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Stabilization of Black Cotton Soil by using Waste Gypsum

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***Abstract*: Soil stabilization means the improvement of stability or bearing capacity of soil by the use of controlled compaction; proportioning or the addition of suitable admixtures or stabilizers. The main objectives of the soil stabilization is to increase the bearing capacity of the clayey soil, it's resistance to weathering process and soil permeability. The long-term performance of any construction projects depends on the soundness of underlying soils. Unstable clay soils can create significant problems for pavements or structures, therefore soil stabilization techniques are necessary to ensure the good stability of clay soil so that it can successfully sustain the load of the superstructure especially in case of clay soil which are highly active, also it saves a lot of time and millions of money when compared to the method of cutting out and replacing the unstable soil. Soil stabilization has been introduced into the field geotechnical engineering for many years in order to improve the property of ground soil in specific it is one of the most popular techniques used for the improvement of poor soil. Black cotton soil which is one of the major soil deposits in India becomes highly problematic because of its property of higher degree of swelling and shrinkage. These soils are used in subgrade of pavement and also in construction of structures. Hence in order to improve the properties of such soils many methods are available like soil stabilization.**

***Keywords*: California Bearing Ratio (CBR), Waste Gypsum (WG), Unconfined Compressive Strength (UCS).**

1. Introduction

Soil is defined as sediments or other accumulation of mineral particles produced by the physical or chemical disintegration of rocks plus the air, water, organic matter and other substances that may be included. Soil is typically a non-homogeneous, porous, earthen material whose engineering behaviour is influenced by changes on moisture content and density. Based on the origin, soil can be broadly classified as organic and inorganic. Organic soils are mixture derived from growth and decay of plant life and also accumulation of skeleton or shell of small organism. Inorganic soils are derived from the mechanical or chemical weathering of rocks. Inorganic soil that is still located at the place where it was formed is referred to residual soil. If the soil has been moved to another location by gravity, water or wind, it is referred to as transported soil. Black cotton soils are highly clay soil grayish to blackish in color. They contain montmorillonite clay mineral which has high expensive characteristics. BC soils have low shrinkage limit and high optimum moisture content. It is highly sensitive to moisture changes, compressible subgrade material. Hence the subgrade and its undesirable characteristics to be modified using a suitable stabilization technique. Stabilization involves the methods used for modifying the properties of a soil to improve its engineering performance. In the construction pf road and airfield prevents the main objective of stabilization is to increase the strength or stability of soil and to reduce the construction cost by making best use of the locally available materials. Here in this project, soil stabilization has been done with the help of waste gypsum from plaster board industry. The improvement in the bearing strength parameter has been stressed upon and comparative studies have been carried out using different method of bearing resistance measurement. In this way, using waste gypsum from plaster board industry has been used to increase engineering properties of black cotton soil.

2. Objective

- To utilize the easily available material (Waste gypsum) rather than other conventional materials such as cement, Murom etc.
- To reduce the cost of construction as using waste material.
- To provide a working platform on site by making soil waterproof.
- To improve physical properties of soil like stability as well as durability.
- To reduce drastic change in volume of Black Cotton Soil by using Waste gypsum.

3. Methodology

A. Source of materials

1) Soil sample

Soil sample used in the project work for the excavated from a depth of 1.5m below the ground level from Dorli village, Nagpur road, Yavatmal. The soil sample collected was expansive in nature and black in color.

2) Gypsum

Waste gypsum was collected from Malani Baag Godowns, Wani Road, Yavatmal. The collected waste gypsum (gypsum plaster board) had papers stuck to it.

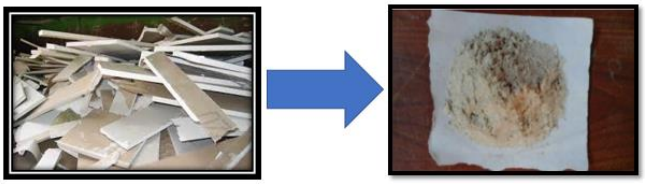

Fig. 1. Gypsum plaster board (wastage) to powdered gypsum from plaster board

Table 1
Physical Properties of Gypsum

Chemical classification	Sulfate
Color	Clear, colorless, white, gray, yellow, red, brown
Streak	white
Luster	Vitreous, silky, sugary
Diaphaneity	Transparent to translucent
Mohs hardness	2
Specific gravity	2.3
Chemical composition	Hydrous calcium sulfate, $CaSO_4*2H_2O$

B. Conduction of tests to determine the basic properties of black cotton soil

1. Specific gravity
2. Atterberg's limit test
3. Free swell index
4. Standard Proctor test
5. California Bearing Ratio test

1) Specific gravity of the soil

Specific gravity of substance denotes the number of times that substance is heavier than water. In simpler words we can define it as the ratio between the mass of any substance of definite volume divided by mass of equal volume of water. In case of soil, specific gravity is the number of times the soil solid is heavier than equal volume of water.

