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"INVESTIGATION OF STRENTH CHARACTERSTIC OF BC SOIL BY COMPOUND A,COMPOUND B,CEMENT AND RED SOIL"

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Abstract — **In the present study, the behavior of Black Cotton soil with and without stabilization has been studied. Because of the poor geotechnical properties of Black Cotton Soil, it has to be stabilized to make it suitable for road construction by improving its geotechnical properties. Modifiers namely Compound A, Compound B and cement were used in different dosages and is stabilized with black cotton and red soil. Laboratory investigations were performed to assess Specific Gravity, Grain size analysis, Atterberg limits, free swell index, Compaction characteristics; CBR and UCC strength of untreated and treated soil were done. The comparison of both soils has been examined.**

Keywords-*BC soil, Terasill, Zycobond, Red soil, Cement, Attriburg limits, Compaction, CBR, UCS*

I. INTRODUCTION

Soil is the deposition of earthen material which is derived naturally from the disintegration of rocks or the long ongoing decaying process of vegetation that can be drilled out easily with commonly available power equipment in the field or disintegrated by gentle mechanical means in the laboratory. The supporting soil that is beneath the pavement layers is called subgrade. Undisturbed soil beneath the pavement is called natural subgrade. Some of the desirable properties of subgrade soil as a highway material are Stability, Incompressibility, Permanency of strength, Minimum changes in volume and stability under adverse conditions of weather and ground water, good drainage and ease of compaction. Soil is typically a non-homogeneous earthen material whose engineering properties are highly influenced by the alterations in moisture content and density of the environment. There are wide range of soil types available which can be used as highway construction materials, so it is necessary to differentiate the soils based on their properties and behaviour. Various surveys were conducted to find the variety soil types, gravel, morum and naturally occurring soft aggregates, which can be used in road construction. The soil types can be broadly categorized as Laterite soil, Red soil, Desert sands, alluvial soil, Clay including Black cotton soil.

Generally the colour of Black Cotton soils (BC soil) is grayish to blackish and they are highly clay soil. Black cotton soil occupies a large area and is considered as one of the major soil available in India, covers an area of approximately 3.0 lakh sq.km. It is highly sensitive to moisture changes, compressible subgrade material hence the black cotton soil as subgrade has to be modified using a suitable stabilization technique

II. OBJECTIVE OF THE STUDY

- *To find the basic properties of BC soil and Red soil.*
- *To find the optimum moisture content and maximum dry density for BC soil and Red soil.*
- *To conduct the CBR for BC soil and Red soil.*
- *Comparison of strength values of all the optimum dosages of compound A, Compound B, Cement, and Red soil.*
- *To conduct CBR and UCS test on the soil sample with optimum dosages of Compound A, Compound B, Cement and Red Soil.*
- *Cost comparison and pavement thickness.*

III. LITERATURE REVIEW

"A Study on stabilization of Black Cotton Soil Using Ferric Chloride" by ***V.R Bharambe and Prof G.K Patil.*** *(1)*

Study consists of using Ferric chloride as a modifier for stabilization of black cotton soil. It is observed that for 2% Ferric chloride along with 12% fly ash, the CBR value of BC soil increased by 155%. It shows that with effective BC soil stabilization can be achieved if fly ash and ferric chloride are combined. Combination of fly ash and ferric chloride can stabilize black cotton soil. The utilization of fly ash is an alternative to reduce construction cost of roads particularly in the area of black cotton soils.

"An Experimental Study on Stabilization of Block Cotton Soil Using HDPE Wastage Fibres, Stone Dust and Lime" by ***Arun Patidar and Dr.H.K.Matiyar et.al.*** [3]
HDPF wastage fibres stone, dust and lime used as a admixtures and treated with BC soil and various tests have been conducted. Soil properties which include Compaction, Unconfined compressive strength (UCS) and California bearing ratio (CBR) were studied along with the different percentage of admixtures. Which includes High density polyethylene fibres(0.5,1.0,2.0),stone dust(05,10,15)and lime (03,06,09) have been used as modifiers for the improvement of properties of expansive BC soil. With increase in percentage of ingredient the UCS value also increased. The soaked CBR value for these ingredients is 1.55% and 7% when added individually. When the all ingredients had been combined and if they mixed at their optimum dosage the same value reaches to 12%.

