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# Stabilization of Black Cotton Soil with Marble Dust

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***Abstract:*** ***Due to increased urbanization and growing population, there arises a high demand for construction activities which in turn increases the waste production day by day. The waste produced in the construction activities comprises of various types of construction debris, rubble, earth, concrete, timber and mixed site clearance materials. Expansive soils are considered as one of the most problematic soil to the geotechnical engineers. The adverse properties of these soils like large volume changes and undesired settlements cause various constructional damages to the structures. But due to the high demand for the land, no site can be abandoned. Therefore the need for the stabilization of the soil arises which improves the properties of the soil making it suitable for construction. In the present study, expansive soil collected locally is stabilized with marble dust which is considered as one of the important waste product in construction activities. Proctor test is conducted on the black cotton soil mixed with various percentages (0, 5, 10, 15 and 20%) of marble dust (MD). The results showed an increase of Maximum dry density (MDD) and a decrease of Optimum Moisture Content (OMC) values with increase of MD percentage. The samples are tested for Unconfined Compressive Strength(UCS) based on the MDD and OMC values obtained from Proctor test for different curing periods of 0, 7 and 14 days. The percentage of marble dust to be added to the expansive soil which yields the maximum UCS strength is reported as the Optimum percentage of marble dust based on the laboratory tests.***
***Keywords: Stabilization, expansive soil, marble dust, UCS***

## I. INTRODUCTION

Soil Stabilization is the process of alteration of soils to enhance their physical properties. Stabilization can increase the shear strength of a soil and/or control the shrink-swell properties of a soil, thus improving the load bearing capacity of a sub-grade to support pavements and foundations. The stabilization process is mostly adopted for soft soils (silty, clayey peat or organic soils) in order to achieve desirable engineering properties. The fine grained granular materials are the easiest to stabilize due to their large surface area in relation to their particle diameter. Expansive soils contain montmorillonite minerals such as smectite clays that are capable of absorbing water. When they absorb water they increase in volume. Expansions of 10% or more are not uncommon. This change in volume can exert enough force on their building or structure to cause damage. Cracked foundations, floors and basement walls are typical types of damage done by swelling soils. Expansive soils will also shrink when they dry out. Marble Dust Powder is a metamorphic rock composed of recrystallized carbonate minerals, most commonly calcite or dolomite. Marble is commonly used for sculpture and as a building material leaving the waste materials to the environment directly can cause environmental problem. Hence the reuse of waste material has been emphasized.

## II. LITERATURE REVIEW

Radhikesh. P et.al [1], investigated the effect of Marble dusts on strength and durability of an expansive soil stabilized with optimum percentage of Rice Husk ash. Marble dust was added to RHA stabilized expansive soil up to 30%, by dry weight of the soil, at an increment of 5%. Compaction tests, UCS tests, Soaked California Bearing Ratio (CBR) tests, Swelling pressure tests and Durability tests were conducted on these samples after 7 days of curing. The UCS and Soaked CBR of RHA stabilized expansive soil increased up to 20% addition of Marble dust. Akshaya kumar sabat[2] presents the effects of waste ceramic dust on liquid limit, plastic limit, plasticity index, compaction characteristics, unconfined compressive strength, California bearing ratio, shear strength parameters and swelling pressure of an expansive soil. The expansive soil collected locally was mixed with ceramic dust from 0 to 30% at an increment of 5%. From the economic analysis it was found that, ceramic dust up to 30% can be used in strengthening the subgrade of flexible pavements, to save the cost of construction. Muthu Kumar M et.al[3],conducted an experimental Study on Expansive Soil with Marble powder. The proportions of marble powder to the expansive soil as 5%, 10% 15%, 20%, 25% and studied the compaction characteristics and strength characteristics. From this experimental work the following results were obtained. The Marble Powder is added about 15%.to the soil as strength point of view. The expansive soil was modified in to low plasticity and silty behavior.

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## III. MATERIALS

### *A. Black Cotton Soil*

The soil specimen is brought from Sheela Nagar, Visakhapatnam. It is sieved by 2mm to remove the lumps, foreign and vegetative matter. The samples thus collected are thoroughly mixed to attain homogeneity and is oven dried at a temperature of around 100-110$^0$ C. The soil samples are stored in air tight containers for further experimental use.

### *B. Marble Dust*

The marble dust used in the present study was collected from Visakhapatnam market which is used as an agent of stabilization. The samples are sieved through 15 microns sieve and stored in air tight container for subsequent use.



