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MANAGEMENT**
**STUDY ON CALIFORNIA BEARING RATIO OF BLACK COTTON SOIL
USE WASTE COPPER SLAG**

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Abstract

Black cotton soil is one of the major regional soil deposits in India, covering an area of about 3.0 lakh sq.km. black cotton soils soil in India are highly problematic, extensive research is going on to find the solutions to black cotton soil. Use of waste materials in road construction has been in vogue in India for quite some time. This is particularly necessitated by the problems of disposal associated with it. Otherwise, these materials would cause problems to the environment. In this research paper result CBR value of Black cotton soil use waste copper slag. Copper slag is one waste byproduct produced by The Sterlite Industries-I Ltd. new delhi (SIIL), India. the production of copper slag is 120-130 lakh ton per annum.copper producing units in India leave thousands of tonnes of copper slag as waste every day, granulated copper slag is more porous and, therefore has particle size equal to that of coarse sand. the previous research studies carried out by various researchers on utilization of copper slag in clayey soil results for good soil stabilizations 2% to 30%. Further we use this ratio for black cotton Soil. We use copper slag to determine C.B.R.values of black cotton soil. The paper presents the results of high value of soaked CBR (4 Days) 5.43% in combination of 72% B.C. soil and 28% copper slag and further it tends to decrease.

Keywords :- Copper slag (C.S.), Black cotton soil (B.C.), MDD, OMC and CBR test.

INTRODUCTION

Copper slag is a by product formed during the copper smelting process. Copper slag is an abrasive blasting grit made of granulated slag from metal smelting processes (also called iron silicate).As refining draw metal out of copper ore,they produce a large volume of non-metallic dust,soots and rock. Collectively,these materials make up slag,which can be used for a surprising number of application in the building and industrial fields.

This material represents a popular alternative to sand as a blasting medium in industrial cleaning. Using blasting or high-pressure spraying techniques, companies can use copper slag to clean large smelting furnaces or equipment. Slag blasting is also used to remove rust, paint, and other materials from the surface of metal or stone. This helps to prep the surface for painting, or simply to remove unwanted finishes or residue.

Copper slag abrasive is suitable for blast cleaning of steel and stone/concrete surfaces, removal of mill scale, rust, old paint, dirt etc.Copper slag blasting grit - is manufactured of the granulated slag of copper refineries, and used for blast-cleaning of metal surface. In different industries it is called different names - abrasive powder, grit, copper slag grit, mineral grit, grinding grains, etc. - but its main use is still for surface blast-cleaning.

Blasting the grit at the surface is the most advanced approach for metal surface cleaning before paint spraying. The blasting media manufactured from copper slag brings less harm to people and environment than sand. The product meets the most rigid health and ecological standards.use of industrial byproducts and wastage in the soil stabilization for road and other type of the construction work is been adapted. At the same time, disposal of industrial waste or by-products has become more difficult and expensive as a result of the increasing stringent

environmental regulations and shortages of suitable, nearby disposal sites Industrial byproducts also creates environmental hazard as they may be toxic for environment. this research was done on the engineering behavior of Black cotton soil when stabilized with copper slag.

MATERIALS USED

Copper Slag : Copper slag were collected from The Sterlite Industries-I Ltd new delhi, India, in collection.

the physical properties of copper slag were explained in Table 1 and chemical composition in Table 2 and shown in fig. 1.

Black cotton soil : Black cotton soil were collected from Shri G.S. Institute of Technology & Sciences, Indore M.P. the soil was used in experimental program and it was classified as high compressibility of clay (CH) according to Indian standard soil classification system (ISSCS). the physical properties of Black cotton soil were explained in Table 3.

S.No.	Physical Properties	Value
1	Particle shape	Irregular
2	Appearance	Black & glassy
3	Specific gravity	2.9-3.9
4	% of voids	43.20%
5	Bulk density	2.08 g/cc
6	Fineness modulus	3.47
7	Angle of internal friction	5' to 20'
8	Moisture content	0.10%
9	IS classification	SP

Chemical Property	(% wt)
Iron oxide (Fe ₂ O ₃)	42-48
Silica(SiO ₂)	26-30
Aluminum oxide(Al ₂ O ₃)	1.0-3.0
Calcium oxide(CaO)	1.0-2.0
Manganese oxide (MgO)	0.8-1.5

Data from - Birla Copper Unit Industries, Dahej. Gujarat, India.

S.No.	Soil Properties	Values
1	Specific gravity	2.57
2	Liquid limit (%)	52.70%
3	Plastic limit (%)	26.25%
4	Plastic index (%)	26.45%
5	Indian Standard soil classification based on	CH

	plasticity chart	
6	compaction study optimum moisture content	18%
7	Maximum dry density	1.58 gm/cc
8	Depth	1.5m

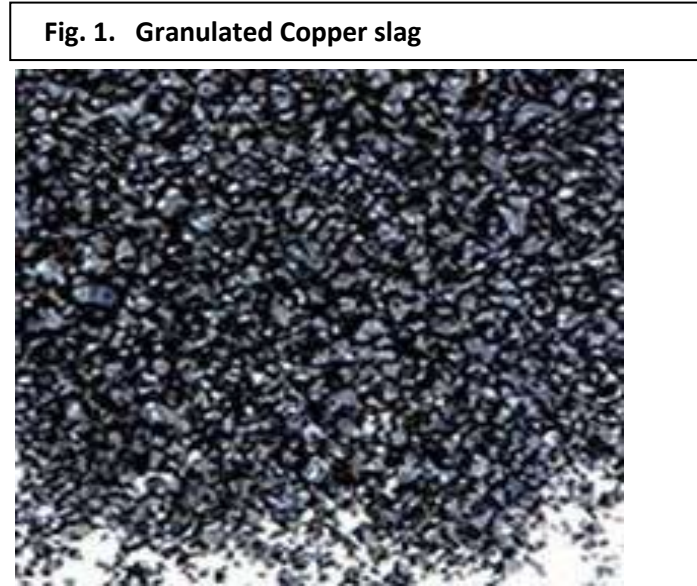


Fig. 1. Granulated Copper slag

TEST RESULTS

Grain Size Analysis

Copper slag has carried out as per Indian Standard procedure (IS 2720 part- 4).The particle-size distribution of Copper Slag is obtained with the help of sieve analysis.The particle size distribution curve was shown in Fig. 2 and B.C. Soil size distribution curve was shown in Fig. 3.

