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Enhance the Engineering Properties of Black Cotton Soil using Marble Powder

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ABSTRACT: With the increasing of population and the reduction of available land, more and more construction of buildings and other civil engineering structures have to be carried out on weak or soft soil. Owing to such soil of poor shear strength and high swelling & shrinkage, a great diversity of ground improvement techniques such as soil stabilization and reinforcement are employed to improve mechanical behaviour of soil, thereby enhancing the reliability of construction. There are several techniques have been researched up till now whether it may be using marble powder, lime, fly ash, or certain admixtures. As a good stabilizing agent, Marble powder is extensively applied in soil stabilization of foundation or roadbed. The study proceeds in such a way that a soil sample will be collected from the areas near Chamaranagara Taluk that will be the Black Cotton soil. Soil sample is tested barely without any mixture of Marble powder and then it will be tested after addition of Marble powder at certain amounts of Marble powder like at 3%, 6%, 9%, 12% and the results study will be done after these tests. A series of basic tests will be practised and these tests will be helpful to make study that using lime will be a best and cheap method of ground improvement.

KEYWORDS: Stabilization, Admixtures, Marble Powder and Black Cotton Soil.

I. INTRODUCTION

Soil stabilization is the process of improving the engineering properties of the soil and thus making it more stable. In its broadest senses, stabilization includes compaction, pre-consolidation, drainage and many other processes. Soil stabilization is used to reduce the permeability and compressibility of the soil mass in earth structure and to increase its shear strength. However, the main use of stabilization is to improve the natural soil for the construction of highways and make an area trafficable within a short period of time for military and other emergency purposes. The modern era of soil stabilization began in the early 1970's, with a general. Serious problems posed by expansive soils to civil engineering structures are well realized by engineers and researchers the world over. Expansive soils swell considerably and exhibit low shear strength when wet whereas; such soils shrink and exhibit high shear strength in dry condition. Thus, the seasonal moisture variations in such deposits around and beneath the structure lead to subsequent upward and downward movements of structures leading to damages of varying degrees. Civil engineering structures such as highways, canals, and embankments occupy vast areas of land as they often stretch over several kilometres.

Indian soils comprised of expansive soils; a large portion of these structures pass through expanses of such soils. Among various methods for the solutions to the problems posed by expansive soils, especially for large area coverage, the stabilization of such soils would be a natural choice. Stabilization of expansive soils using lime is widely adopted by practicing engineers the world over. When the black cotton soil comes in the contact of water then excessive swelling is caused and when water content decreases shrinkage occurs in the soil. Because of this movement lightly loaded structures such as foundations, pavements, canal beds, linings, and residential buildings founded on them are severely damaged. In India expansive soils covers about 0.8×10^6 Km² area approximately 20% of surface area. The black cotton soil contains a high percentage of montmorillonite mineral which imparts expansive behaviour to it. Disposal of waste materials generated from different industries causes many problems like environment pollution in the nearby locality, scarcity of land for disposal, etc. Industrial waste like blast furnace slag, fly-ash, silica-fume, rice husk ash and stone dust, etc., are considered as alternative materials for soil stabilization.

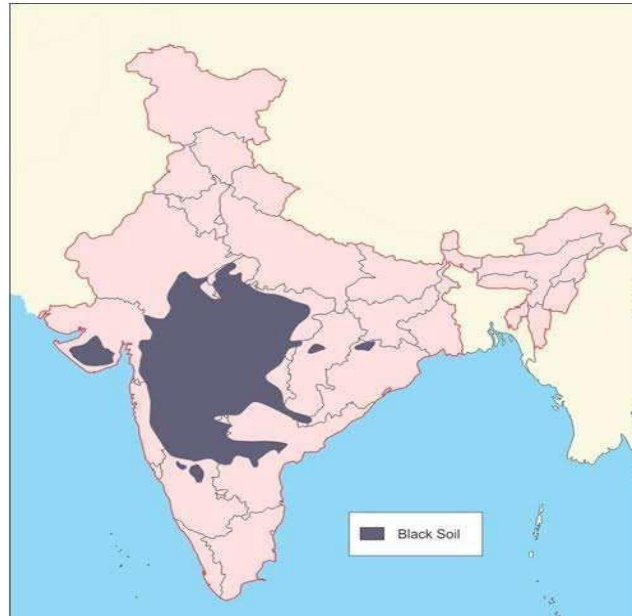


Fig. 1 Area Covered by BC Soil in India

II. LITERATURE REVIEW

Agapitus Ahamfele Amadi (2014) worked on Enhancing durability of quarry fines modified black cotton soil subgrade with cement kiln dust stabilization. The tests were carried out on soil mixtures prepared with Black cotton soil mixed with constant dosage of 10% Quarry fine and five levels of Cement kiln dust concentration (0%, 4%, 8%, 12% and 16% by dry weight of soil). The LL, PL and PI decreased slightly as the CKD content increased.