"Feasibility Study of Improving Properties of Black Cotton Soil Using Industrial Wastes" by ***Sanjeev Tanaji Jadhav, Sushma Shekhar Kulkarni.*** [4]
Feasibility study was conducted on the BC soil using Industrial wastes. To improve the properties of BC soil experiments were conducted on BC soil and industrial wastes by varying the percentage of these by 0% to 60% at the interval of 10% for an untreated BC soil soaked CBR is 2.08%. Soil with rice husk in the proportion 60:40, the soaked CBR value is 10.04%, it is increased to 79.28% when compared to untreated soil. It also has 21.91% cost reduction as compared with conventional flexible pavement.

"A Laboratory Investigation on Black cotton soil stabilized with nan traditional stabilizer" by ***B.M Lekha, S.Goutham, AV Ravishankar.*** [5]
This paper will give the explanation about behaviour of BC soil with and without stabilization. A chemical stabilizer named Compound A was used for different dosages and period of curing is 7-28 days. The soil mass densifies by minimizing the voids between particles and the soil surface become impervious because of chemical reaction in the soil mass. It is note that the increase in percentage of stabilizer will increases the CBR values. For treated soil the permeability will be nil. It makes the soil completely impermeable.

"Experimental study on stabilization of black cotton soil with stone dust and fibres" by ***K.Suresh et.al.*** [7]
Experimental study has been conducted on BC soil with stone dust and fibres. Only stone dust with 3% is admixed. CBR value is found to be 2.912% for soaked condition with 1.574 times higher than CBR value with soil sample only. When soil is mixed with fibres at 0.6% CBR value at soaked condition is found to be 2.35%, with 1.27 times more than soil alone. When stone and fibres are admixed, maximum CBR value was found with a proportion of soil+3% stone dust 0.6% fibres. CBR value for this combination was 4.16% in soaked condition with 2.25 times higher than soil alone.
It has also observed that unconfined compressive strength is increased with adding stone dust and fibres. Comparison was done with optimum stone dust and fibres to only stone dust and fibres.

"Performance of Crusher Dust in High Plastic Gravel soils as road construction material" by ***Satyanarayana et.al.*** [8]
Has done the performance study on flexible pavement depending upon the functions of the component layers especially sub-base layer. They found that after the addition of the crusher dust, the plasticity characteristics were reduced and CBR values increased. Addition of 25% of crusher dust makes the soil mix low plastic and 35% of the crusher mix makes non plastic, and high CBR values are observed. And hence from the results obtained it is identified that addition of 25-35% of crusher dust make the gravel soils meet the specifications of MORTH as sub-base material.

"Study on the Geotechincal Properties of cement based compsite Fine-grained soil" by ***F.Grytansarkar, rafiqulislam, Md. Rokonuzzaman et.al.*** [9]
In this paper it is reported that Study on the Geotechnical Properties of Cement based Composite Fine-grained Soil expresses that the impact of cement on the execution of soil. The expansion of cement was found to enhance the building properties of accessible soil in settled structures particularly quality, workability, and compaction and compressibility attributes.A study has been conducted to investigate the fundamental properties such as consistency, compaction, compressive strength, shear strength and settlement characteristics of untreated and cement treated soil. It can be concluded that there is an improvement of all the geotechnical properties of cement treated soil.