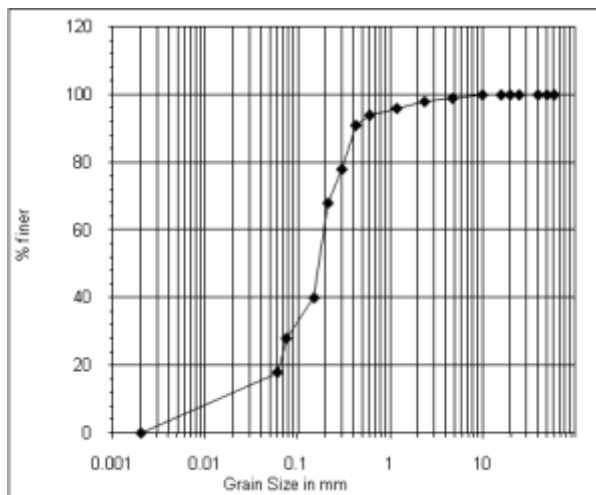


Fig.2. Particle size distribution curve of Copper slag

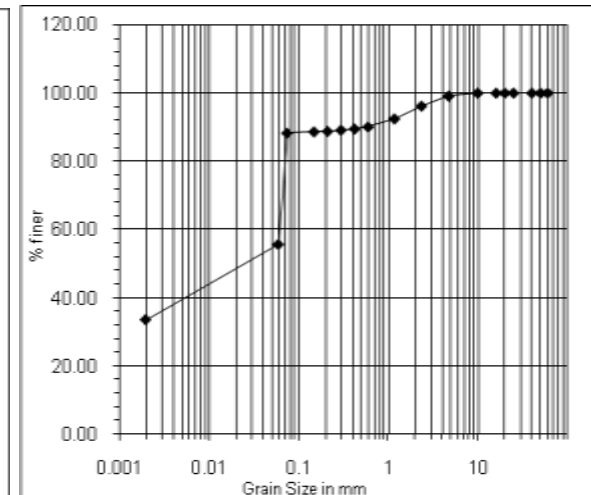


Fig.3. Particle size distribution curve of B.C.soil

Chemical Analysis Report

The chemical composition of CaO = 26%, MgO = 0.8%, SiO₂ = 26%, Fe₂O₃ = 42%, Al₂O₃ = 1% and loss on ignition = 4.2%. The combined percentage of silica, alumina, and iron oxide in copper slag as natural pozzolana as per ASTM C618 (1999).Therefore,

Copper Slag was expected to have good potential to produce high quality pozzolanas.very less amount of MgO (0.8%) The summation of silica, alumina,Calcium,Magnesium and iron oxide in copper Slag was 95.8%. So it has good potential to produce high quality pozzolanas.

Mechanical Properties

Compaction Characteristics

Standard Proctor Test was carried out as per Indian Standard Procedure (IS:2720 part-7).The optimum moisture content (OMC) and maximum dry density (MDD) of the B.C. soil are found as 18% and 1.58gm/cc and for combination 68% B.C.soil with 32% C.S. was 18% and 1.90gm/cc .The variation in dry density w.r.t. change moisture in the various combinations of B.C.soil and copper slag were shown in Fig. (4 - 20). The values of maximum dry density and optimum moisture content of various

combinations were shown in Table 4 and fig. 38.

California Bearing Ratio Test

California Bearing Ratio (CBR) test was carried out as per Indian Standard procedure (IS 2720, Part-16). It was observed that soaked CBR (4 Days) values of combinations of B.C.soil and copper slag were in the range 1.98 - 5.43 %, while CBR values of 72 % B.C. soil with 28 % C.S. have high CBR value 5.43% and further it tends to decrease. CBR was 5.32%, 70% B.C Soil with 30% C.S. combination and CBR was 5.26%, 68% B.C Soil with 32% C.S. combination so decrease results. results various combination to C.S with B.C. soil were shown in Fig. (21-37) Table 4 and fig.39.

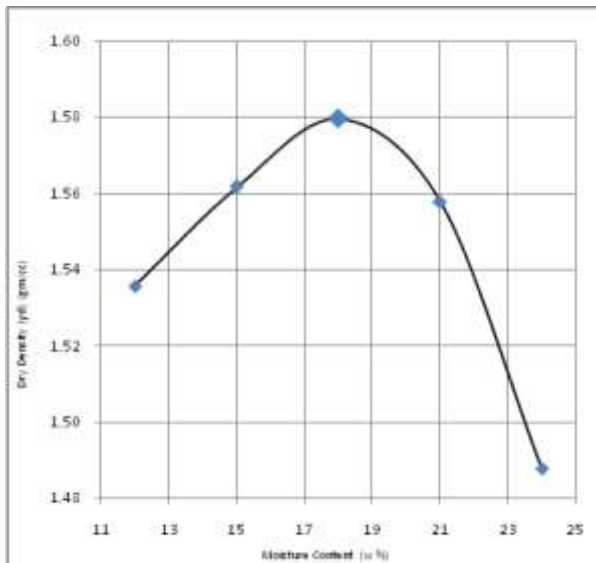


Fig. 4. Variation in Dry Density with moisture in 100% B.C. Soil

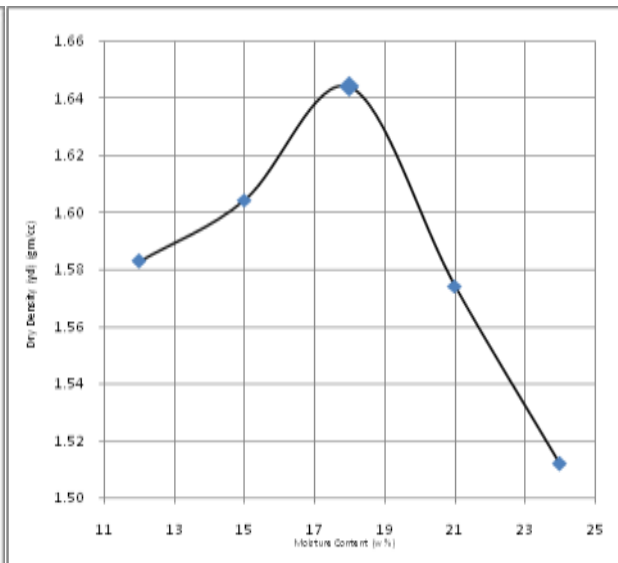


Fig. 5. Variation in Dry Density with moisture in 98% B.C. Soil with 2% C.S.

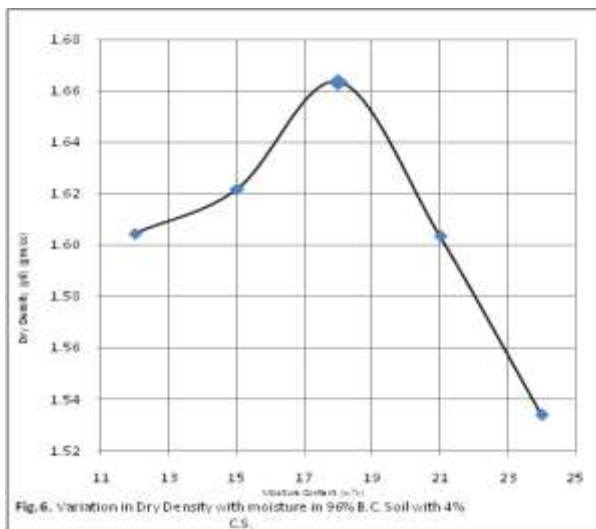


Fig. 6. Variation in Dry Density with moisture in 96% B.C. Soil with 4% C.S.

