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Study on Properties of Black Cotton Soil Treated with Mixed of Red Mud and Polythene Strips

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Abstract- The aim of this investigation is to improve the engineering properties of black cotton soil, which is one of the major soil deposits of India. Black cotton soil is a type of soil with poor shear strength and high swelling and shrinkage properties. By stabilization process using industrial waste and waste polythene, it increases the bearing capacity of black cotton soil. In this study, two additives were used with black cotton soil, to stabilize it. Red mud & polythene strip, both additives are waste and harmful for the environment. Observation of this study shows Black cotton soil was treated by mixing with 10%, 15% and 20% of red mud and blended with polythene by 0.2%, 0.3% and 0.5% for every red-mud mix. It was observed that when polythene mix increases the CBR value constantly decreases. The result was optimum for soaked CBR value at 20% of red-mud & 0.2% of polythene mixed with black cotton soil sample.

Keyword's:- Red Mud, Polythene Strips, OMC, MDD, Un-Soaked CBR, Soaked CBR, Natural Soil.

INTRODUCTION

Soil is the basic construction material. It supports the substructure of any structure and in case of pavement structures; sub-grade soil is an essential component as it supports the sub-base/base. However, in many situations, soils in natural state may not possess adequate geotechnical properties so as to be used as foundation layers, pavement layer or as a construction material. This may be due to the fact that the existing soil at a particular location exhibits poor bearing capacity and higher compressibility. Also, soils with significant plasticity may shrink and swell substantially with changes in moisture conditions. The repeated cycles of swelling or shrinkage of soil, further cause deteriorations and distresses on the structures if these are supported in these types of soil, This necessitates the improvement/stabilization of soil at a site as an indispensable activity, due to rising cost of the land and a huge demand for infrastructure development in developing countries like India. Soil stabilization is a technique introduced with the main purpose to modify the geotechnical properties of the soils making them capable of meeting the requirements of the specific engineering projects. The most common improvements achieved through stabilization include better soil gradation reduction of plasticity index or swelling potential and increases strength and durability. Various stabilizers such as red mud, polythene, lime, cement, and calcium chloride are traditionally used for the stabilization of expansive soils, However, the over-dependency on the utilization of such industrially manufactured soil stabilizing additives may significantly increase the cost of construction.

II LITERATURE REVIEW

This chapter discusses the different investigation for characteristics of redmud as construction material, stabilization of redmud in different applications in general. **Nawabsharif Risaldar etal.(2017)**Investigation on the properties of black cotton soil, it is observed that its strength properties are very low. In order to construct any foundation one such soil, we need to stabilize the black cotton soil. Red mud is material produced by aluminum industries, which, nowadays creating so many problems when we dump it on open space. To beat both the criteria red mud is used as a stabilizer. The number of

mixes is proposed here and experiments are done on the same. Black cotton soil was stabilized with red mud by varying the % of mix from 15% to 30% with 1% interval Gypsum is also used in the mixes in order to give better binding between the particles. It is observed that results obtained at the mix proportions 0% to 25% is increasing. Optimum of 25% of red mud replacement gives better results. After obtaining the test results as stated above, another attempt has been made to understand the interrelation (linear) between the parameters; regression analysis is made. This regression analysis is made using Microsoft Excel 2010; regression summary output is also discussed in this study.

Nitin Mane, etal.(2018)in particular, construction activities on black cotton soil brings challenging tasks to him to handle. When the civil structures are needed to construct over the soils, which are unable to provide the desired properties to civil structures for the construction in such cases stabilization is the only method to get the desired properties of soil. By studying the properties of black cotton soil, it is observed that its strength properties such as UCS and CBR are very low. In order to construct any foundation on the same soil, we need to stabilize the black cotton soil. Black cotton soil was stabilized with red mud by varying the % of mix from 10% to 40% with 2% interval sodium silicate is also used in the mixes in order to give better binding between the particles. It is observed that results obtained at the mix proportions 10% to 30% is increasing. Optimum of 30% of red mud replacement gives better results. Along with this 6% of sodium, silicate replacement gives better results. The sodium silicate content increased CBR values got increased up to 8% of sodium silicate. Later as the percentage of sodium silicate increased, CBR values got decreased. The maximum value of CBR being 3.9 %, which is obtained for D308 combination