IV. METHODOLOGY

Following steps are considered for present study:

- BC Soil is collected from Hiriyuru towards Bellary in NH-19 Chitradurga, Karnataka.
- As per codal provisions basic tests are conducted to find the properties of BC soil and red soil and obtained results are compared with standard values.
- Optimum dosage of the modifiers are found by conducting compaction test, CBR test and UCS test.
- With different dosages of modifiers are added to soil and CBR, UCS tests are conducted and test results are compared.
- Cost comparison is done with and without addition of modifiers

V. LABORATORY INVESTIGATIONS

Table 1. Properties of black cotton soil

Sl No.	Properties	Value
1	Soil classification	CH
2	Liquid limit (%)	62
3	Plastic limit (%)	39
4	Plastic index (%)	23
5	Free swell index (%)	114.29
6	Specific gravity	2.62
7	Compaction characteristics	
	Optimum moisture content (%)	22.23
	Maximum dry density (kN/m^3)	16.54
8	California bearing ratio (%)	3.1
9	Soil classification	
10	BIS system	CH
11	HRB system	A-7-b

Table 2: Geotechnical Properties of Red Soil

Sl No.	Properties	Value
1	Soil classification	GM
2	Liquid limit (%)	42
3	Plastic limit (%)	28.28
4	Plastic index (%)	14.51
5	Free swell index (%)	114.29
6	Specific gravity	2.48
7	Compaction characteristics	
	Optimum moisture content (%)	8.6
	Maximum dry density (kN/m^3)	18.85
8	California bearing ratio (%)	15.32
9	Soil classification	
10	BIS system	GM
11	HRB system	A-2-6

Table 3: Calculation of quantity of Water, Compound A, Compound B and Cement

SL No.	Items	Calculation	Example
1	Water	Soil sample in kg*(OMC)% in litre	For 10kg of soil if OMC is 10% the water quantity will be W=10kg*10%=1 litre
2	Compound A	(Soil sample in kg*Compound A kg/m³ *1000gm)/soil density kg/m³	For 10kg of soil if Compound A dosage is 1kg/m³ &soil density is 1800kg/m³ (10*1*1000)/1800=5.6gm
3	Compound B	(soil sample in kg*Compound B kg/m³ *1000gm)/soil density kg/m³	For 10kg of soil if Compound B dosage is 1kg/m³ &soil density is 1800kg/m³ (10*1*1000)/1800=5.6gm
4	Cement	(Soil in kg *cement in kg/m³)/soil density in kg/m³)*1000	For 10kg of soil if cement dosage is 18kg/m³ and soil density is 1800kg/m³ (10*18/1800)*1000=100gm

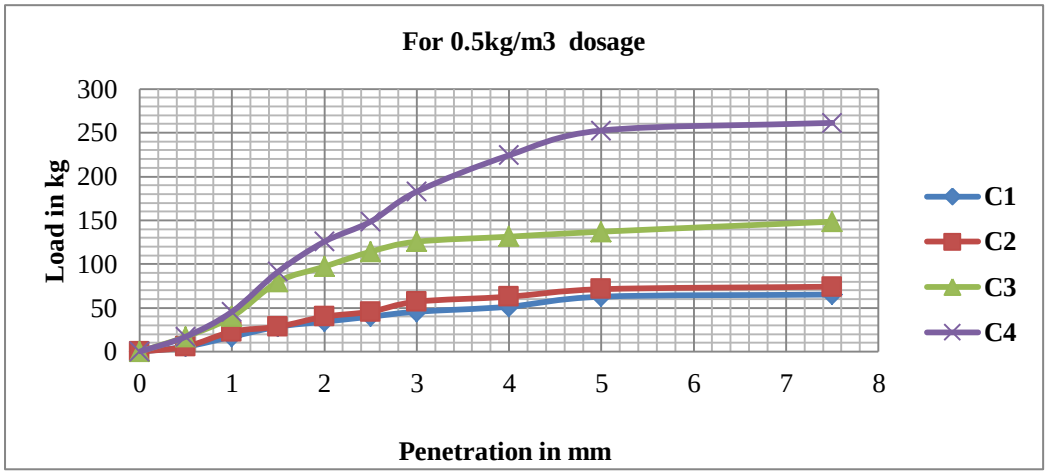
(Source: Zydex Industries)

EFFECT OF MODIFIERS ON CALIFORNIA BEARING RATIO FOR BC SOIL.

