

Soil Stabilization by use of Chemical

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ABSTRACT

This work presented to see the efficiency of nano technology used in terms of chemical named as Terrasil which acts as a modifier and improves the engineering properties of black cotton soil. In India, we see about 51.8 million hectors of land area is covered with black cotton soil which is an expansive soil. It is seen that black cotton soil is very hard when it is dry, and it loses its strength completely when it is wet. Expansive soils are problematic soils worldwide and create problems while constructing structures on it. To improve their properties various methods are adopted. These soils are removed completely or mixed with better quality material or mixed with various additives. This chemical called terrasil is tested by conducting various tests like Proctor test, free swelling test, etc. Soil samples are treated with different percentage of Terrasil 0.9%, 1.1%, and 1.3%. Terrasil gives improved results up to 40% increasing compressive strength of soil. It reduces the swelling property of soil from 60% to 42%.

KEYWORDS: Soil stabilization, Nano technology, Terrasil, Expansive soil

How to cite this paper: Sheetal Nalbilwar "Soil Stabilization by use of Chemical"

Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-3 | Issue-6, October 2019, pp.411-413, URL: <https://www.ijtsrd.com/papers/ijtsrd28118.pdf>



IJTSRD28118

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1. INTRODUCTION

Expansive soils are those soils, which have a tendency to shrink and swell with the variation in water content. It is mostly found in areas such as Gujarat, Madhya Pradesh and Maharashtra. It is also found in states like Tamil Nadu, Andhra Pradesh and Karnataka. Black soil is extremely fine and clayey and has the capacity to hold a lot of moisture. It becomes sticky in the rainy season and develops cracks when dry. Black soil is good for producing cotton, oilseeds, wheat, linseed, millets, and tobacco.

Black cotton soil shows property of high plasticity and water receptivity which makes it highly problematic due to clay mineral. More the soil will absorb the water more will be the volume change. Black cotton soil are considered as potential natural hazard, if not treated well can cause extensive damage to the structures built on it and in terns cause loss of human life. As India is a developing country it becomes a national interest to have stable highways and structures.

Soil Stabilization is the process which improves the load bearing capacity of soil. It involves changes in properties like strength, density, porosity, permeability, swelling behavior, etc. Among the various methods of soil stabilization chemical stabilization has got preference as it reduces setting and curing time. However, it may prove to be expensive than other methods of stabilization.

Terrasil is a nano technology based material. It is made of 100% organosilane molecules. It forms Si-O-Si bonded nano-siliconize surfaces and converting water loving silanol group to water repellent Alkyl Siloxane group in soil. Terrasil is highly water soluble, UV stable, Heat stable and active soil stabilizer which is used for sub grade stabilization till yet. Terrasil is user friendly product which makes treated soil

highly water repellent. Terrasil delivers proven results with all types of soils and doesn't change its appearance. When applied on soil, it start bonding with soil's silica and oxygen molecule. This chemical reaction makes the soil about 98% water resistant. The bonding process starts within 3 hours of application and completes after about 72 hours. After application it becomes a permanent part of each soil molecule and do not separate or leach out into groundwater.

2. MATERIALS AND METHODS

The raw materials, chemicals, and method of preparation are mentioned below.

2.1. Black Cotton Soil

The black cotton soil used in experiment is collected from Ravet area located at Ravet-Aundh BRT road, Pune, Maharashtra. The soil is classified as highly compressible clay, CH as per IS: 1498-1970. Following are the geotechnical properties of parent soil.

TABLE1. Physical Properties of Parent Soil

Physical Properties	Value
Gravel	0
Sand	0
Silt	5%
Clay	95%
Specific Gravity	1.69
Liquid Limit	77.65
Plastic Limit	58.59
Plasticity Index	19.06
I S Classification	CH
MDD	1.43 gm/cc
OMC	23.7%

2.2. Terrasil

Terrasil is a nano technology based material. It is available in concentrated liquid form and is to be mixed with water in specific proportion before mixing with the soil. The Terrasil is purchased from Zydex Industries Pvt. Ltd.

TABLE2. Chemical Composition of Terrasil

Chemical Compound	Value in range, %
Hydroxyalkyl-alkoxy-alkylsilyl	65-70
Benzyl alcohol	25-27
Ethylene glycol	3-5

TABLE3. Mechanical Properties of Terrasil

Mechanical Properties	Description
Appearance	Pale yellow liquid
Solid content	68±2%
Viscosity at 25°C	20-100cps
Specific Gravity	1.01
Solubility	Forms water clear solution
Flash Point	Flammable 12°C

2.2.1. Dosage of Terrasil

The dose of Terrasil used in soil is about 1 litre of Terrasil for 1000 kg of soil. Trials were carried out by mixing the soil at 0.9% (dose 1), 1.1% (dose 2), and 1.3% (dose3) by weight of dry soil. As per the guidelines of Zydex industries, application of stabilizer is done in two levels.

2.3. Experimental Investigation

2.3.1. Standard Proctor Test

Standard Proctor test has been conducted on parent soil and the soil treated with different dosage of chemical to know the Maximum dry density and Optimum water content.

Sample was prepared by taking 3 kg of oven dried soil. Terrasil was diluted in water at 150% of OMC and added to soil, mixed properly and the mixture was kept for air drying for 3 days. After 3 days of drying, mixture surface was 90-95% water resistant. In second stage, 1% of cement by the weight of soil was added before compaction to achieve desired density.

