading	LoadKg
0	0	0
0.5	43	13.98
1	87	28.28
1.5	127	41.28
2	178	57.85
2.5	197	64.03
3	211	68.58
3.5	237	77.03
4	253	82.23
4.5	273	88.73
5	283	91.98
5.5	292	94.90
6	297	96.53
2.5 mm CBR	**4.67**	

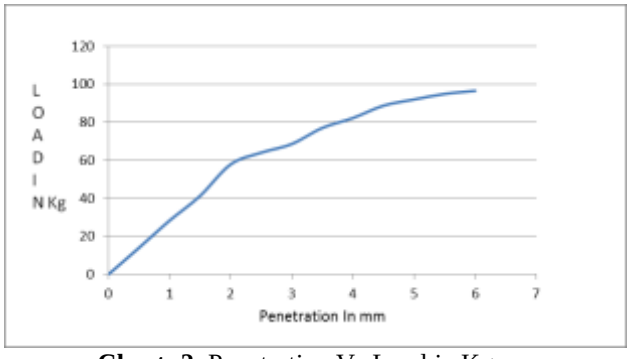

Chart -2: Penetration Vs Load in Kg

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Inthetableno.3penetrationobservedforcorrespondingloadincaseof BCsoil+5steelslagsample.CBRvalueobtainedfromthetableno.3is4.67%.

c) CBR TEST ON PLAIN SOIL + 10 % STEELSLAG

Table -4: Penetration and Load value for CBR

Penetration (mm)	Dial GaugeReading	LoadKg
0	0	0
0.5	56	18.20
1	94	30.55
1.5	132	42.90
2	198	64.35
2.5	256	83.20
3	279	90.68
3.5	302	98.15
4	328	106.60
4.5	352	114.40
5	376	122.20
5.5	397	129.03
6	401	130.33
2.5 mm CBR	**6.07**	

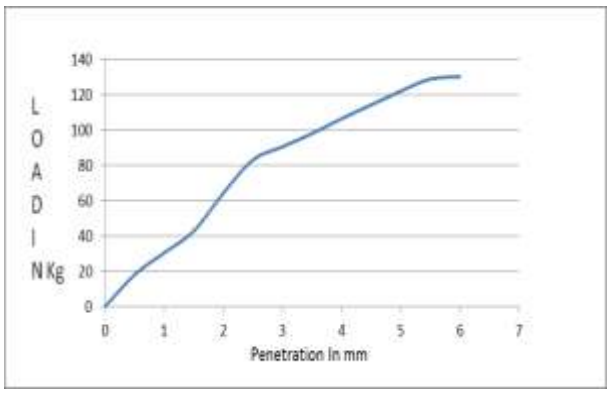

Chart -3: Penetration Vs Load in Kg

Tableno.4showsthepenetrationvaluesobtainedoncorrespondingloadapplicationforBCsoilsampleaddedwiththe10% ofsteelslag.This10%additionofslagshowsconsiderableimprovementinCBRvaluethanthatplainBCsoilsample.

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d) CBR TEST ON PLAIN SOIL + 15 % STEELSLAG

Table -5: Penetration and Load value for CBR

Penetration (mm)	Dial GaugeReading	LoadKg
0	0	0
0.5	66	21.45
1	112	36.40
1.5	176	57.20
2	239	77.68
2.5	286	92.95
3	312	101.40
3.5	345	112.13
4	379	123.18
4.5	391	127.08
5	408	132.60
5.5	436	141.70
6	455	147.88
2.5 mm CBR	**6.78**	