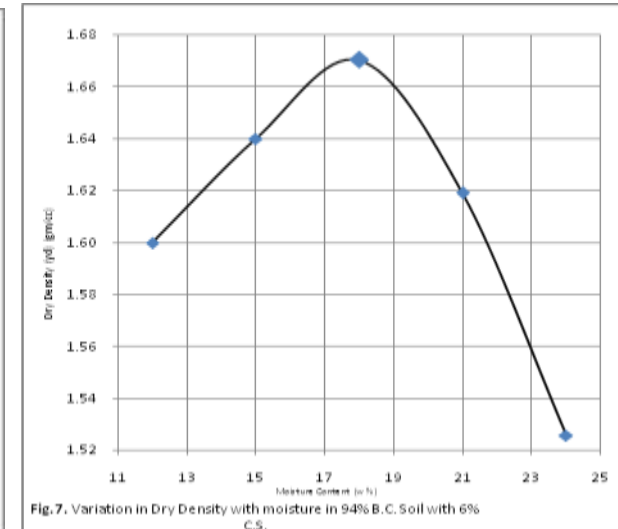


Fig. 7. Variation in Dry Density with moisture in 94% B.C. Soil with 6% C.S.

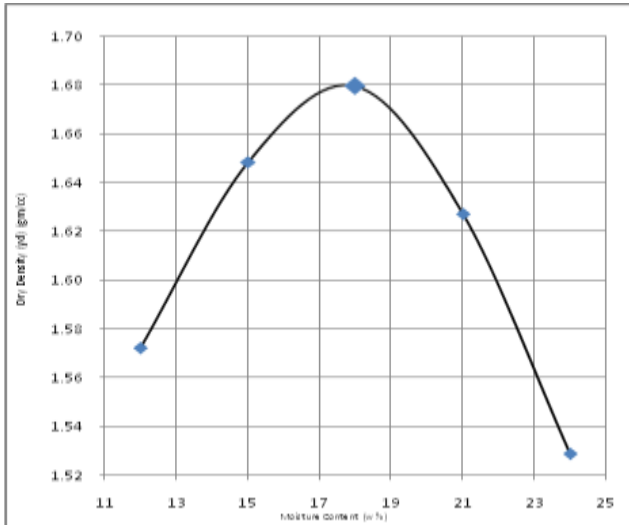


Fig. 8. Variation in Dry Density with moisture in 92% B.C. Soil with 8% C.S.

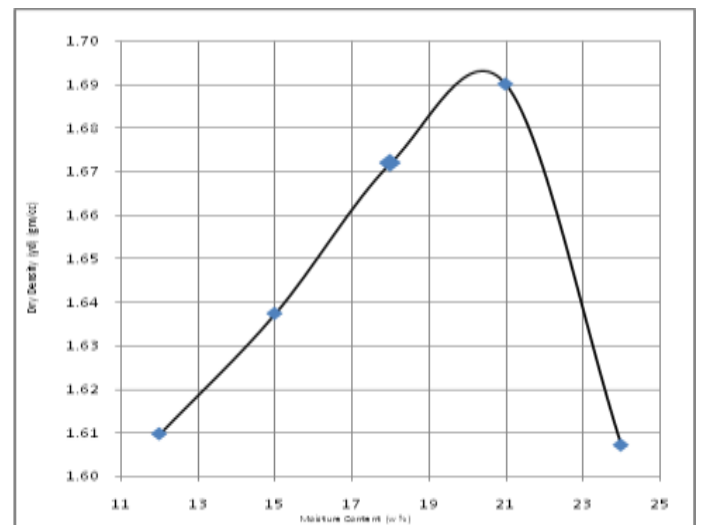


Fig. 9. Variation in Dry Density with moisture in 90% B.C. Soil with 10% C.S.

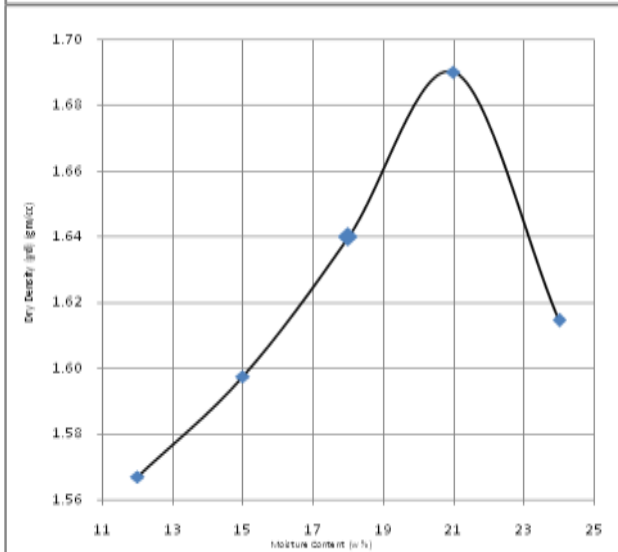


Fig. 10. Variation in Dry Density with moisture in 88% B.C. Soil with 12% C.S.

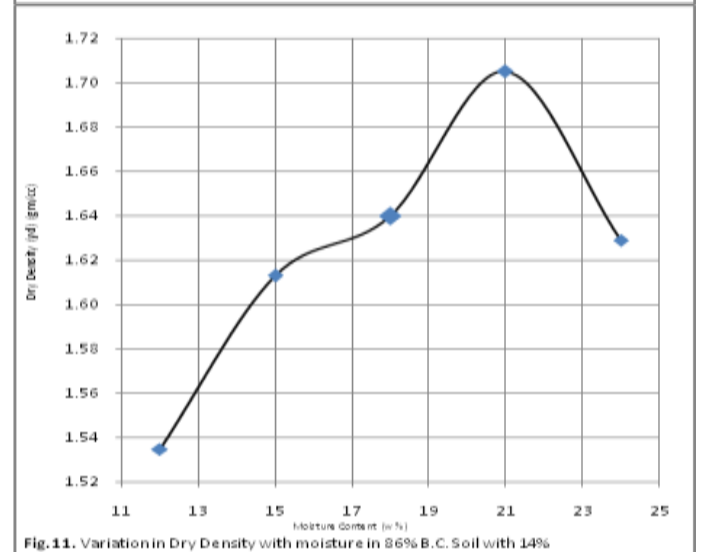


Fig. 11. Variation in Dry Density with moisture in 86% B.C. Soil with 14% C.S.