Itthikorn Phummiphana, Suksun Horpibulsuk, Runglawan Rachanc, Arul Arulrajahd, Shui-Long Shene, Prinya Chindapasirt (2018) studied High calcium fly ash geopolymer stabilized lateritic soil and granulated blast furnace slag blends as a pavement base material. This paper studied the viability of using two types of wastes (class C FA and GBFS) with a liquid alkaline activator to stabilize marginal lateritic soil to form a sustainable pavement base material. The soaked 7-day UCS of FA geopolymer stabilized LS/GBFS blends at various NS:NH ratios met the strength requirements for both low and high-volume roads specified by Department of Highways and Department of Rural Roads, Thailand.

Nurmunira Muhammad, Sumi Siddiqua, and Nima Latifi (2018) studied Solidification of Subgrade Materials Using Magnesium Alkalinization: A Sustainable Additive for Construction. The stabilization of problematic soils with chemical additives has become a popular practice globally. This study introduces the novel concept of using an alkaline activator, along with magnesium chloride ($MgCl_2$), to activate the silica and alumina components of silty sand. Compaction and unconfined compressive strength (UCS) tests were used to assess the mechanical properties of the stabilized soil. The mechanisms that have contributed to the stabilization process are discussed based on the results of microstructural analysis using field-emission scanning electron microscopy (FESEM), energy-dispersive spectroscopy (EDS), and Fourier transform infrared spectroscopy (FTIR) analysis.

III. METHODOLOGY

Material for Study:

- The source and relevant properties of these materials are as follows.
- Soil used in the investigation is brought from Chamarajanagara Taluk.

- Marble Powder used in the investigation so brought from Kadakola, Mysore.



Fig. 2 Soil Sample

Marble Powder:

Marble was obtained from an industry factory at Kadakola, Mysore. Then the stones were crushed into powder in the Ministry of Minerals. The chemical composition of Marble Powder is shown in Table 1.



Fig. 3 Marble Powder

Table 1: Chemical Composition of Marble Powder

Composition	Amount %	Composition	Amount %
Na ₂ O	0.075	Fe ₂ O ₃	0.140
MgO	0.235	CaO	54.207
Al ₂ O ₃	0.508	P ₂ O ₅	0.083
SiO ₂	1.079	TiO ₂	0.021
SO ₃	0.042	SrO	0.040
K ₂ O	0.020	L.O.I	43.50

IV. EXPERIMENTAL RESULTS

Table 2: Engineering Properties of Soil

Liquid Limit	24%
Plastic Limit	20.5%
Plasticity Index	3.5%
Maximum dry density	1.93 gm/cc
Optimum moisture content	13.5%
UCS Value	0.325 kg/cm ²
CBR value	0.94% at 2.5mm 0.83%at 5mm

Effect of marble powder on CBR of soil.

	2.5mm	5mm
3% Marble Powder	1.33%	1.17%
6% Marble Powder	2.65%	2.33%
9% Marble Powder	11.94%	10.49%

V. CONCLUSION

- Replacement of some percentage of marble powder with soil will increase the engineering properties of Black cotton soil which also increase its stability.
- With the conduction of CBR test by varying the percentage of marble powder in the soil mix, there is an increase in the CBR values with the increase in percentage of stabilizers. Form the fig no 24 and fig no 25 if soil has low liquidity than % need of marble powder is high for stabilize the soil.
- Marble powder is environmental friendly material & can be used for construction purposes which also leads to increase in bonding properties of BC soil which also leads to increased bearing capacity of BC soil.
- It is one of the economical method of soil stabilization of BC soil where the raw materials are cheaper when compared to other methods of stabilization of soil.
- After using marble powder in place of black cotton soil we can reduce cost of sub-grade of 10,000/- per lane per km as well along with increase in various parameters.

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