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STABILIZATION OF BLACK COTTON SOIL BY USING WASTE CEMENT

[1]Bahul Tripathi,[2]Dr. Amit Vishwakarma

[1]PG Student,[2]Professor UIT,RGPV,Bhopal

[1]Civil Engineering Department,

[1]UIT,RGPV,Bhopal,India.

ABSTRACT: In India black cotton soil is on the market in many countries and it covers around 20 – 25% of area. Thanks to their moisture content variation characteristics they cause severe damage to foundations and super structures of buildings which results in high economic loss. Thus the advancement within the engineering properties of black cotton soil is important to extend its strength, stability and sturdiness, because the conventional soil stabilizers like gravel, sand etc. are depleting and becoming expensive day by day at a really rapid pace, so it becomes necessary to appear towards for alternative eco-friendly stabilizers as their substitute.

The waste cement is proven to be very effective and economical. Another advantage of the waste cement is it's environment friendly nature. The effect of waste cement on the unconfined compressive strength, Optimum moisture content(omc) and Maximum dry density(mdd) values, California bearing ratio(cbr) value and on the atterberg's limits were studied. The waste cement treated soil showing significant improvement in unconfined compressive strength and CBR values .MDD value increases and OMC value also increases. There's an improvement in plastic limit values but liquid limit value decreases.

Index Terms: Waste cement, Optimum moisture content, Maximum dry density, California bearing ratio, Unconfined compressive strength.

1. **INTRODUCTION**: Black cotton soil is considered as an expansive soil due to its high swelling and shrinkage properties. When it comes in contact with water it shows immense swelling but after the water dries out, the soil gets shrink and cracks are developed. In worst case the cracks may extend upto severe limits. Swelling of soils is generally observed in the unsaturated clays which contains clay minerals such as montmorillonite. Black cotton soils are formed from basalt and rock traps. These soils are suitable for growing cotton. Black cotton soils are clay of high plasticity. The shear strength of soil is quite low. These soils are highly compressible with low bearing capacity. So in order to improve the geotechnical properties of this soil a stabilizer should be used. In this study we are using waste cement. Waste cement is that which catches moisture and small lumps are formed in it, basically this type of cement is not suitable for construction purpose. As this cement is unsuitable for construction purpose it is now a waste, so we are using it as a stabilizer in our study.

2. LITERATURE REVIEW:

A.A Amadi et al(2018) studied the effect of quarry fine & cement kiln dust as a stabilizer for black cotton soil. Liquid limit decreased from 85% to 72.5% when 10% quarry fine was introduced and decreased further with the addition of cement kiln dust. The minimum liquid limit value of 44.62% was recorded upon addition of 16% cement kiln dust. Plastic limit generally decreased as the cement kiln dust content increased, recording 38.09% and 25.5% respectively for 0&16% CKD content. Plasticity index values as low as 12.6% was achieved for 16% CKD. Improvement in UCS values ranged from 1.5 to 5 times higher than those tested immediately after preparation.

Ahmed Ejaz Fazal et. Al(2018) studied the effects of marble dust, bagasse ash and cement kiln dust on shear parameters and compaction characteristics of black cotton soil. Optimum moisture content has decreased by 4% and maximum dry density has increased from 1.55g/cc to 1.64g/cc. Combination of black cotton soil,15% marble dust,8% bagasse ash,8% cement kiln dust when cured for 21 days is most effective in increasing the shear strength of black cotton soil. Dry density and UCS has got increased for the addition of 8% cement kiln dust.

Akruti Sagathiya et. Al(2020) studied the effect of cement kiln dust based geopolymer as subgrade soil stabilizer. Maximum dry density was increased from 1.46g/cc to 1.62g/cc. Increment in MDD of modified soil at 20% CKD replacement was 10.96%.Increment in OMC of modified soi at 20% CKD replacement was 19.92%.Increment in unsoaked CBR value at 20% CKD replacement was 135.62%.Soaked CBR value of 20% CKD replacement was increased by 242.57%.

In the present study, characterization of black cotton soil for atterberg's limit, Maximum dry density, optimum moisture content, cbr value and unconfined compressive strength were conducted by mixing black cotton soil with waste cement at different percentage. Pulverized black cotton soil passing through 4.75mm I.S. sieve was used with Waste cement added at 0%, 4%, 8%, 12% and 16%. The optimum percentage of Waste cement that gives maximum improvement in properties was arrived at based on the experimental study.