California bearing ratio tests were directed on untreated and treated BC soil with various dosages of modifiers.

Table 4: Variation in CBR values of soaked untreated and treated BC soil with 25% Red soil combination.

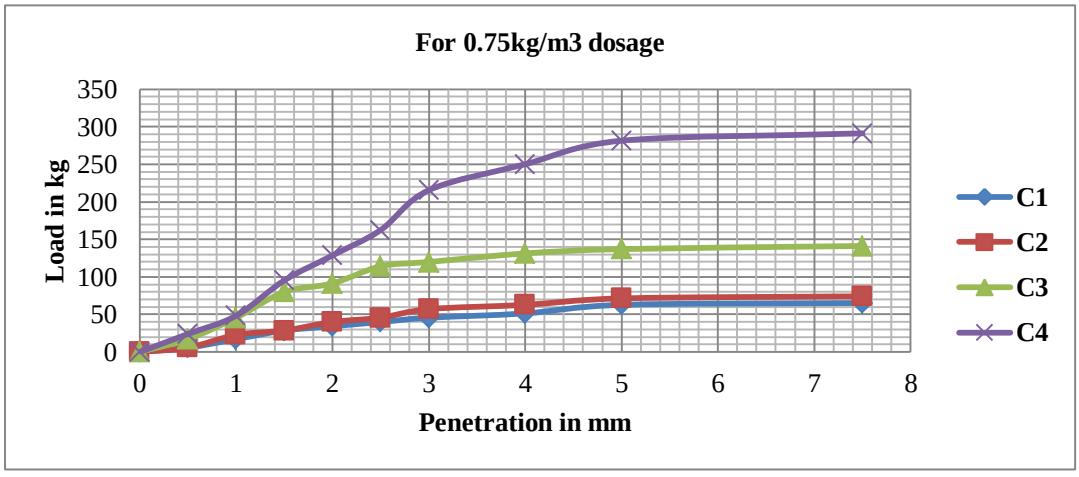
Combination	Compound A in kg/m³	Compound B in kg/m³	Cement in kg/m³	Red soil in %	CBR values in %	Increased CBR values(no's of times)
01	0	0	0	0	3	0
02	0	0	18	0	3.4	1.13
03	0.5	0.5	18	0	6.3	2.1
04	0.5	0.5	18	25	12.2	4.06



Graph 1: CBR values for 0.5kg/m³ dosage

Table 5: Variation in CBR values of soaked untreated and treated BC soil with 25% Red soil combination.

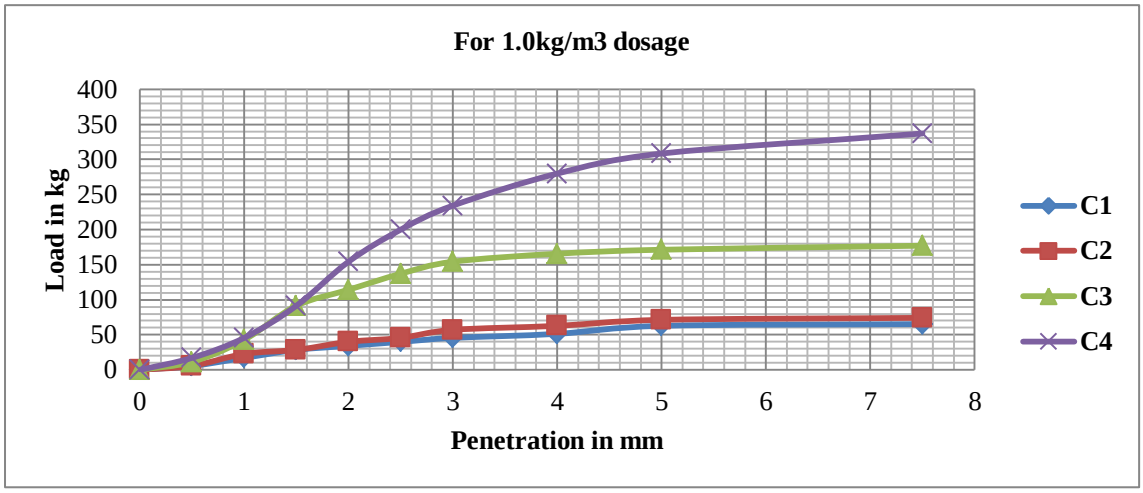
Combination	Compound A in kg/m³	Compound B in kg/m³	Cement in kg/m³	Red soil in %	CBR values in %	Increased CBR values(no's of times)
01	0	0	0	0	3	0
02	0	0	18	0	3.4	1.13
03	0.75	0.75	18	0	7.51	2.51
04	0.75	0.75	18	25	13.56	4.52