2.3.2. Unconfined compression test

Specimen of parent soil and soil treated with Terrasil were prepared with Maximum dry density and Optimum moisture content. Terrasil was mixed in water as 150% of OMC and kept aside for drying for 3 days. Before using for the test, one percent cement by the weight of soil was added to achieve desired compaction density. The unconfined compression test (with 7 days curing period) was conducted on the soil specimens to determine the shear strength of soil for each dosage.

2.3.3. Free Swell Test

About 10 gm of oven dried soil, passing through 425 micron IS sieve, was taken. Soil Samples treated with different dosage of Terrasil and parent soil were taken in 100 ml cylinder. One cylinder was filled with distilled water and other was filled with kerosene oil. Entrapped air was removed by shaking and by stirring with glass rods. Both the cylinders were kept aside and allowed to settle for 24 hours. Final volume of both the cylinders was noted down.

Free Swell Index (%) = $(V_2 - V_1) / V_1 * 100$

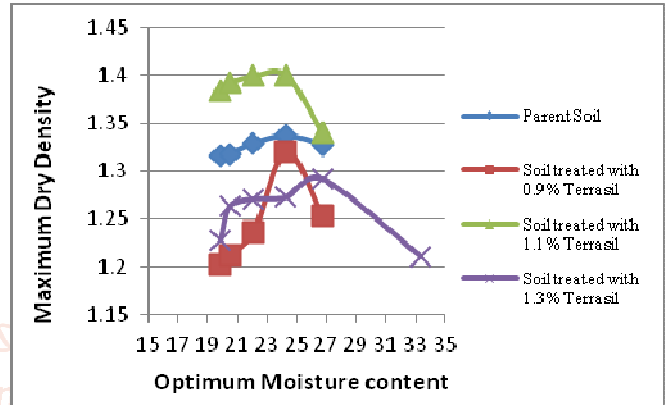
Where, V_1 = Volume of soil specimen in the cylinder containing Kerosene oil

V_2 = Volume of soil specimen in the cylinder containing distilled water.

3. RESULT AND DISCUSSION

3.1. Moisture density relationship

Standard Proctor test has been conducted to determine the Optimum moisture content and maximum dry density of soil under investigation, stabilized with different dosage of Terrasil. The graph shows the values of MDD and OMC for soil under investigation with various dosage of stabilizer.



Graph 3.1 Compaction curve for different dosage of stabilizer along with parent soil

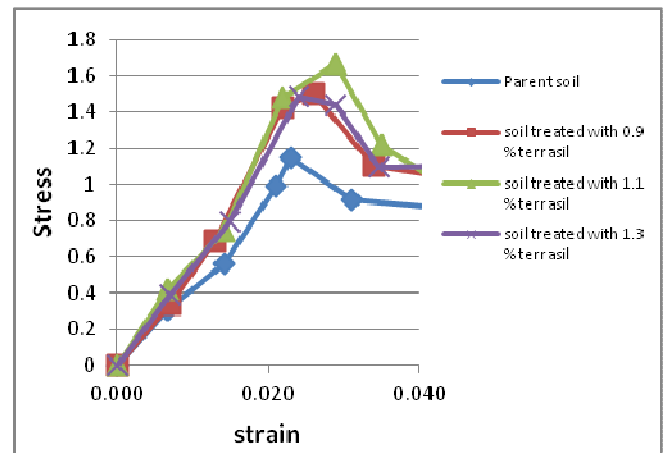
For parent soil, OMC and MDD were observed to be 23.71 % and 1.337 g/cc. It is observed that OMC for different dosage of Terrasil increases as we increase the dosage of Terrasil.

Maximum dry density of Parent soil is 1.337 g/cc. MDD found to get decreased as we increase the dosage of Terrasil.

Maximum value of MDD is obtained at dosage of 1.1 % of Terrasil in the soil.

3.2. Unconfined compression strength

The stress strain relationship has been determined from unconfined compression test. The results are shown below.



Graph 3.2 Stress Vs Strain curve for different dosage of stabilizer along with parent soil

It has been seen that the unconfined compression strength increases from parent soil till the dosage of Terrasil is 1.1% and further increase in dosage of stabilizer causes decrease in strength.

3.3. Free Swell test

Normally when black cotton soil comes in contact with water it swells. This tendency of BC soil is determined by free swell test. Parent soil showed swelling to be 60%. As it was treated with various dosage of Terrasil, the swelling was observed to be decreasing.

TABLE4. Free swell test results

Dosage	Vol. of soil in cylinder containing kerosene (v1) (ml)	Vol. of soil in cylinder containing water (V2) (ml)	Free swell index
Parent soil	10	16	60%
0.9%	10	15	50%
1.1%	9.5	13.5	42.1%
1.3%	9	12.8	42.2%

4. Conclusion

This study shows the influence of Chemical Stabilizer Terrasil with various dosages on geotechnical properties of black cotton soil. As the dosage of Terrasil increases the properties get enhanced. From all the tests, it is found that the dosage 1.1% of Terrasil gives better results. There is significant change in swelling behavior as well as the

compressive strength of black cotton soil which proves Terrasil is worthy stabilizer for black cotton soil.

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