Fig 1: Expansive soil



Fig 2: Marble dust

The properties of the soil sample which is oven dried is tabulated below.

| Parameter | Value |
|---|---|
| Specific gravity | 2.58 |
| Liquid limit % | 78.14 |
| Plastic limit % | 39.55 |
| Optimum Moisture Content (OMC) % | 13 |
| Maximum Dry Density (MDD) g/cc | 1.315 |

## IV. METHODOLOGY

### *A. Compaction Test*

The specimens are prepared with lime marble dust percentages 0, 5, 10, 15 and 20 % in the mini compaction mould of volume 500 cc in 3 layers with 36 blows each with the standard hammer. The specimens kept in oven for 24 hours give the moisture content.

| | OMC (%) | Max. Dry Density(g/cc) |
|---|---|---|
| Expansive soil | 13 | 1.315 |
| Expansive soil + 5% MD | 12 | 1.786 |
| Expansive soil + 10% MD | 11 | 1.8 |
| Expansive soil + 15% MD | 10 | 1.91 |
| Expansive soil + 20% MD | 9 | 2.02 |

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*B. Unconfined Compressive Strength*

The Unconfined Compressive strength of black cotton soil with different percentages of marble dust powder as stabilizer (0, 5, 10, 15 and 20) is studied. The samples are cured at constant temperature of $27^0$ C for 0, 7and 14 days.

## V. RESULTS AND DISCUSSIONS

*A. Compaction test*

It is observed that with an increase in marble dust to black cotton soil, the dry density increases and optimum moisture content decreases. The MDD of black cotton soil varies from 1.315 g/cc to 2.02g/cc and the water content decreased from 13% to 9% for increase in marble dust content from 0% to 20%.

*B. Unconfined Compressive test*

The strength of the black cotton soil samples increased from 0.72kPa to 4.1kPa with no marble dust to 20% marble dust respectively. The marble dust added as stabilizer undergoes pozzolonic reaction with the soil. The soil sieved through 2mm sieve is used, which is in fine form resulting in speed reaction. This ultimately results in increase in strength of the soil samples when marble dust is added to it.

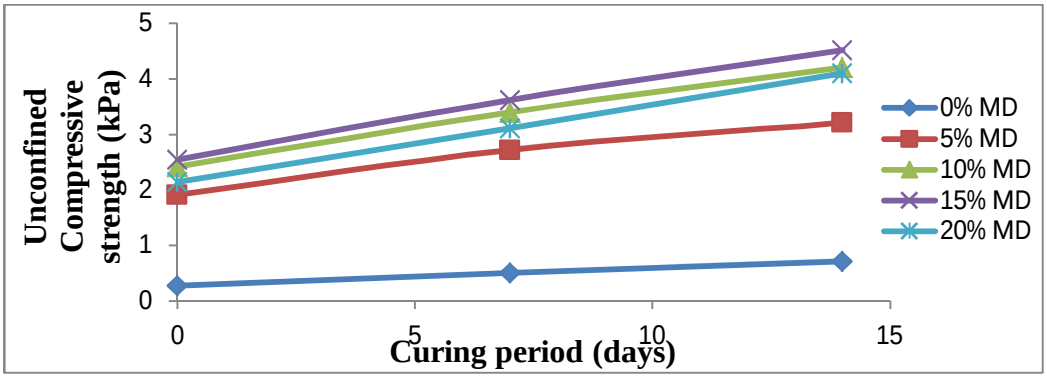



Fig 3: Variation of Unconfined Compressive strength with different curing periods

The results thus obtained from the Unconfined Compressive strength gives the optimum marble dust (%). The value keeps on increasing from 0% to 15% and then decreases from 15% to 20%. Optimum MD percentage of 15% gives the higher strength of soil when the stabilizer is added to it.

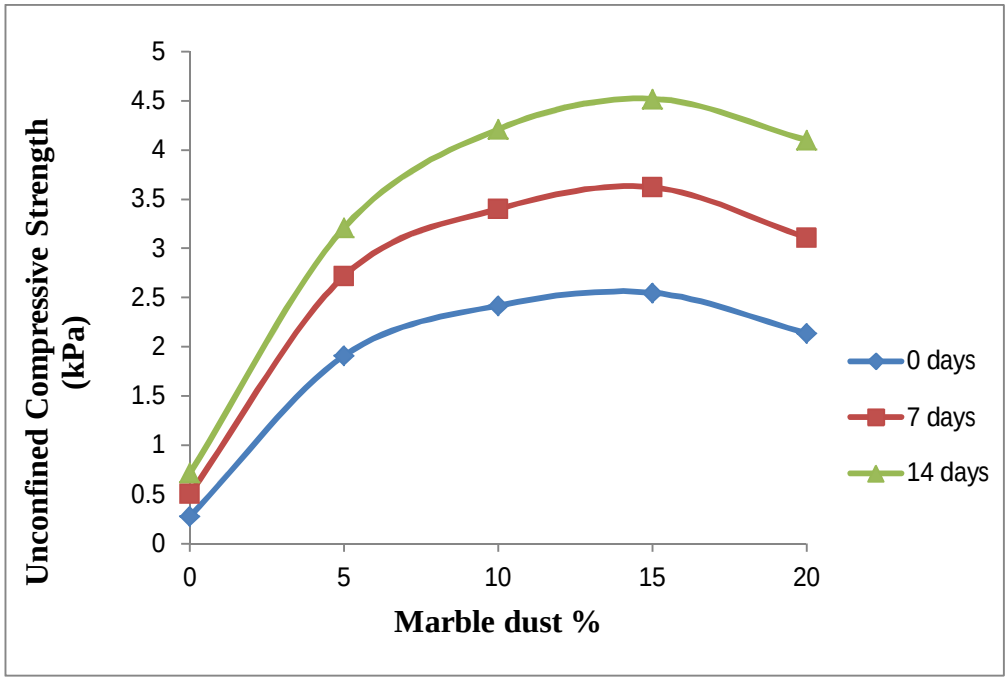



Fig 4: Variation of Unconfined Compressive strength with different percentages of marble dust