III OBJECTIVES

1. To study the physio-mechanical properties of red mud and polythene strip.
2. Techno-economical study of mixed soil for subgrade pavement.
3. The experimental work is to find the increase in strength of the natural soil by using red mud and polythene stripfor the subgrade of the pavement in black cotton soil.
4. For which the soil samples were collected from the site, to find the index properties such as plastic limit, liquid limit, grain size distribution, optimum moisture content (OMC) and maximum dry density (MDD) and finally the CBR value of the B.C Soil.
5. Use of Soil stabilizing elements (red mud) to serve as intrusion barriers and to serve as capillary cut off.
6. Addition of various percentage of red mudand polythene strip (0%,10%, 15%, and 20% With 0%, 0.2%, 0.3% and 0.5% polythene strip) and to find the index properties such as plastic limit, liquid limit, grain size distribution, optimum moisture content (OMC) and maximum dry density (MDD) and the CBR value of every proportion of red mud with the natural soil.

IV MATERIALS USED

Soil-Soil is a collection of earth material, obtained naturally from the decay of vegetation and rocks that may be excavated instantly with help of power equipment in the field or disintegrated by gentle mechanical means in the laboratory. Supporting soil underneath pavement and its unique under courses is termed as subgrade. Undisturbed soil beneath pavement is termed as natural subgrade. Compacted subgrade is soil compacted with the help of controlled movement through heavy compactors. The soil used for this investigation is an expansive clay, one type of most problematic soil for subgrade constructions is used for current research work which is locally available NaturalSoil sample was collected in the proper method of distributed sampling after removing the top layer of soil at 500 mm depth and transported to the laboratory.

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Figure 1: Natural Soil Sample.

Redmud- This Red-mud (RM) was collected from the NHAI highway construction plant near kokta bypass, Raisen Road Bhopal, Madhya Pradesh. This red-mud was produced in the Bayer process. In India, about 4 million ton's red-mud is produced/year. Hindalco is the largest red-mud producer in India and they discharge it in a slurry form to the red-mud pond. This slurry consists of 45% of liquid and 55% solid. About 250 tons of red-mud is produced in an hour.

Figure 2: Red mud and Polythene sample.

Polythene-Polythene used in this investigation is Low-density polythene and were collected from our surrounding. This polythene has the tendency to hold stress and it may increase the bearing capacity of the selected soil sample.

Sample Preparation-Samples are prepared with the mix of black cotton soil+ Red-mud% + Polythene %The mix proportion of red-mud is 10%, 15% and 20% of soil sample wt. and for the polythene mix proportion is 0.2%, 0.3% and 0.5% of total wt. of sample. The proportion % of polythene is mix with each red-mud sample. Mixed samples are denoted by their name as denoted down.

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Table 1.1 Naming of mix proportion

S.NO	SYMBOL	MIX PROPORTION
1	S1	(BC)+(0%RM)+(0%Polythene)
2	S10a	(BC)+(10%RM)+(0.2%Polythene)
3	S10b	(BC)+(10%RM)+(0.3%Polythene)
4	S10c	(BC)+(10%RM)+(0.5%Polythene)
5	S15a	(BC)+(15%RM)+(0.2%Polythene)
6	S15b	(BC)+(15%RM)+(0.3%Polythene)
7	S15c	(BC)+(15%RM)+(0.5%Polythene)
8	S20a	(BC)+(20%RM)+(0.2%Polythene)
9	S20b	(BC)+(20%RM)+(0.3%Polythene)
10	S20c	(BC)+(20%RM)+(0.5%Polythene)

Size Analysis-Grain size analysis on natural soil and soil-additive mixture were conducted according to I.S. 2720 (Part IV):1975.

Figure 3: Sieve Analysis Apparatus (Motorised Sieve Shaker)

Specific Gravity-Specific gravity which is a measure of the heaviness of soil particles are determined by method of pycnometer method using a soil sample passing No. 10 sieve and oven-dried at 105-degree centigrade. The test includes the determination of specific gravity for natural soil and soil-red mud mixture. Test is executed in accordance with AASHTO T100-93 testing procedure

Figure 4: Specific Gravity test Apparatus (pycnometer)

Liquid limit (LL)-Liquid limit of fine-grained soil is defined as the water content at which soil behaves practically like liquid but has small shear strength. It is determined in the laboratory by Cassagrande apparatus.

Figure 5: Liquid Limit, Plastic Limit Apparatus

Plastic limit (PL)-Plastic limit of a fine-grained soil is water content of soil below which it ceases to be plastic. It begins to crumble when rolled into threads of 3mm diameter. Or the minimum water content at which a soil will just begin to crumble when it is rolled into a thread of approximately 3 mm in diameter.