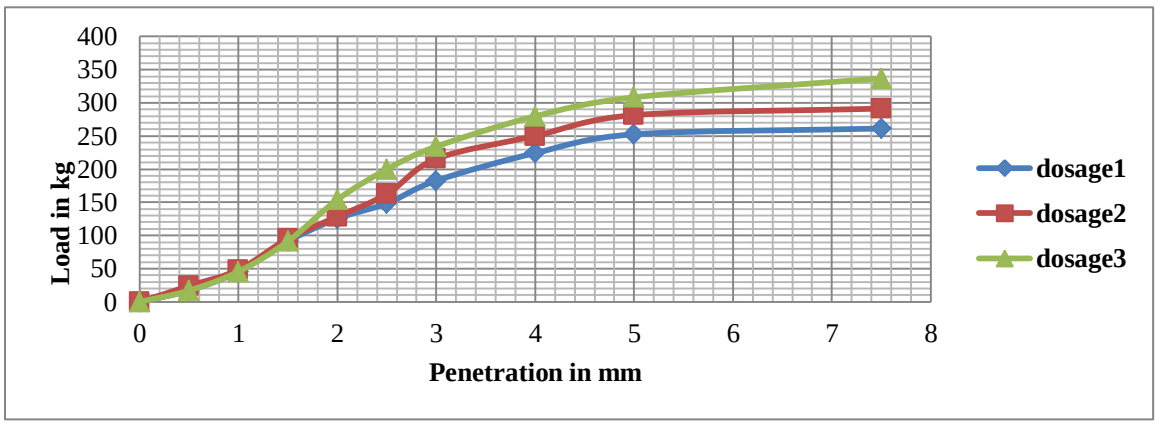
Graph 2: CBR values for 0.75kg/m³ dosage

Table 6: Variation in CBR values of soaked untreated and treated BC soil with 25% Red soil combination.

Combination	Compound A in kg/m³	Compound B in kg/m³	Cement in kg/m³	Red soil in %	CBR values in %	Increased CBR values(no's of times)
01	0	0	0	0	3	0
02	0	0	18	0	3.4	1.13
03	1.0	1.0	18	0	8.3	2.76
04	1.0	1.0	18	25	14.6	4.86