3. MATERIALS:

The present research has been made using black cotton soil obtained from Awadhpuri, Bhopal district. Before digging top soil layer was removed, Because it contains natural vegetation. The soil was taken from a depth of 1.5 meter for the research work. Soil passing through 4.75mm sieve was taken in this research work. Table 1 shows various properties of black cotton soil

Table 1- Properties of black cotton soil

Properties of Black cotton soil	I.S. codes	Values
Specific gravity	IS: 2720 Part 3	2.65
Natural moisture content	IS: 2720 Part 2	13.63%
Liquid limit	IS: 2720 Part 5	57.06%
Plastic limit	IS: 2720 Part 5	31.45%
Plasticity index	IS: 2720 Part 5	25.61%
Optimum moisture content(OMC)	IS: 2720 Part 7	15.38%
Maximum dry density(MDD) (gm/cc)	IS: 2720 Part 7	1.378
CBR value	IS: 2720 Part 13	2.44
UCS value (KN/M2)	IS: 2720 Part 10	130

Waste cement bag is purchased from a construction material shop. Grade of waste cement used is OPC- 43.

4. METHODOLOGY:

In order to study about stabilization of soil, soil is mixed with Waste cement in different proportions and their engineering properties were determined. Different proportions of waste cement used are 0%,4%,8%,12% and 16%. Following laboratory tests have been conducted as per IS2720-(1985) (Reaffirmed 1995): Standard proctor Compaction Test as per IS-2720 (Part VII), Atterberg's Limit Test (Liquid limit & Plastic Limit) as per IS-2720(Part V), Unconfined Compression Test as per IS-2720 (Part X) and CBR Test as per IS-2720 (Part 13).

5. TESTS RESULTS AND DISCUSSION:

Following are the laboratory test results obtained for different percentages of Waste cement (0 % to 16 %) when mixed with dry weight of Soil