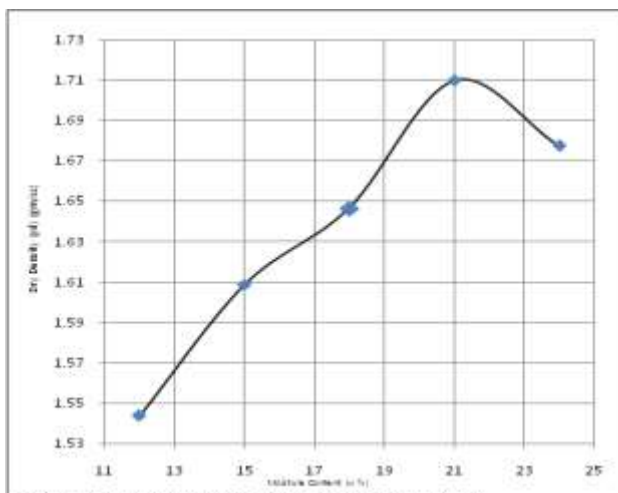


Fig. 12. Variation in Dry Density with moisture in 84% B.C. Soil with 16% C.S.

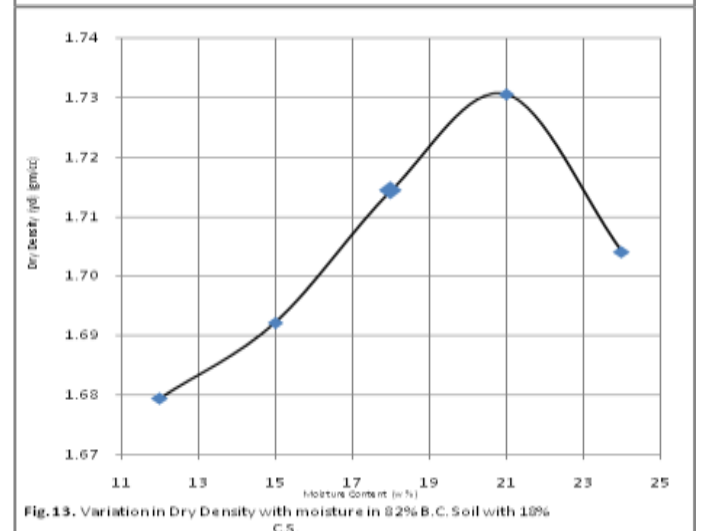


Fig. 13. Variation in Dry Density with moisture in 82% B.C. Soil with 18% C.S.

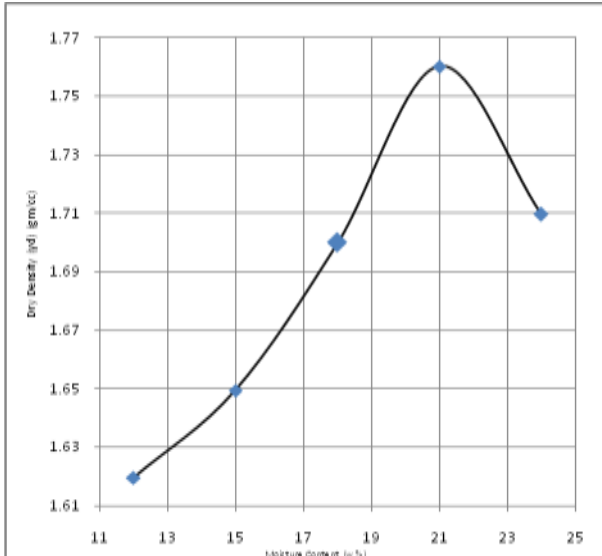


Fig.14. Variation in Dry Density with moisture in 80% B.C. Soil with 20% C.S.

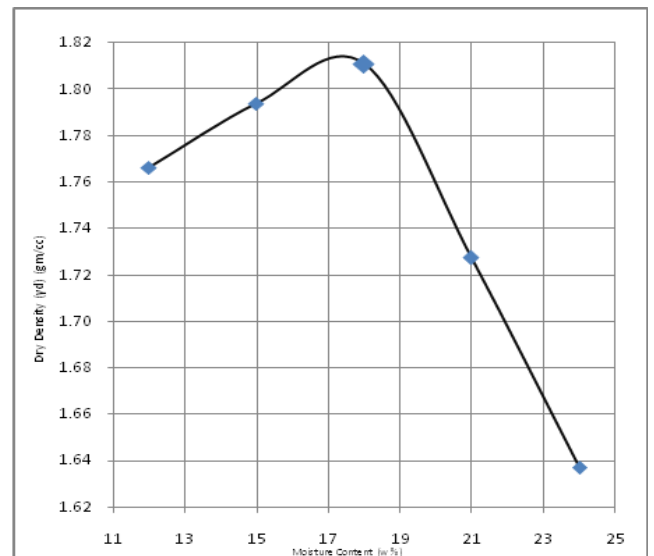


Fig.15. Variation in Dry Density with moisture in 78% B.C. Soil with 22% C.S.

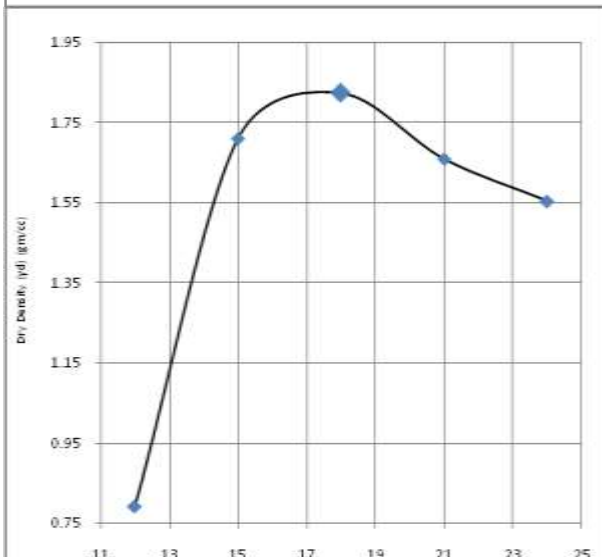


Fig.16. Variation in Dry Density with moisture in 76% B.C. Soil with 24% C.S.

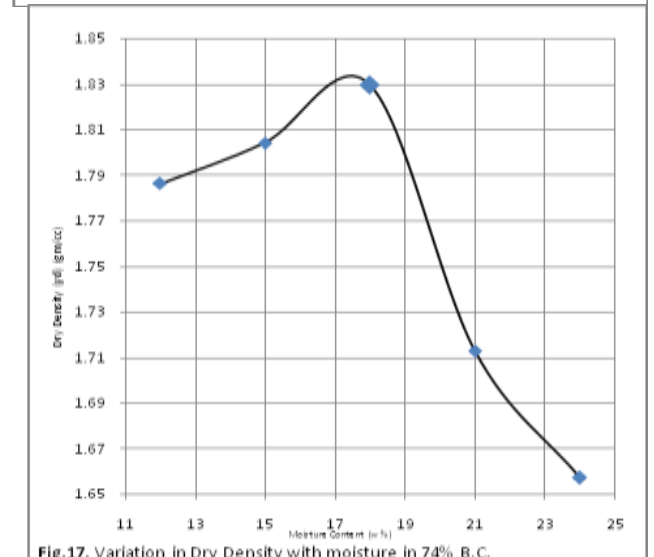


Fig.17. Variation in Dry Density with moisture in 74% B.C. Soil with 26% C.S.

