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A STUDY ON THE BEHAVIOR OF BLACK COTTON SOIL WITH MARBLE DUST

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Abstract: Black cotton soil is an expansive soil. It is a boon for the farmhands but also a nuisance for civil engineers as it shows swelling-shrinkage behavior with seasonal variations in moisture content. Montmorillonite mineral kept the onus for this behavior. On field various additive i.e. fly-ash, lime, various bio-enzymes are being used for improving the swell-shrink behavior of black cotton soil. In the present paper, we will be analyzing the efficacy of waste marble dust to improve the swell-shrink behavior of black cotton soil. Following the research work, we found an effective dose of 30% marble dust by weight of black cotton soil. Results show an increase of 193% in CBR and around 43% in UCS value.

Keywords: Marble Dust, black cotton soil, montmorillonite, swell-shrink, stabilization

I. INTRODUCTION

Soil stabilization meant by the improvement of the stability or bearing capacity of the soil by the use of controlled compaction, proportioning and the addition of suitable admixture or stabilizers. Due to the lack of suitable soil in many places, it needs for soil stabilization. The common soil stabilized methods are lime stabilization and cement stabilization, which may be replaced by marble dust for the economy. This reduces its disposal volume. Stabilization is being used for a variety of engineering works, the most common application is in the construction of road and airfield pavements.
Methods of stabilization may be grouped under two main types.
a. Modification or improvement of a soil property of the existing soil without any admixture.
b**.** Modification of the properties with the help of admixtures. Compaction and drainage are examples of the first type, which improve the inherent shear strength of the soil. Examples of the second type are mechanical stabilization, stabilization with cement, lime, bitumen, and chemical.
Mostly the available soils do not have adequate engineering properties to bear the wheel loads. Building fails due to lack of use of soil having adequate engineering strength. So the need for improvement of engineering properties of soil is always a major concern to Geo-tech engineers. To improve the engineering properties of soil continuous researches have been carried and still being carried out. The provision to make the soil better with enhanced soil properties lead to the concept of soil stabilization.
Keeping this view in mind, the present study has been carried out to determine the efficacy of **waste Marble Dust (MD)** and an optimum dose to be added in black cotton soil.

II. LITERATURE REVIEW

1. Parte Shyam Singh et. al. (2014) To investigate the effect of marble dust on index properties of black-cotton soil a series of laboratory experiments have been conducted on black-cotton soil samples mixed with 0% to 40% of marble dust by weight of dry soil. The test results showed a significant change in consistency limits of samples containing marble dust. The liquid limit would decrease from 57.67% to 33.9%. The plasticity index decreased from 28.35% to 16.67% and shrinkage limit increased from 8.06% to 18.39% with the addition of marble dust from 10% to 40% of the dry weight of the black-cotton soil. Also, the differential free swell decreased from 66.6% to 20.0%.

2. R. Ali et. al. (2014) This research is an attempt to investigate the effect of marble dust and bagasse ash on the stabilization of expansive soils. Addition of 4%, 8% and 12% marble dust and bagasse ash are led to reducing the liquid limits, plastic limits, plasticity index, and expansive index. The dry density of expansive soil alsoincreases with the addition of marble dust and bagasse ash and remain maximum approximately at 8% addition but again decline with the addition of 12% marble dust and bagasse ash.

3. Sachin N. Bhavsar et.al. (2014) In this present paper we are performing Atterberg's limits test, linear shrinkage test, free swell index, and modified proctor test for determination of dry density and moisture content on black cotton soil and the mix proportions of black cotton soil and marble powder with 30%, 40%, & 50% replacement of soil by its dry

weight. The liquid limit values for 30% replacement are nearly equal to 37 which 13% less than the black cotton soil value. As the same for 40% replacement liquid limits value decrease by 22% and for 50% marble powder it reduced by 36%.

III. MATERIAL USED

2.1 BLACK COTTON SOIL: Black cotton soil (BCS) shows swelling when it comes to contact with moisture and in absence of moisture it shrinks. In the present study, the soil used is being procured from a field near Borkheda, Kota.