W1= Weight of bottle in gms.
W2= Weight of bottle + Dry soil in gms
W3= Weight of bottle + soil + water
W4= Weight of bottle + water

2) Plastic Limit

The plastic limit of a soil is the moisture content, expressed as a percentage of the weight of the oven-dry soil, at the boundary between the plastic and semisolid states of consistency. It is the moisture content at which a soil will just begin to crumble when rolled into a thread ⅛ in. (3 mm) in diameter using a ground glass plate or other acceptable surface.

IP = Wl – Wp
IP = Plasticity index
Wl = Liquidity index
Wp = Plasticity index

3) Liquid Limit

The liquid limit of a soil is the moisture content, expressed as a percentage of the weight of the oven-dried soil, at the boundary between the liquid and plastic states of consistency. The moisture content at this boundary is arbitrarily defined as the water content at which two halves of a soil cake will flow together, for a distance of ½ in. (12.7 mm) along the bottom of a groove of standard dimensions separating the two halves, when the cup of a standard liquid limit apparatus is dropped 25 times from a height of 0.3937 in. (10 mm) at the rate of two drops/second.

4) Free swell index

Free Swell Index is the increase in volume of a soil, without any external constraints, on submergence in water.

5) Standard proctor test

In geotechnical engineering, soil compaction is the process in which a stress applied to a soil causes densification as air is displaced from the pores between the soil grains. It is an instantaneous process and always takes place in partially saturated soil (three phase system). The Proctor compaction test is a laboratory method of experimentally determining the optimal moisture content at which a given soil type will become most dense and achieve its maximum dry density.

6) California bearing ratio

C.B.R. is defined as the ratio of the test load to the standard load. Expressed as percentage for given penetration of the plunger. C.B.R test is considered to be one of the most commonly used and widely accepted tests. The C.B.R test can be used for the analysis of existing pavements, layers by layer in respect of their strength and load carrying capacity. C.B.R test also helps in identifying the cause of failure of load pavement. The C.B.R values are usually calculated for penetration of 2.5 mm and 5mm Generally, the C.B.R values at 2.5mm penetration will be greater than that at 5mm penetration and in such case the former is to be taken as the CBR Value for design purposes. If the C.B.R. Value corresponding to a penetration of 5mm exceeds that for 2.5mm the test is repeated. If identical result follows, the C.B.R value corresponding to 5mm penetration shall be taken for design purpose

4. Result and discussion

The test results are summarized in table the variation in the specific gravity, free swell index, optimum moisture content, maximum dry density are shown in table.

Table 2
For sample pattern

S. No.	Sample Name	Sample Contents
1	Sample - A	Black Cotton Soil + 0 % Gypsum
2	Sample - B	Black Cotton Soil + 10 % Gypsum
3	Sample - C	Black Cotton Soil + 20 % Gypsum
4	Sample - D	Black Cotton Soil + 30 % Gypsum

Table 3
Table Summery of result

Sr. No.	Tests	Sample - A	Sample - B	Sample - C	Sample - D
1	Specific gravity of the soil	2.532	2.415	2.22	2.16
2	Liquid Limit	52.30	50.80	46.80	45.60
3	Plastic Limit	27.54	25.18	20.06	18.59
4	Free Swell Index	47.91	37.49	25	14.58
5	Standard Proctor Test				
•	O.M.C	19	16	15.5	14.35
•	M.D.D	1.71	1.92	1.79	1.857

5. Conclusion

From this experimental study we calculated that the,

- The specific gravity decreases by 4.62%, 12.32% & 14.69% for the sample of 10%, 20% & 30% gypsum respectively in Black Cotton Soil.
- Liquid limit of the soil will be decrease if we increase gypsum in Black Cotton Soil if we add 10% gypsum, 20% gypsum and 30% gypsum. It reduced limit 2.86%, 10.51% and 12.81% respectively, from original soil liquid limits.
- Plastic limit of the soil sample will be decreases when we add 10%, 20% & 30% of gypsum separately in soil and the result we get are 7.56%, 26.34% & 42.76% respectively.
- The free swell index reduced by 8.70%, 22.60% & 40.86% for the sample of 10%, 20% & 30% gypsum respectively in Black Cotton Soil.
- From Standard Proctor Test we concluded that, The MDD increased by 1.16%, 4.67% & 8.5% for the sample of 10%, 20% & 30% gypsum respectively in Black Cotton Soil.
- OMC decreases by 15.78%, 18.42% & 24.47% for the sample of 10%, 20% & 30% gypsum respectively in Black Cotton Soil.

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