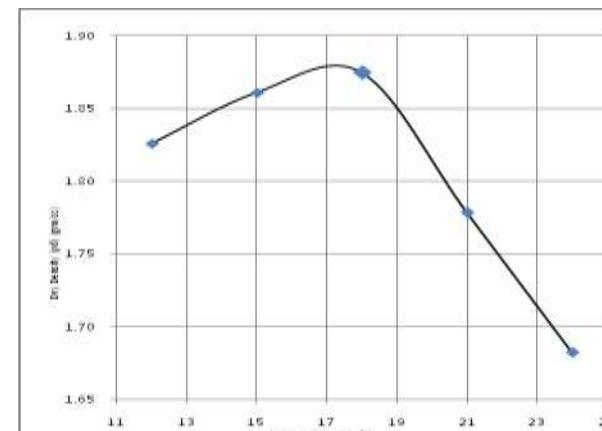


Fig.18. Variation in Dry Density with moisture in 72% B.C. Soil with 28% C.S.

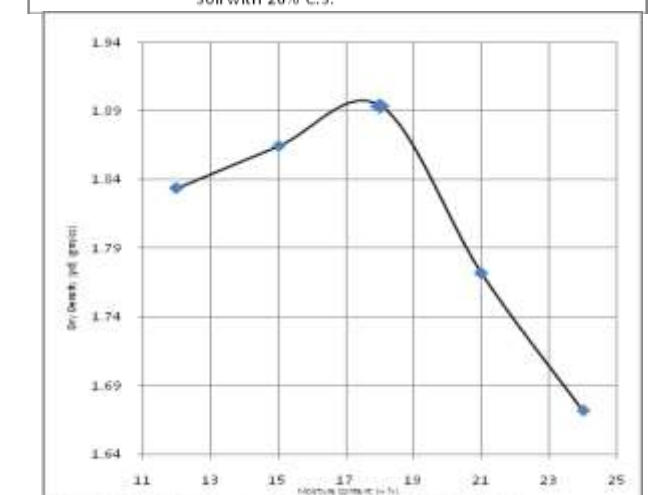
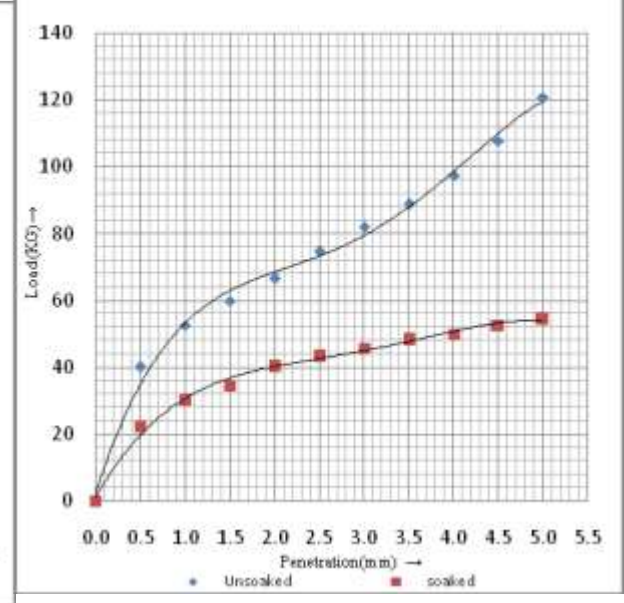
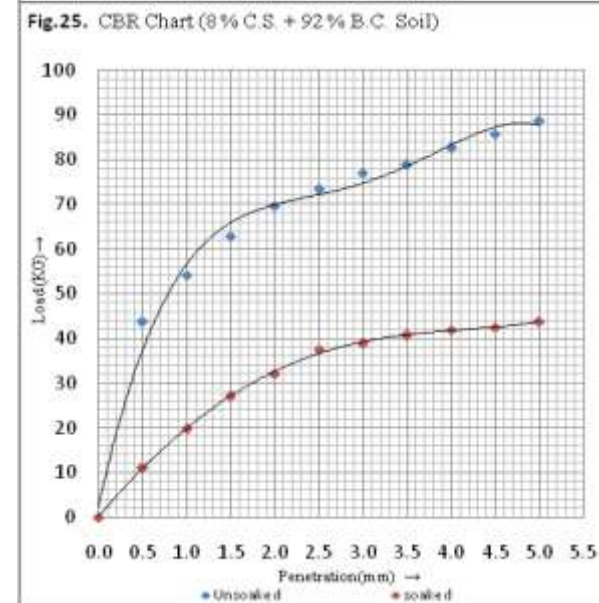
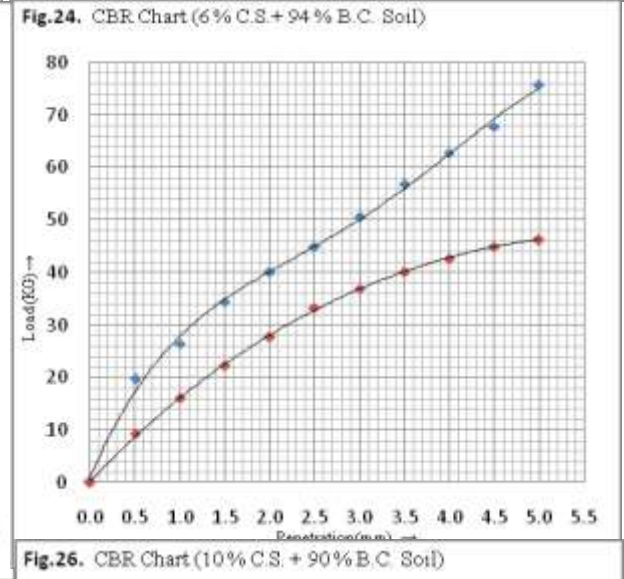