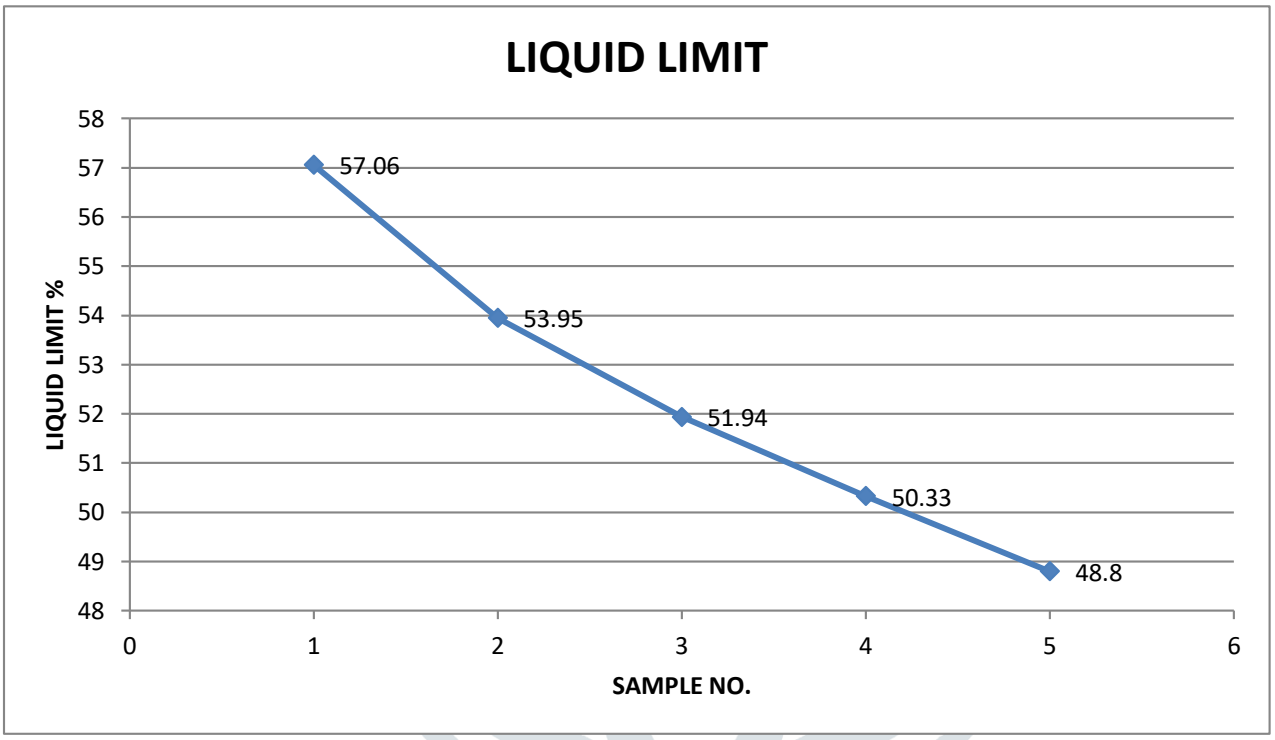
TABLE 5.1 SUMMARY OF RESULTS

S.NO.	PARAMETERS	0% WC	4% WC	8% WC	12% WC	16% WC
1	LIQUID LIMIT (%)	57.06	53.95	51.94	50.33	48.80
2	PLASTIC LIMIT (%)	31.45	30.345	30.14	28.17	26.925
3	PLASTICITY INDEX (%)	25.61	23.605	21.8	22.16	21.875
4	OMC (%)	15.38	16.67	18.11	20.97	22.58
5	MDD (gm/cc)	1.378	1.386	1.39	1.42	1.439
6	CBR (%)	2.44	2.63	2.9	3.28	3.47
7	UCS(KN/M2)	130	132	134	140	145

In below graphs some notations are as follows:

- Sample 1- BCS + 0% Waste cement
- Sample 2- BCS + 4% Waste cement
- Sample 3- BCS + 8% Waste cement
- Sample 4- BCS + 12% Waste cement
- Sample 5- BCS + 16% Waste cement