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## VI. CONCLUSIONS

*A.* The Maximum Dry Density of black cotton soil varies from 1.315g/cc to 2.02g/cc and the Optimum Moisture Content decreased from 13% to 9% for increase of marble dust from 0 to 20%

*B.* With an increase in marble dust content, the unconfined compressive strength of soil samples increases due to pozzolonic reaction. The strength of the lack cotton soil samples increased from 0.72kPa to 4.1kPa with no MD to 20% MD respectively

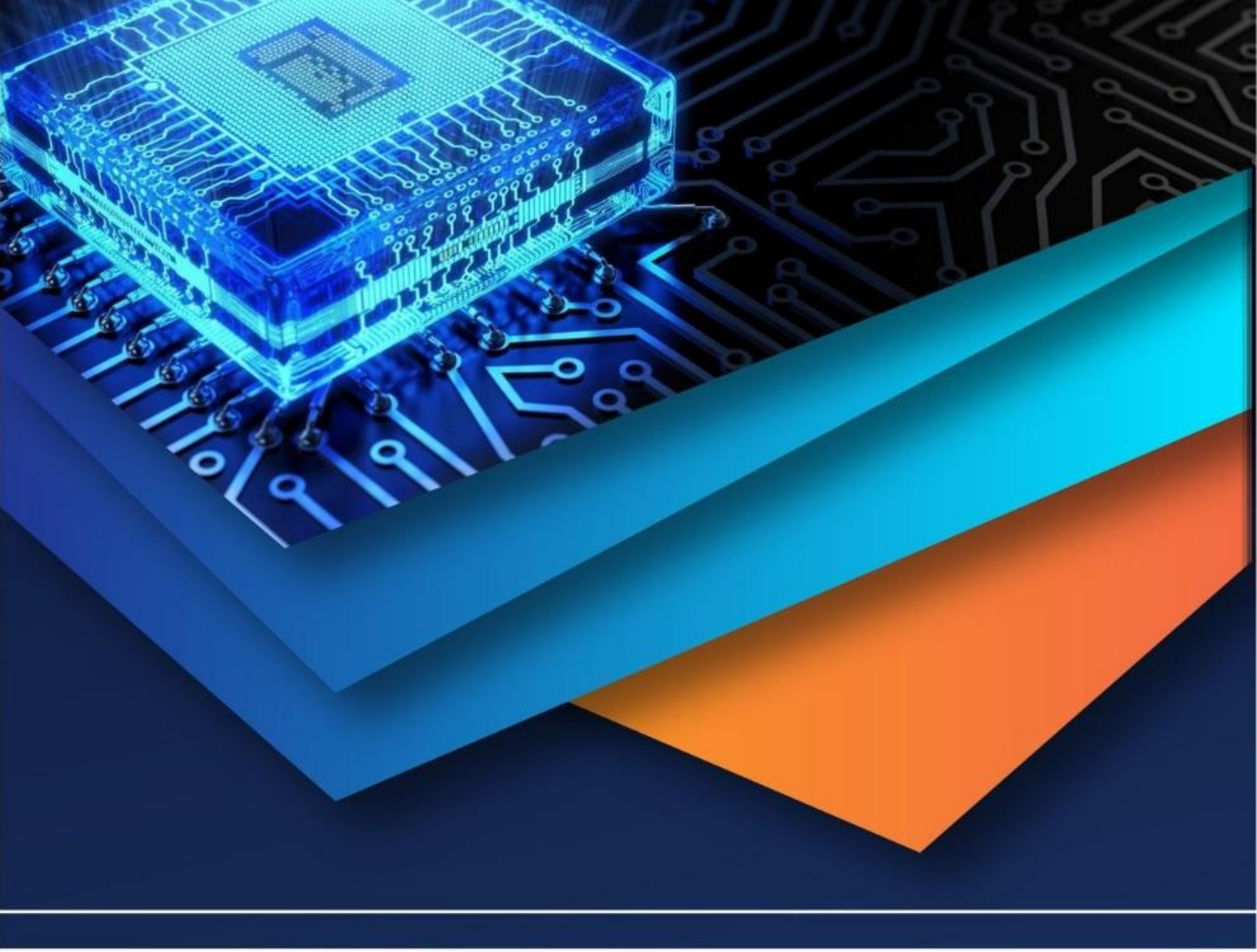
*C.* The immediate strength of black cotton soil samples increased with an increase of marble dust content up to 15%. The strength decreased from 2.55kPa to 2.14kPa from 15% marble dust to 20% marble dust in soil samples

*D.* With an increase in marble dust content, the unconfined compressive strength of black cotton soil samples increases .The strength of the UCS samples immediately showed an increase from 0.28kPa to 2.14kPa for the percentage varying of marble dust from no marble dust to 20% marble dust.

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