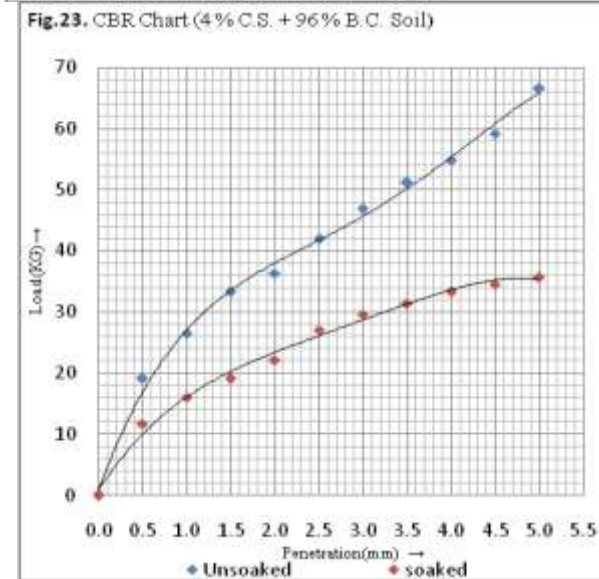
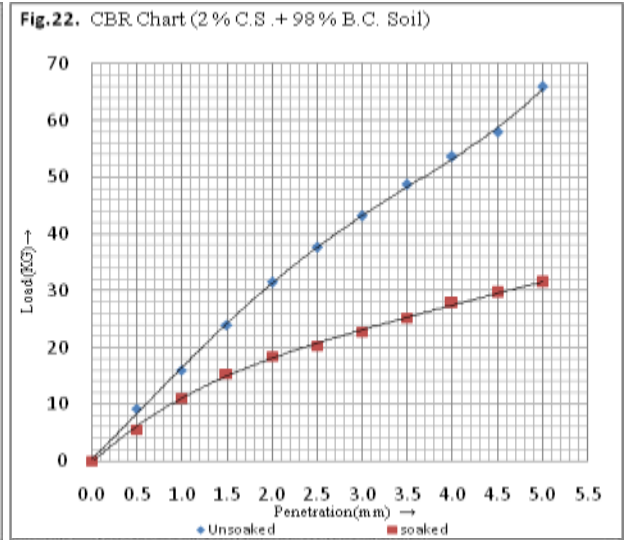
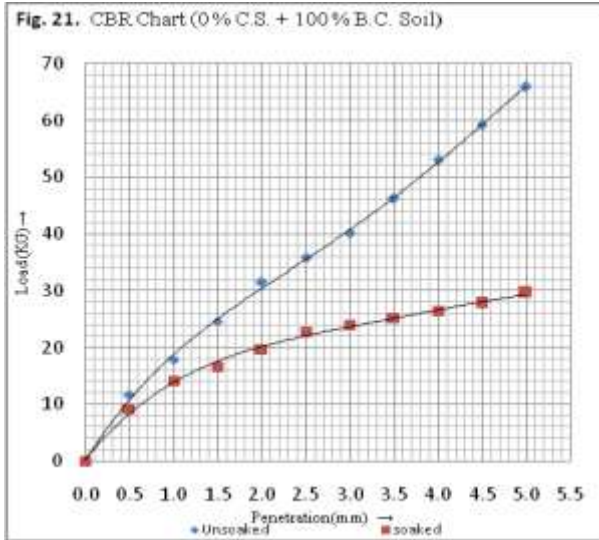
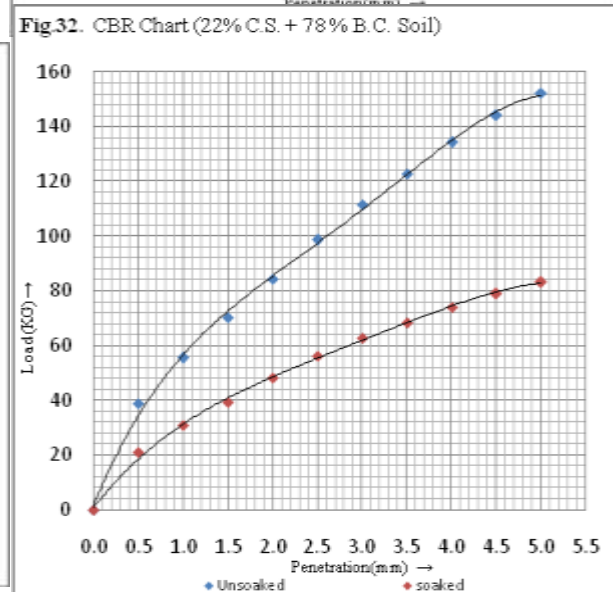
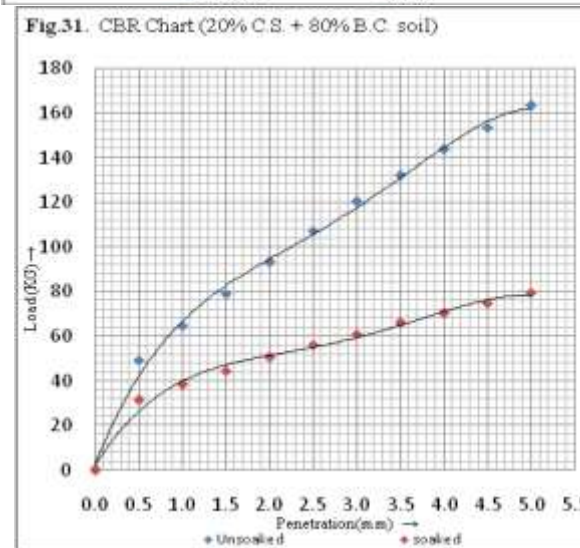
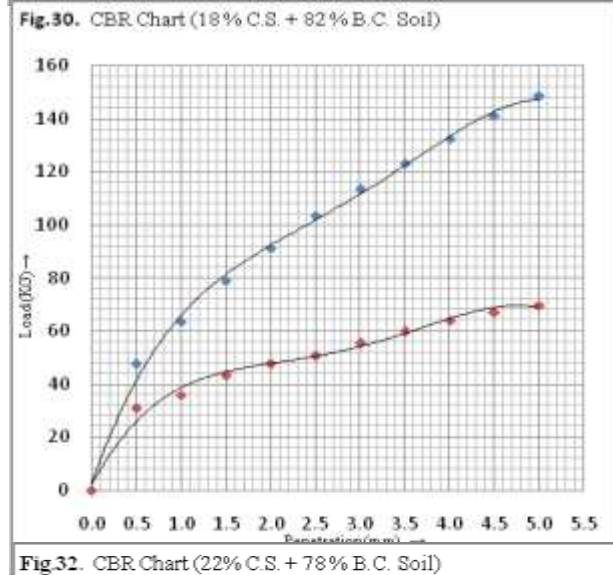
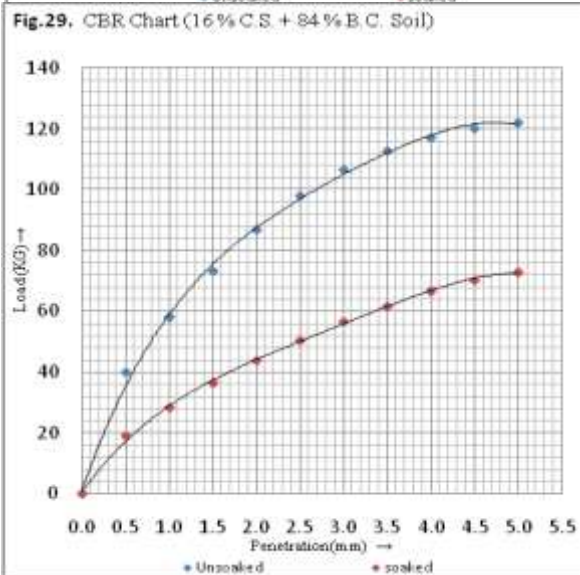