A. Variation of Liquid limit:



5.1: LIQUID LIMIT VARIATION GRAPH

B. Variation of plastic limit:

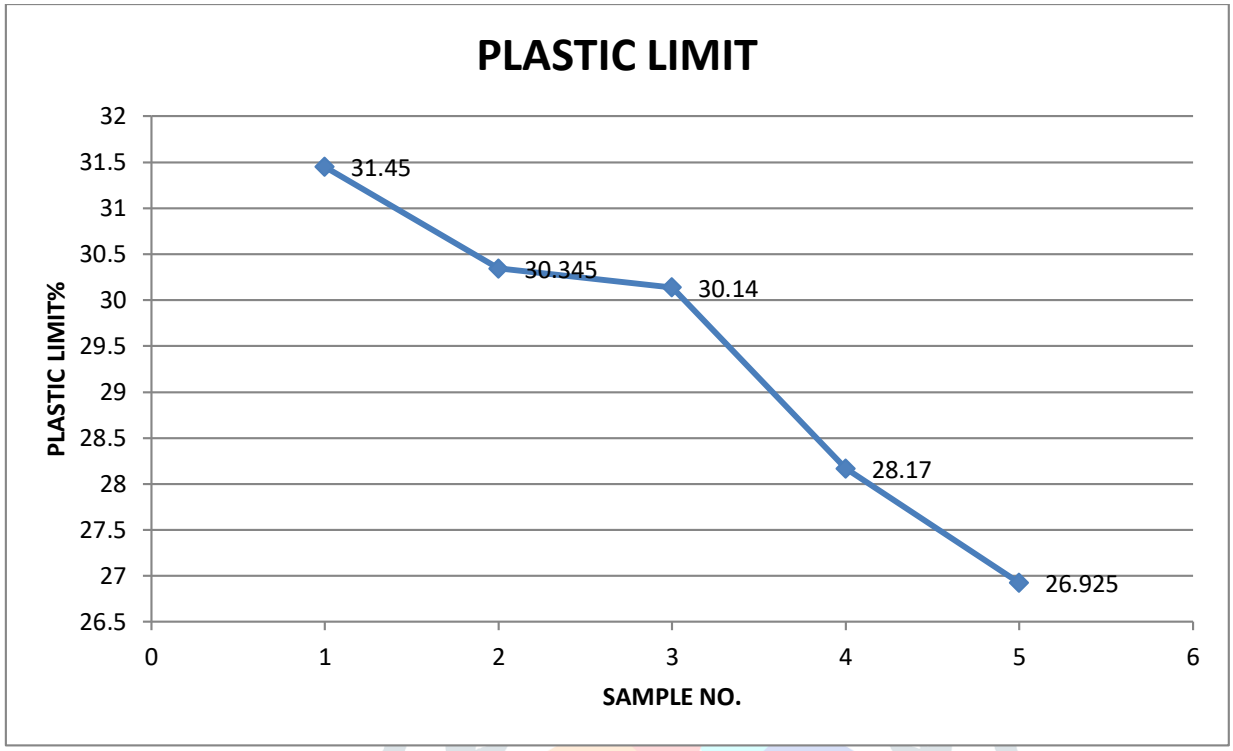
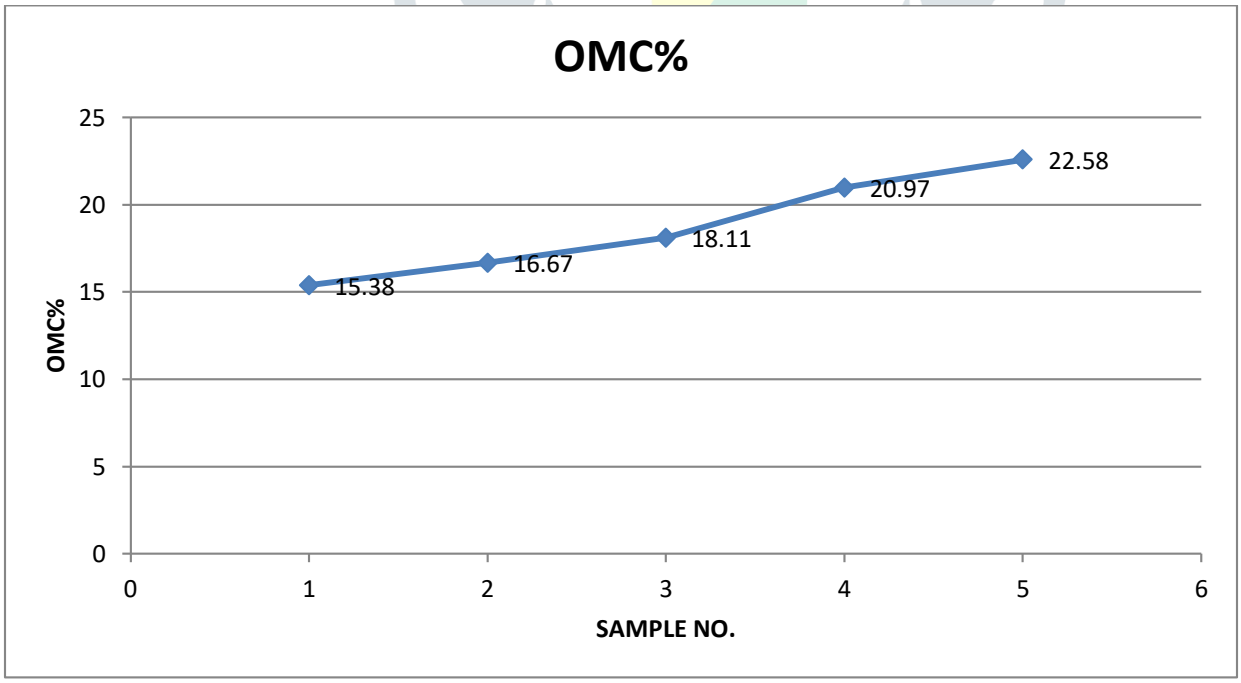