Compaction test-Compaction tests to obtain moisture-density relationship of soil-additive mixtures were conducted according to I.S. 2720 (Part viii)-1965 (11). Compaction is the process of soil densification with help of reduction of air voids. Degree of compaction for given soil is calculated in terms of its dry density. The dry density is maximum at optimal water content.

Figure 6: Rammer Apparatus and Sample Prepare for Compaction Test

California Bearing Ratio (CBR)-In 1928, California division of highways in the U.S.A. developed the CBR method for pavement design. The majority of curves developed later are based on original curves proposed by O. J. porter. At the start of the Second World War, Corps Engineer of the U.S.A. made a survey of the existing method of pavement design and adopted the CBR method to design military airport pavements. One of the chief advantages of C.B.R method is the simplicity of the test procedure. The CBR tests were executed according to I.S. 2720 (Part xi) 1977. A standard CBR mould with a detachable collar was used.

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Figure 7: Working process of CBR lab test

V RESULT AND ANALYSIS

In the present study, the results of the material properties of red mud and polythene discussed in the chapter. The main aim is to stabilize black cotton soil with red mud and polythene to enhance its engineering properties. And can be used at-list as pavement material. The basic properties and engineering properties of Black cotton soil are analyzed before and after treatment. For better geotechnical properties of the soil is increased by mixing red-mud and polythene.

Table 1.2: Properties and Classification of Natural Soil

Specific Gravity	**2.60**
Gravel(%)	**18.40**
Coarse Sand (%)	**7.20**
Medium Sand (%)	**52.60**
Fine Sand (%)	**20.30**
Silt and Clay (%)	**1.50**
Liquid Limit (%)	**48.94**
Plastic Limit (%)	**30.34**
Plasticity Index (%)	**18.60**
O.M.C. (%)	**13.70**
Maximum Dry Density (gm/cm^3)	**1.882**
CBR (%)	**2.53 (Soaked)**
IS Classification	**MH**

Table 1.3 Final Calculated results for all samples

SR. NO.	SAMPLE	LL(%)	PL(%)	MDD (g/cc)	OMC (%)	CBR (%)
1	S1	48.94	30.34	1.882	13.70	2.53
2	S10a	44.86	27.24	1.865	12.02	3.25
3	S10b	44.86	27.24	1.724	13.66	2.89
4	S10c	44.86	27.24	1.880	12.15	1.81
5	S15a	40.41	24.12	1.820	13.73	4.15
6	S15b	40.41	24.12	1.799	12.84	3.43
7	S15c	40.41	24.12	1.779	16.35	2.17
8	S20a	37.23	21.82	1.800	17.72	6.14
9	S20b	37.23	21.82	1.792	17.13	5.06
10	S20c	37.23	21.82	1.809	16.59	3.61

We observed that the increment of polythene strip with the Red-mud mix reduces the CBR value. In sample S10c with 0.5% of polythene strip, the CBR value goes down at 1.81%. Similarly in sample S15c & S20c with 15% & 20% Red-mud and 0.5% polythene, we again observed that the value goes down. Samples S10a, S15a & S20a all with 0.2% of polythene we observed a constant increment in CBR value. And the best one is at S20a which is 20% red-mud and 0.2% of polythene gives a CBR value of 6.14%.