Table I: Properties of Black Cotton Soil

Sr. No.	Property	value
1	Specific Gravity	2.53
2	Liquid Limit	49.51%
3	Plastic Limit	25.92%
4	Plasticity Index	23.59%
5	Maximum Dry Density	1.63 gm/cc
6	Optimum Moisture Content	21.88%
7	Unconfined Compressive Strength	1.56 kg/cm^2
8	Sand	12.46%
9	Silt & Clay	87.54%
10	Soil classification	CI
11	Differential free swell	58.82%
12	California Bearing Ratio	1.58%

2.2 Marble dust: In the present study the used the marble dust was procured from dumping site of discarded Waste Marble slurry near Makrana.

IV. METHODOLOGY

The experimental programme includes the following experiments

Table II: Experimental Program

Sr. No.	Experiment Name	Provision (IS: 2720)
1	Specific Gravity	Part 3
2	Atterberg-Limits	Part 5
3	Standard Proctor Test	Part 7
4	Unconfined Compression Test	Part 10

For the study various proportions i.e. 0%, 10%,20%,30%,40% by weight of Black Cotton Soil.

V. RESULT & DISCUSSION

4.1 Atterberg's-Limits**:**
With increasing the proportion of Marble dust both Liquid limit and Plastic limit tends to decrease.

Table III: Atterberg's Limit Test

Sr. No.	The proportion of MD by weight of BCS(%)	Liquid Limit (%)	Plastic Limit (%)
1	0	49.51	25.92
2	10	45.35	23.07
3	20	41.15	20.58
4	30	36.46	16.67
5	40	32.55	14.28

4.2 Compaction characteristics:
With increasing the proportion of MD the Maximum Dry Density content increase the Maximum Moisture Content tends to decrease to MD 30% by weight of BCS. and after that not sufficient results found.

Table IV: Compaction Test Result

Sr. No.	The proportion of MD by weight of BCS (%)	Optimum Moisture Content (%)	Maximum Dry Density (gm/cc)
1	0	21.88	1.63
2	10	19.78	1.69
3	20	18.49	1.79
4	30	16.84	1.88
5	40	17.58	1.85

4.3 Unconfined Compression Test**:**
With increasing the proportion of MD dust in BCS up to 30% the UCS strength value increases and after that it starts to decrease.

Table V: Unconfined Test Result

Sr. No.	The proportion of MD by weight of BCS (%)	UCS Value (Kg/Cm^2)
1	0	1.56
2	10	1.85
3	20	2.03
4	30	2.22
5	40	2.12

4.4 California Bearing Ratio:
With increasing the proportion of MD dust in BCS up to 30% the CBR value increases and after that it starts to decrease.

Table VI California Bearing Ratio Result

Sr. No.	The proportion of MD by weight of BCS (%)	CBR Value %
1	0	1.58
2	10	2.43
3	20	3.11
4	30	4.63
5	40	4.40

VI. CONCLUSION

1. Plasticity index reduced from 23.59 % to 18.27 %.

2. The maximum dry density increased by 16% on adding 30% Marble Dust by weight.
3. UCS value increased by 43% on adding 30% Marble Dust by weight.
4 An increase 196% in CBR value on adding 30% Marble Dust by weight.

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Standard Codes:

7. IS: 2720 (Part 2) - 1973, "Determination of Water Content"
8. IS: 2720 (Part 4) - 1985, "Determination of Grain Size Analysis"
9. IS: 2720 (Part 5) - 1985, "Determination of Liquid and Plastic Limit"
10. IS: 2720 (Part 8) - 1983, "Determination of Water Content - Dry Density Relation Using Heavy Compaction"
11. IS: 2720 (Part 16) - 1987, "Laboratory Determination of CBR"
12. IS: 2720 (Part X) - 1991, "Determination of Unconfined Compressive Strength"
13. IRC: 37 - 2001, "Guidelines for the Design of Flexible Pavements"
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