Graph 3: CBR values for 1.0kg/m³ dosage



Graph 4: CBR values for different dosage

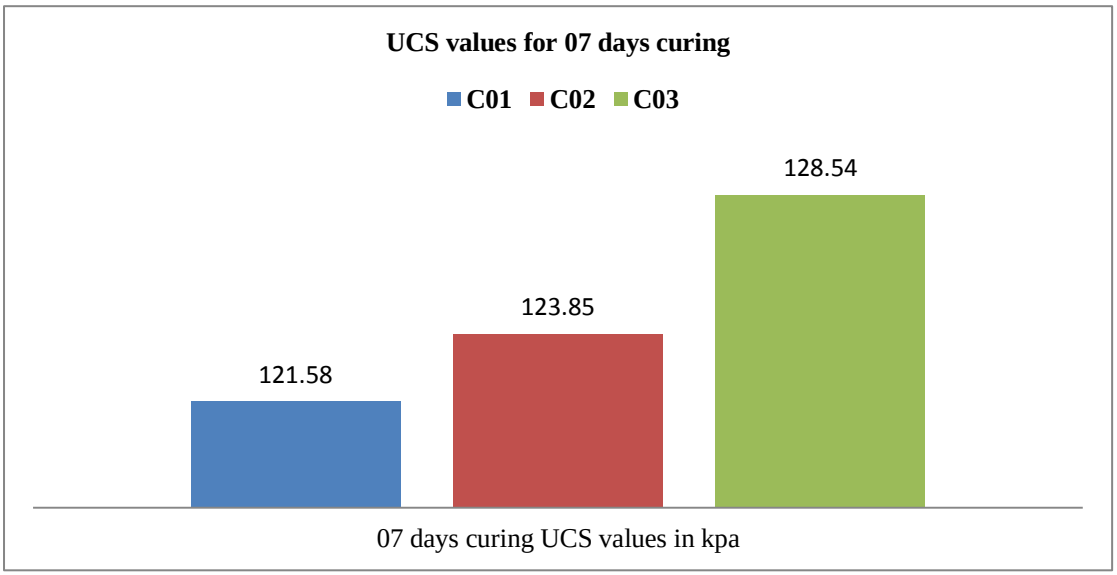
From the above outcomes it can be observed that with increase in percentage of dosage of modifiers increases the CBR values. Out of three dosages with various combinations, for 1.0kg/m³ compound A, 1.0kg/m³ compound B, 18kg/m³ cement and 25% red soil the CBR value is observed to be high and it can be considered as economical in dosage. Therefore this dosage value can be adoptable. At the point when the CBR values for various dosages are compared with the original CBR values, for 0.5kg/m³ Compound A, Compound B and 18kg/m³ cement the CBR value is increased by 2.1 times the original value. For 0.75 kg/m³ Compound A Compound B and 18kg/m³ cement the CBR value is increased by 2.51 times the original value. 1 kg/m³ Compound A, Compound B and 18kg/m³ cement the CBR value is increased to 2.72 times the original value. A soil sample without modifier the CBR value is 3% and for soil sample with cement is 3.4%. A soil sample with 0.5kg/m³ dosage modifiers and cement the CBR value is 6.3% and soil sample with 25% Red soil, modifiers and cement the CBR value is 12.2%. A soil sample with 0.75kg/m³ dosage modifiers and cement the CBR value is 7.51% and soil sample with 25% Red soil, modifiers and cement the CBR value is 13.56%. A soil sample with 1.0kg/m³ dosage modifiers and cement the CBR value is 8.3% and soil sample with 25% Red soil, modifiers and cement the CBR value is 14.6%.

UNCONFINED COMPRESSIVE STRENGTH OF BC SOIL TREATED WITH MODIFIERS.

To untreated and treated BC soil with various combinations unconfined compressive quality tests are led for 7 days curing.

Table 7: UCS values in kPa of treated BC soil with different combinations.

Combination	Dosages	07 days curing UCS values in kPa
01	BC+ 18kg/m³ cement+0.5kg/m³ dosage additive +25% red soil	121.58
02	BC+18kg/m³ cement+0.75kg/m³ dosage additive +25% red soil	123.85
03	BC+18kg/m³ cement+1.0kg/m³ dosage additive +25% red soil	128.54



Graph 5: Variations of UCS values for different curing period

From the above table it can be observed that natural soil with 18kg/m³ cement, 0.5kg/m³ additives and 25% red soil the UCS value is 121.58kPa, with same combination for 0.75kg/m 123.85kPa, with same combination for 1.0kg/m³ it is 128.54kPa.It is observed that with combination 03 that is BC soil with 18kg/m³ cement 1.0kg/m³ additives and 25% red soil the UCS value is increased.