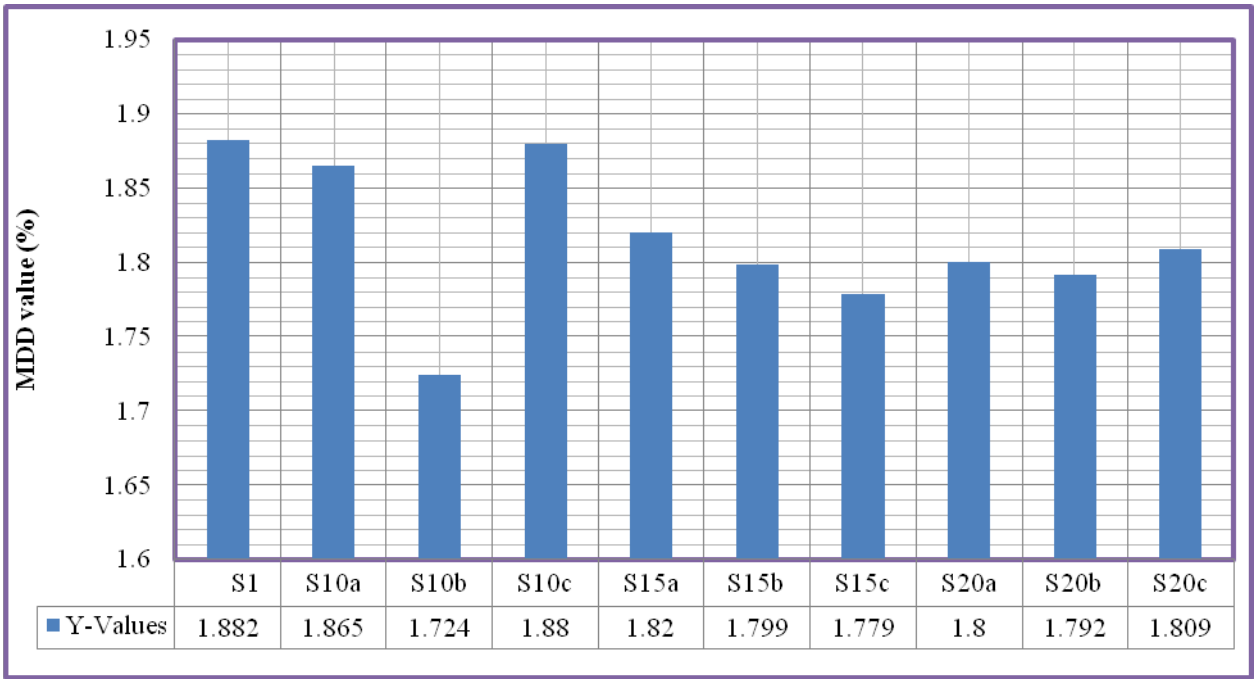

Figure 8: Comparison of MDD for all samples

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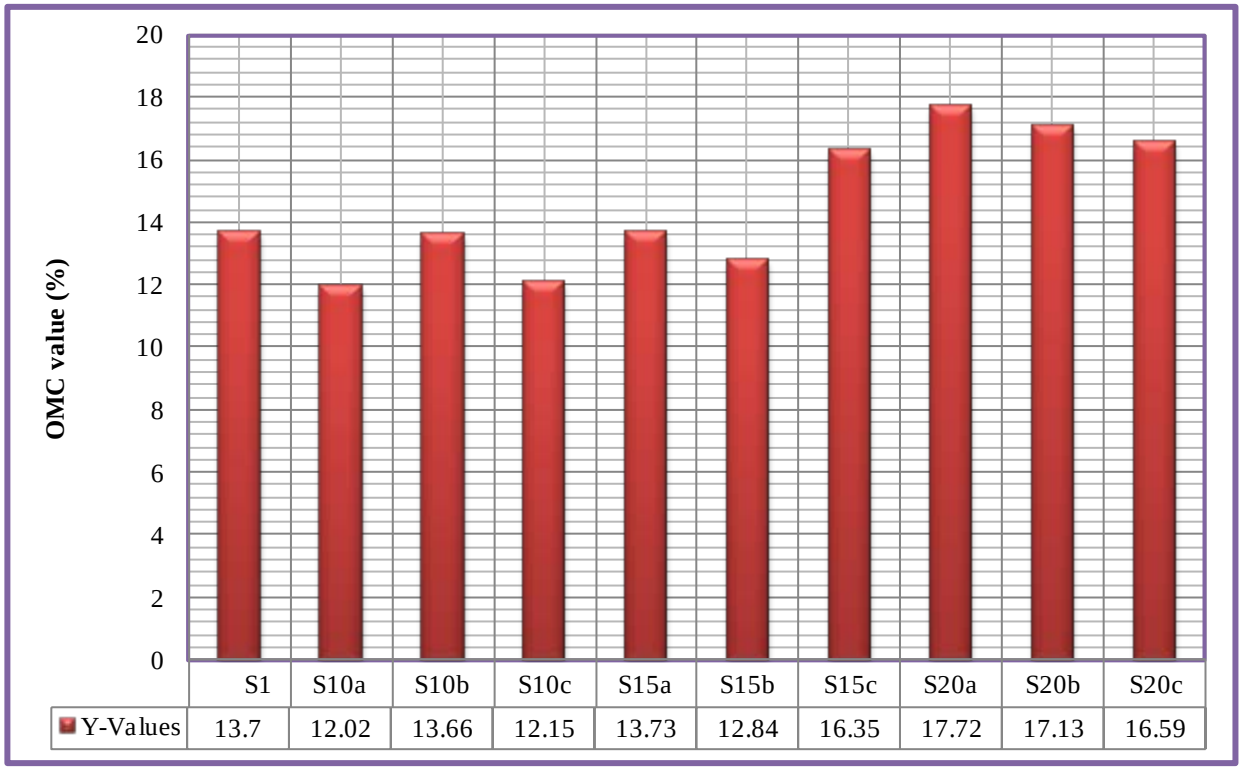