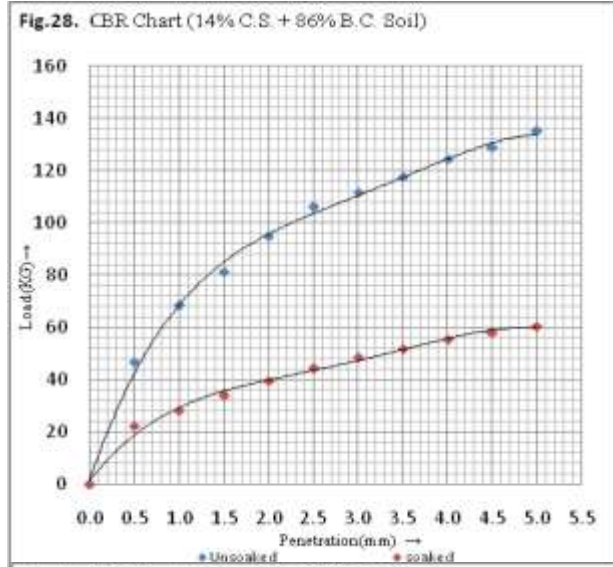
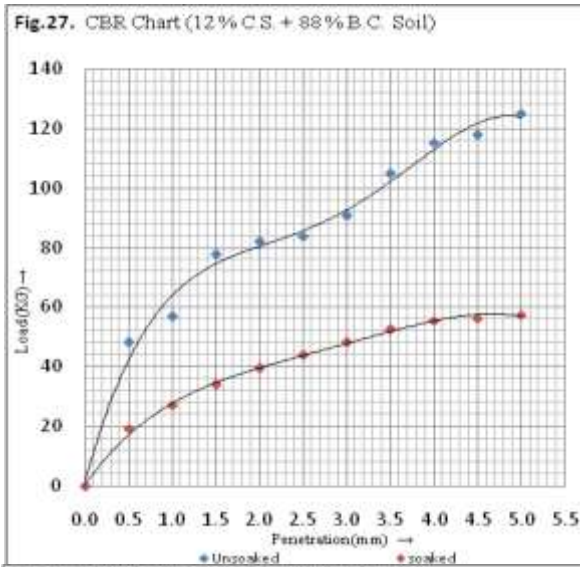
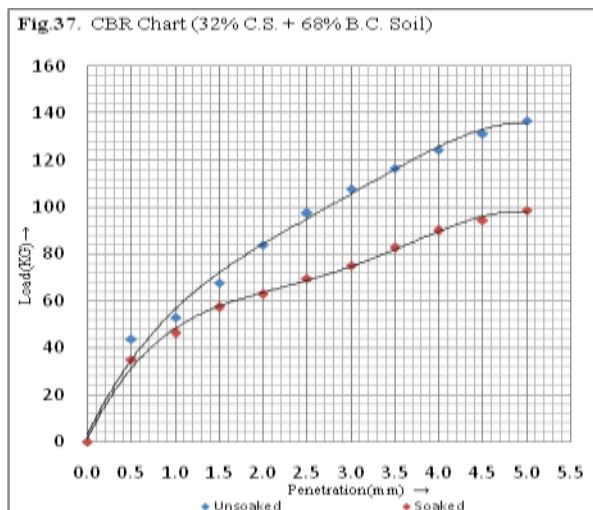
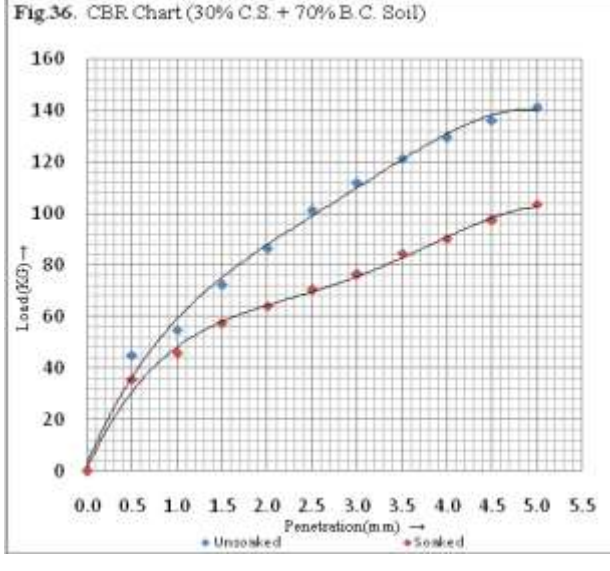
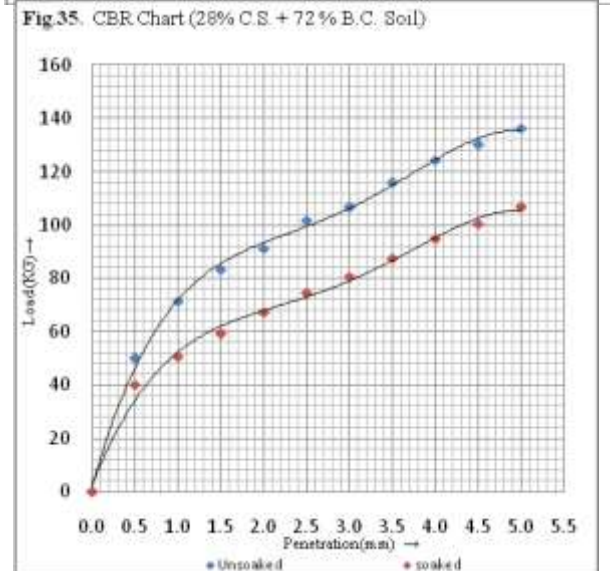
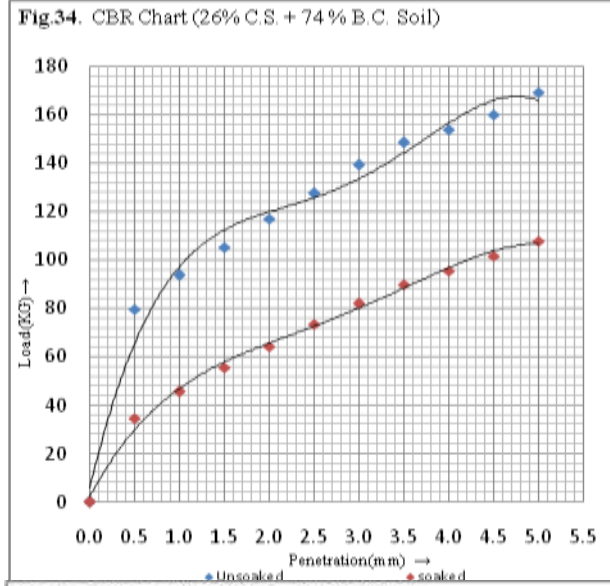
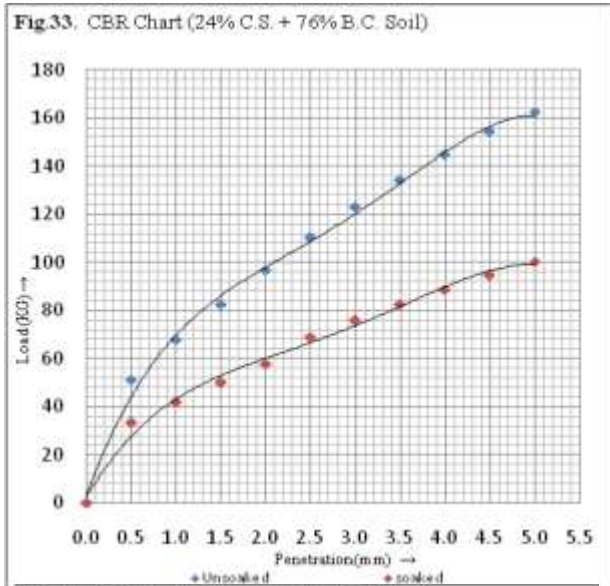