VI Cost Analysis for BC Soil

For this pavement design 1km length and single lane with 3.75m width (3% and 8% CBR, 100msa is assumed)

The following costs are designed as per standard rate schedules.

Table 8: Cost analysis for B.C soil with 3% CBR value

CBR	Pavement layers	Thickness (m)	Quantity (m³)	Rate/m³	Cost (Rs)
3% for 100msa	Sub grade	0.2	750	1408	211200
	GSB	0.38	1425	1212	656298
	WMM	0.25	937.5	1668	390937.5
	DBM	0.155	581.25	7392	665973
	BC	0.05	187.5	8408	78825
	Total cost (Rs)				**2003233.5**

Table 9: Cost analysis for B.C soil with 8% CBR value

CBR	Pavement layers	Thickness (m)	Quantity (m^3)	Rate/m^3	Cost (Rs)
8% for 100 msa	Sub grade	0.2	750	1408	211200
	GSB	0.2	750	1212	181800
	WMM	0.25	937.5	1668	390937.5
	DBM	0.135	506.25	7392	505197
	BC	0.05	187.5	8408	78825
	Compound A	0.2	750	600	90000
	Compound B	0.2	750	200	30000
	Total cost (Rs)				**1487959.5**

Table 10: Cost analysis for B.C soil with 15% CBR value

CBR	Pavement layers	Thickness (m)	Quantity (m^3)	Rate/m^3	Cost (Rs)
15% for 100 msa	Sub grade	0.2	750	1408	211200
	GSB	0.2	750	1212	181800
	WMM	0.25	937.5	1668	390937.5
	DBM	0.08	506.25	7392	299376
	BC	0.05	187.5	8408	78825
	Compound A	0.2	750	600	90000
	Compound B	0.2	750	200	30000
	Total cost (Rs)				**1283479.13**

SOURCE: SCHEDULE OF RATES 2016-17 PW, P & IWTD, SOUTH ZONE, BENGALURU

Table 11: Cost comparison of BC soil for 3% and 15% CBR

CBR in (%)	Cost in Rs.	Total Savings in the cost by the use of modifiers (%)
3%,100msa	2003233.5	0
8%,100msa	1487959.5	25.72
15%,100msa	1282138.5	36

Above tables demonstrates that for 3% CBR value and 100 msa with 3.75m width and 1km pavement plan consideration the development cost is Rs 2003233.5.And for 8% CBR value, and 100 msa with same length and width considerations the development cost is Rs 1487959.5 and for 15% CBR value, and 100 msa with same length and width considerations the development cost is Rs 1282138.5 hence from cost analysis comes about, it is concluded that with increase in CBR value for 8 % treated BC soil Rs 515274 is saved and with increase in CBR value for 15 % treated BC soil Rs 721095 is saved.

VI. CONCLUSIONS

Based on the laboratory investigation, the following conclusions can be drawn:

1. Specific Gravity of Black cotton soil is found to be 2.42 and specific gravity of Red soil is found to be 2.48.

2. Black Cotton Soil contains 8 % of gravel, 18% of sand and 19.50 % of silt and 56.50% clay, it is found that Liquid Limit is 62 % and plasticity index of soil is 23 %. Red Soil contains 55.3 % of gravel, 27.5% of sand and 7.2 % of silt and 10 % clay, it is found that Liquid Limit is 42 % and plasticity index of soil is 14.51 %.

3. The MDD and OMC of Black cotton soil is found to be 16.54 kN/m3 and 22.23 %. The MDD and OMC of Red soil is found to be 18.85 kN/m3 and 13.30 %.

4. The Soaked California Bearing Ratio of Black cotton soil is 3.1 %.and Un-soaked California Bearing Ratio of soil is 5.4 %. The Soaked California Bearing Ratio of Red soil is 17.68 %.