Figure 9: Comparison of OMC for all samples

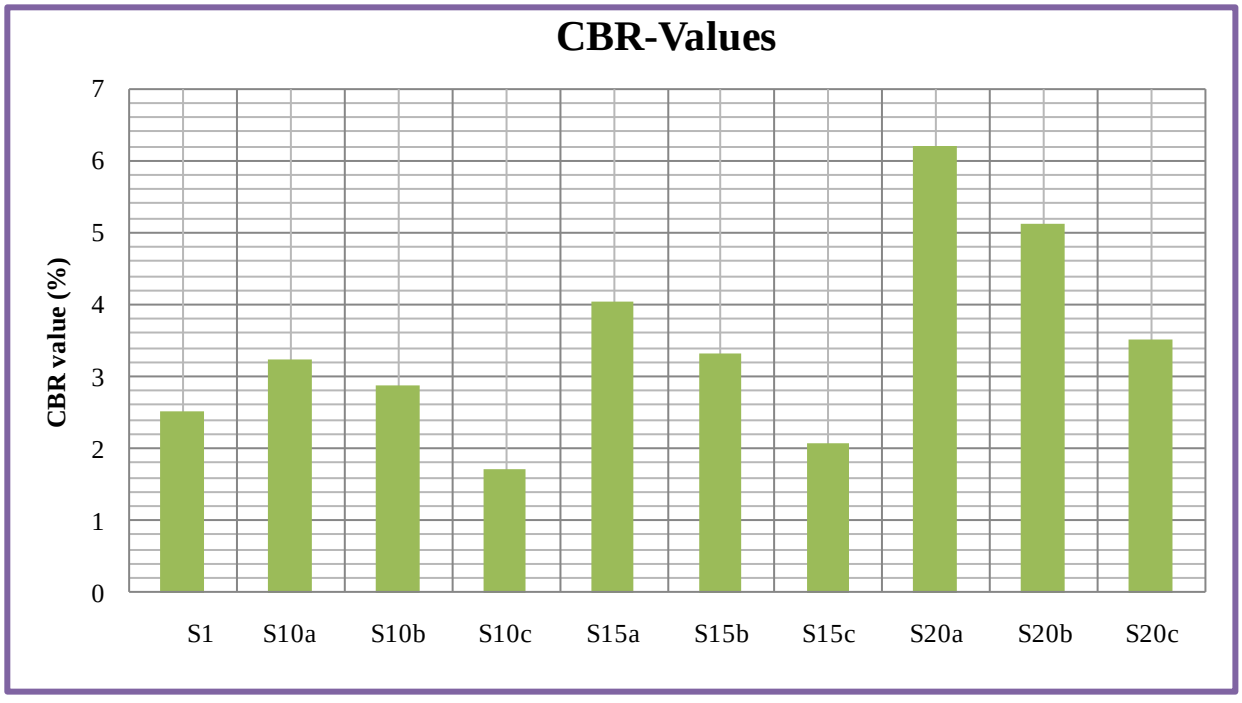

Figure 10: Comparison of CBR for all samples

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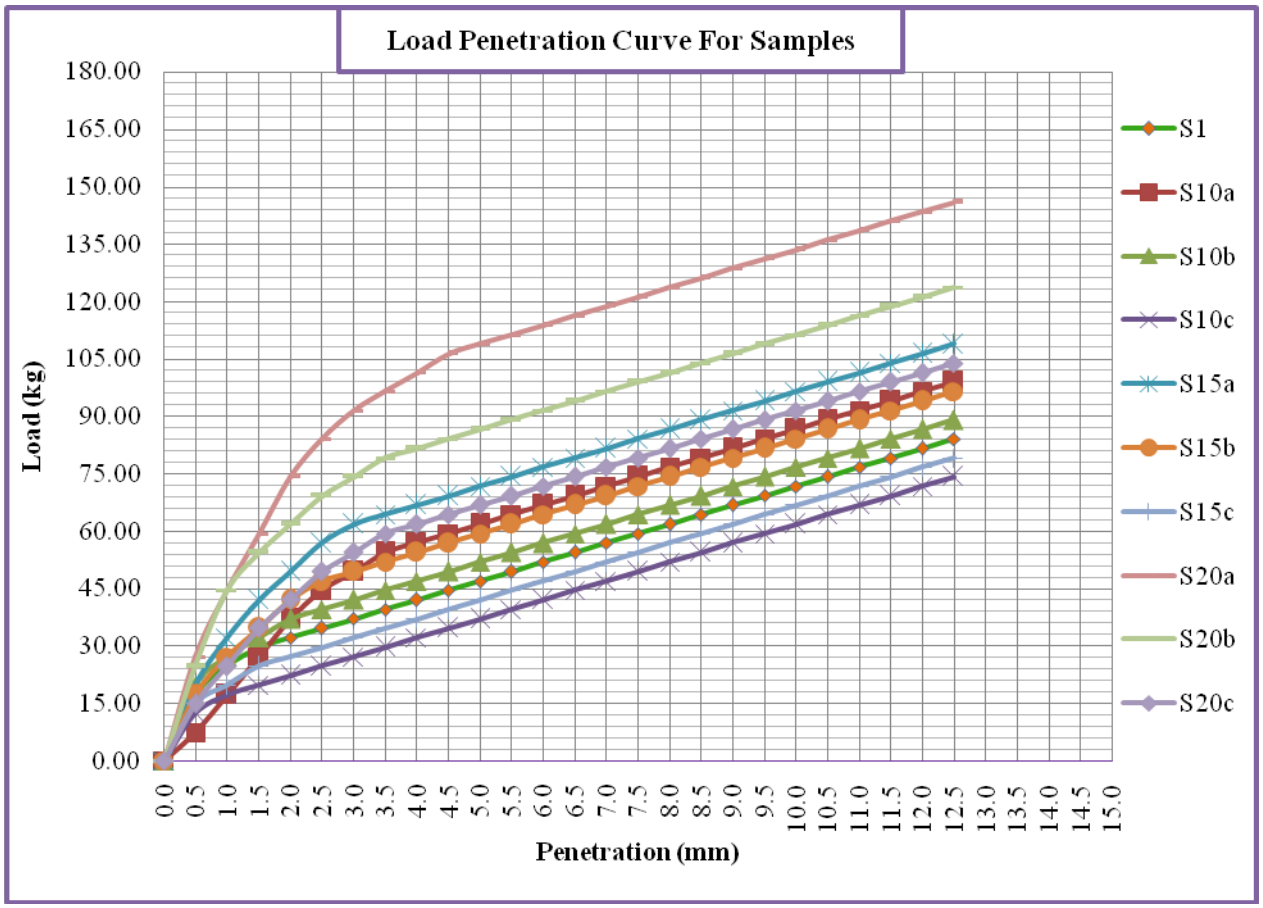

Figure 11: Comparison between CBR values of sample S1 to S20c

VI CONCLUSION

Investigating all the samples, we observe the following conclusion

- Black cotton soil was stabilized with red-mud and polythene. Mixed with a percentage of 10%, 15%. & 20% red-mud mixed well with polythene strip percentage 0.2%, 0.3% and 0.5% with each sample of red-mud.
- While we increase the percentage of red mud mix with soil sample at 0.2% polythene, it constantly increases. But the best results were at 20% red mud + 0.2% polythene mix with soil. Where MDD value 1.8g/cc at OMC of 17.72%.
- Max soaked 96 Hrs. CBR value was obtained optimum with mixed 20% of red-mud + 0.2% of polythene when mixed with soil sample. The value of CBR was 6.14%.
- To understand the flowing characteristics of the soil sample, liquid limit and plastic limit tests were conducted, these values decreased when the red mud content increased. The maximum value of the liquid limit of black cotton soil is 51.00% and the same of the minimum is 47.57% Corresponding maximum and minimum. The plastic limit is 30.56% and 30.12% respectively.

- Red-mud is good to be used for embankment as a filler material due to low permeability.
- This utilization of red-mud and polythene may resolve our environmental problem of disposal of red-mud and polythene.
- Red-mud and polythene may be used for sub-grade material, due to its high specific gravity, Density and strength in comparison to the soil is better.

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