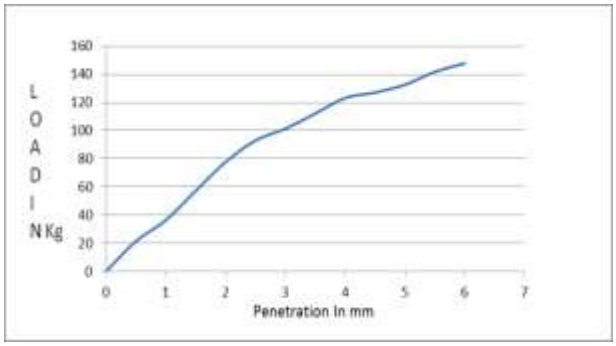

Chart -4: Penetration Vs Load in Kg

Ontheadditionof15%steelslaginBCsoil,CBRvalueshowstheconsiderableimprovementwhichsymbolizesuseofsteelslaginBCsoilmakeitgreaterstrengthwitheconomy.

e) Effect of various percentage of steel slag on BCsoil

Bycalculating CBRvalue forplain BCsoil andalso forvarious percentageof steelslag with it,the comparativeanalysishasdoneforevaluatingtheeffectofsteelslagontheCBRvalueofBCinfollowingtableno.6

Table -6: CBR value for different BC soil samples

BC SOIL SAMPLE	**CBRVALUE**
PLAIN SOIL	2.40
SOIL+5% STEELSLAG	4.67
SOIL+10% STEELSLAG	6.07

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SOIL+15% STEELSLAG	6.78

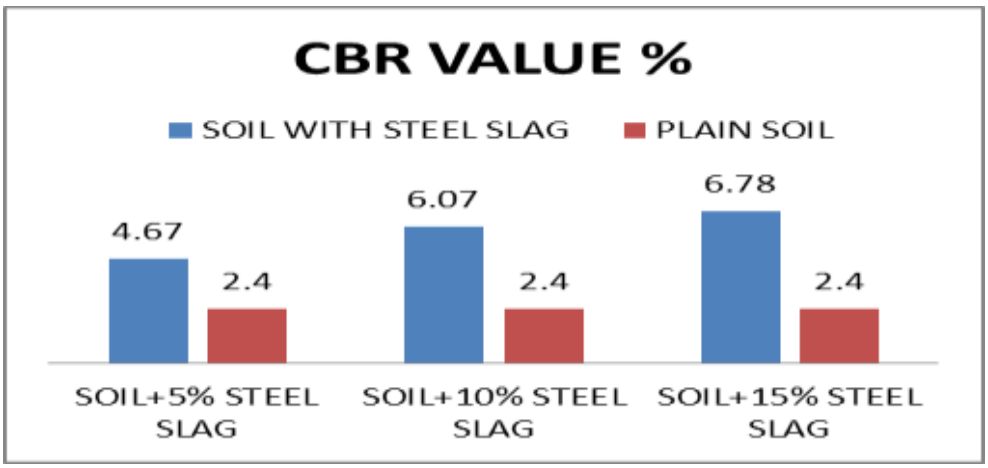

Chart-5:CBRvalueforplainandvariousSteelslagmixedBCsoilsample

Fromtheobtainedchart no.5 it is clear that asthe percentageofsteelslagincreasesinthesoilsamplethent hebearing capacity ofthe BC soil against the load also increases

V. CONCLUSION

Thestudyhasbeenconductedtoassessthepot entialofthesteelslagtostabilizetheBlackcottonsoil.B Csoilwasmixedwiththe various percentage of steel slag (5,10 and 15%). Performance of the black cotton soil is evaluated experimentally by CBRtest. The results of CBR for plain BC soil and sample mix with the various percentage of BC soil indicates that, the use of slagsignificantlyimprovedandstrengthenedtheprope rties ofBCsoilinwhichitwaspoor.Thereissignificantreduct ioninswellingbehavior of soil. In this study it is found that sample with 5% addition shows 48.60% increment in CBR value of plain BC soilwhereasitis60.46%and64.60%forthesoilsample withadditionofslag.10and15%respectively.Presentp aperconcludesthatsteelslagisoneoftheeconomicalma terialsandthatcanbeusedasagoodstabilizerforBCsoil sforstrengtheningitsengineeringproperties.

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