5. CBR values for
   a. 0.5kg/m³ Compound A and Compound B and 18kg/m³ cement the CBR value is increased to 6.3%.
   b. 0.5kg/m³ Compound A, Compound B, 18kg/m³ cement and 25% red soil the CBR is increased to 12.2%.
   c. 0.75 kg/m³ Compound A, Compound B and 18kg/m³ cement the CBR value is increased to7.51%.
   d. 0.75 kg/m³ Compound A Compound B, 18kg/m³ cement and 25% red soil the CBR value is increased to13.56%.
   e. 1 kg/m³ Compound A, Compound B and 18kg/m³ cement CBR value is increased to 8.3%.
   f. 1 kg/m³ Compound A, Compound B, 18kg/m³ cement and 25% red soil the CBR value is increased to 14.6%.

6. UCS values for 7days curing
   a. 0.5kg/m³ Compound A, 18kg/m³ cement and 25% red soil the UCS value is increased to 121.58kPa.
   b. 0.75 kg/m³ Compound A and 18kg/m³ cement and 25% red soil the UCS value is increased to 123.85kPa.
   c. 1 kg/m³ Compound A and 18kg/m³ cement and 25% red soil UCS value is increased to 128.54kPa.

From the above exchange, it can be stated that as the dosage amount increases the CBR and UCS values also increase. In case of UCS tests, as the curing time frame increases the quality also increases. It can also be inferred that the CBR and UCS test consequences of BC soil for 1.0kg/m³ Compound A and compound B with 25% red soil,18kg/m³ cement, the test values are considerably high and also it can be considered as economical in dosage. Thus this value could be adopted.

7. Cost Analysis: From the cost analysis, hereby we estimate that Rs 515274 is saved when Compound A, Compound B and cement are used and Rs 721095 is saved when Compound A, Compound B cement and 25% red soil are utilized for the stabilization of BC soil.

VIII. REFERENCES

1. V. R. Bharambe, Prof. G. K. Patil “A Study on Stabilization of Black Cotton Soil Using Ferric Chloride.” December 2013

3.Arun Patidar and Dr.H.K.Mahiya 2014 “An Experimental study on stabilization of Black cotton soil using HDPE wastage fibres, stone dust and lime” Issue:4 volume:6,Nov-Dec.2014,ISSN 2249-9954.

4. Sanjeev Tanaji Jadhav and sushma shekhar kulkarni July 2014,”Feasibility study of improving properties of Black cotton soil using Industrial waste” Issue:4 volume:3, June-July-2014 ISSN:2279-0535.

5. B M Lekha, S Goutham, A U Ravi Shankar “Laboratory investigation of soil stabilized with Nano chemical”.2013

6. Dilip Shrivastava1, A K Singhai and R K Yadav "Effect of Lime and Rice Husk Ash on engineering properties of Black Cotton soil ". ISSN 2319-5991 Volume: 3 May 2014.

7.K. Suresh, V. Padmavathi, Apsar Sultana “Experimental study on Black Cotton soil with stone dust and fibres” Indian Geotechnical Conference,Guntur,volume:1 2009.

8. Satyanarayan, P.V.V,;Raghu,P;kumar,R.A.and Pradeep. N."Performance of Crusher Dust in High Plastic Gravel soils as road construction materials.IOSR Journal.Volume:10, issue 3, 01-05.

9. Grytansarkar, md.rafiqual Islam, Muhammed alamgir, md.Rokonuzzaman,"Study on Geotechnical Properties of Cement based Composite Fine-grained soil".2012.

10. Rate schedules for 2015 – 2016.

11. "Compound A and Zycobond Test Protocol" by Zydex industries.

Compound-A-Terrasil
Compound-B-Zycobond
Combination 02-Soil+Cement.
Combination 03-Soil+Compound A+Compound B+Cement.
Combination 04-Soil+Compound A+Compound B+Cement+25% Red soil.

1.

Casagrande Apparatus

2. Thread Formation for Liquid Limit

3. Terrasil sample

4. Zycobond sample

5. Compaction mould preparation