Fig.19. Variation in Dry Density with moisture in 74% B.C. Soil with 30% C.S.







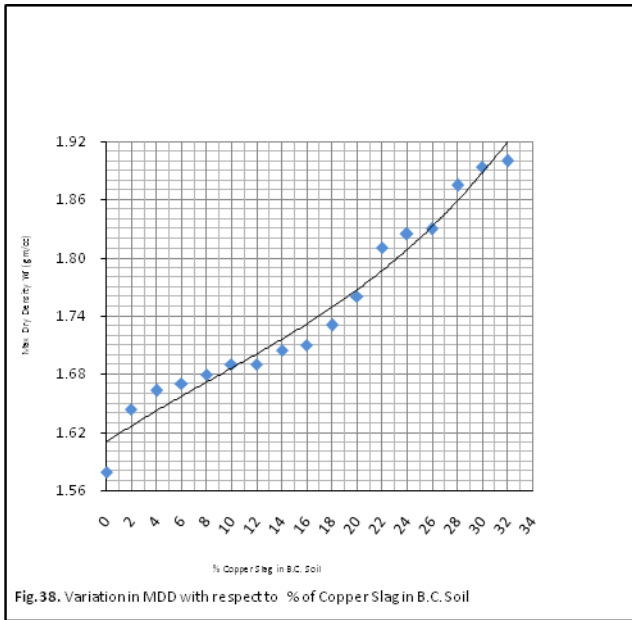


Fig.38. Variation in MDD with respect to % of Copper Slag in B.C. Soil

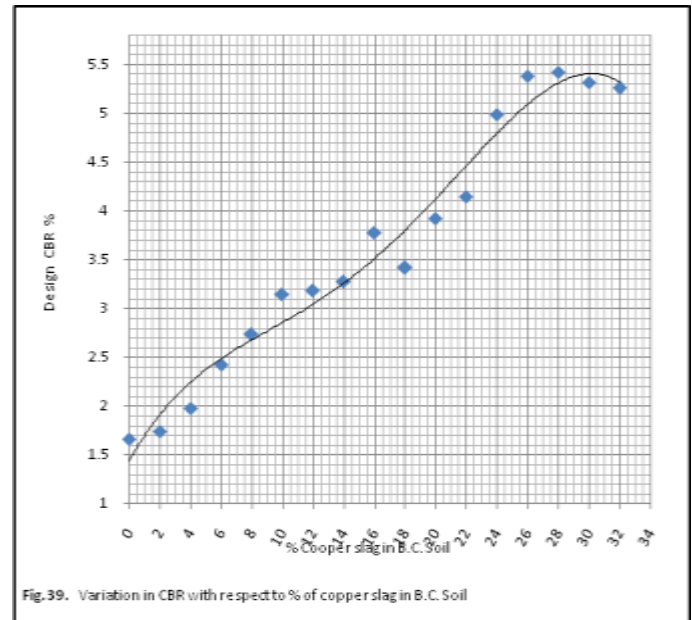


Fig.39. Variation in CBR with respect to % of copper slag in B.C. Soil

Table 4 :- Peak Value of OMC, MDD and Soaked CBR (4 Days)

S. No.	Combinations	OMC	MDD	Design CBR
	Black cotton Soil + Copper slag	IS: 2720 (Part - 7)	IS: 2720 (Part - 7)	IS: 2720 (Part - 16)
	%	%	(gm/cc)	%
1	100 % B.C. Soil	18	1.58	1.66
2	98 % B.C. Soil with 2% C.S.	18	1.64	1.74
3	96 % B.C. Soil with 4% C.S.	18	1.66	1.98
4	94 % B.C. Soil with 6% C.S.	18	1.67	2.43
5	92 % B.C. Soil with 8% C.S.	18	1.68	2.74
6	90 % B.C. Soil with 10% C.S.	21	1.69	3.15
7	88 % B.C. Soil with 12% C.S.	21	1.69	3.19
8	86 % B.C. Soil with 14% C.S.	21	1.70	3.28
9	84 % B.C. Soil with 16% C.S.	21	1.71	3.78

10	82 % B.C. Soil with 18% C.S.	21	1.73	3.42
11	80 % B.C. Soil with 20% C.S.	21	1.76	3.93
12	78 % B.C. Soil with 22% C.S.	18	1.81	4.15
13	76 % B.C. Soil with 24% C.S.	18	1.82	4.99
14	74 % B.C. Soil with 26% C.S.	18	1.83	5.39
15	72 % B.C. Soil with 28% C.S.	18	1.87	5.43
16	70 % B.C. Soil with 30% C.S.	18	1.89	5.32
17	68 % B.C. Soil with 32% C.S.	18	1.90	5.26

CONCLUSION

On the basis of this study and observations made, the conclusions are as follow.

- The combination B.C. soil with C.S. (2% to 32% copper slag) the Maximum Dry Density (MDD) of range 1.64 gm/cc to 1.90 gm/cc are increases. High value of M.D.D. 1.90 gm/cc and O.M.C. 18% in combination of 68% B.C. soil with 32% copper slag.
- It was observed that soaked CBR (4 Days) values of combination B.C. soil with C.S. (2% to 28% copper slag) are increases and further it tends to decrease. High value of soaked CBR 5.43 % in combination of 72% B.C. soil with 28% copper slag. high CBR value as compared to B.C. soil and satisfied the P.W.D. criteria for use in sub grade/ sub base layer of road pavement.
- Copper slag with 22% to 32% can be mixed with problematic soils to improve or modify the soil characteristics.
- The combination of 72% B.C. Soil with 28% C.S. was most satisfactory combination to get good soil stabilizations.
- Based on the experimental findings it may be concluded that the mix 28% C.S. + 68% B.C. Soil is suitable the P.W.D. criteria for use in the subbase layers of the flexible pavements. The utilization of this mix in pavement construction will solve two problems with one effort:
 - (a) Solid waste disposal problems and
 - (b) Provision of needed construction material.

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