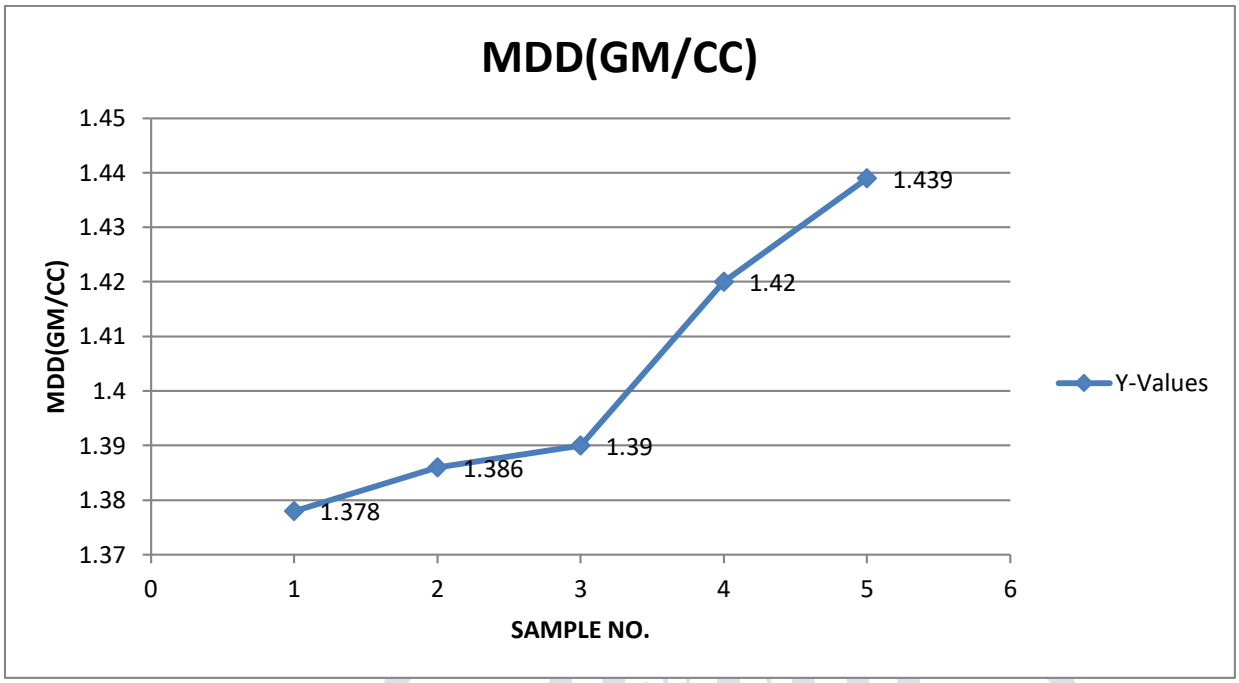
FIGURE 5.2:

PLASTIC LIMIT VARIATION GRAPH

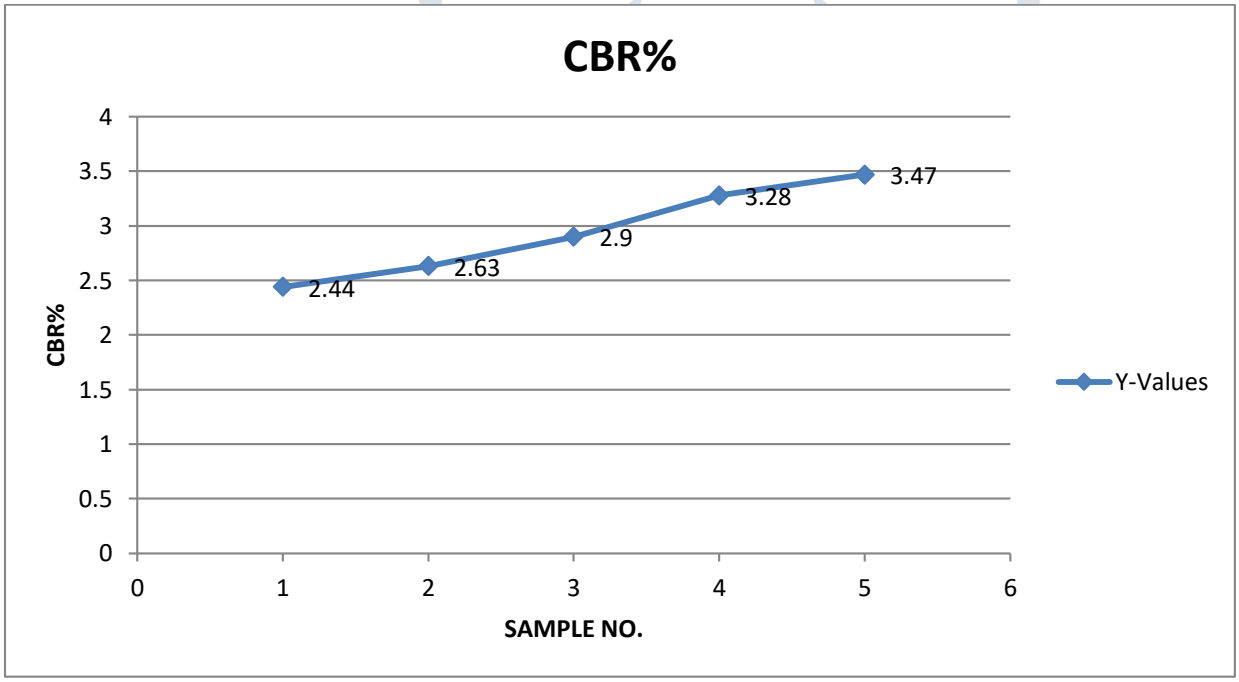
C. Variation of OMC:



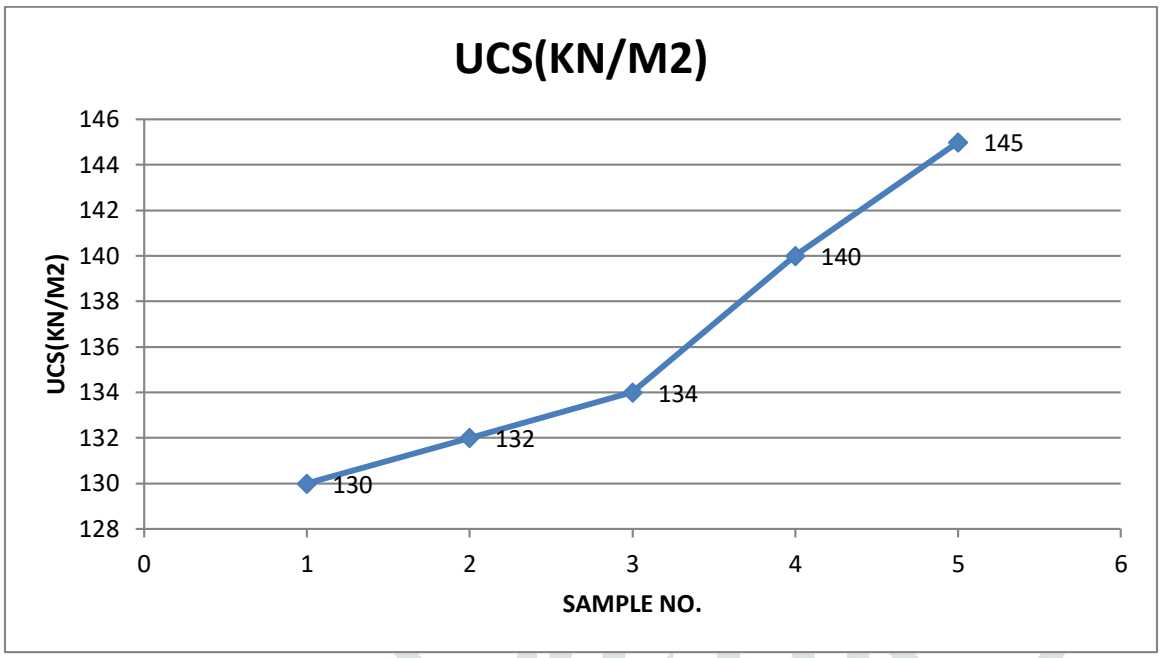
D. Variation of MDD:



E. Variation of CBR:



F. Variation of Unconfined compressive strength:



6. CONCLUSIONS:

Based on laboratory tests conducted on black cotton soil mixed with different proportions of waste cement, following outcomes can be summarized:

- Liquid limit and plastic limit values decreases upon addition of different percentages of waste cement.
- Plasticity index value also decreases upon addition of different percentages of waste cement
- OMC value increases upon addition of different percentages of waste cement
- MDD value also increases upon addition of different percentages of waste cement
- CBR value increases slightly upon addition of different percentages of waste cement
- UCS value also increases slightly upon addition of different percentages of waste cement

Overall it can be concluded that the use of Waste cement as a stabilizer for Black cotton soil is satisfactory, but it does not show a high increase in values for any property of soil.

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