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STABILIZATION OF SUBGRADE SOIL USING SAND, CEMENT AND TERRASIL CHEMICAL AS AN ADDITIVE

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Abstract - The present work is done in stabilizing the black cotton soil by using Sand, Cement and Terrasil chemical. The tests conducted for this study were Atterberg's limit, specific gravity, sieve analysis, standard proctor, unconfined compression test and California bearing ratio test. So in this present study the black cotton soil is collected from HAGARGA (KALABURAGI). It has been stabilized by using Sand, Cement and Terrasil chemical. The present work aims to determine the optimum dosage of Terrasil chemical using 30% Sand and 3% Cement as constant in improving the strength characteristics of soil. The effectiveness of Terassil is tested by conducting various tests like UCS, SPT, CBR. On the soil sample treated with different dosages of Terrasil as 0.6Kg/m^3, 0.75Kg/$m^3$and 1Kg/m^3. The combination of all these, i.e. 30% Sand, 3% cement and different dosages of Terrasil chemical has great influence on swelling behavior of black cotton soil. It proved to be worthwhile as well as versatile stabilizer in case of expansive soil as it enhances almost all geo-technical properties of soil.

Key Words: Stabilization, Black cotton soil, Sand, Cement, CBR ETC.

1. INTRODUCTION

Many civil engineering structures fail due to failure of soil underlying the structure for e.g. construction of buildings, dam, bridges, etc. Building foundations need to be on stable and strong soils. Expansive soils pose several problems to civil engineers and to Geotechnical Engineers. Expansive soils such as black cotton soil have the tendency to increase in volume when water is available and to decrease in volume if water is removed. Black cotton soil contains the clay mineral montmorillonite which is responsible for the excessive shrinkage and swelling characteristics of soil. These volume changes in swelling soils are the cause of many problems in structures that come into their contact or constructed out of them.

1.1 BLACK COTTON SOIL

During monsoon's, these soils absorb water, swell, become soft and their capacity to bear water is reduced, while in drier seasons, these soils shrinks and become harder due to evaporation of water. These types of soils are mainly available in arid regions of the world. Black cotton soil shows the property of high plasticity and water receptivity which makes it highly unsuitable due to a clay mineral called montmorillonite. More the soil will absorb the water more will be the volume change. Black cotton soil is considered as a potentially hazardous soil which if not treated well can cause extensive damages to not only to the structures built upon them but also can cause loss of human life.

1.2 STABLIZATION

It refers to various process or methods which improves the load carrying capacity of soil. Soil stabilization involves changes in properties like strength, density, swelling behavior etc. By means of soil stabilization techniques, strength characteristics of poor soil like Black Cotton soil can be improved. Such techniques are very economical which reduces overall cost of a project.

2. MATERIALS

The materials used in the investigation are Black Cotton Soil, Sand, Cement and Terrasil chemical.

2.1 Black cotton soil: The soil is classified as highly Compressible clay, CH, as per IS: 1498(1970).

2.2 Terrasil: Terrasil is a nanotechnology based material. It is made of 100% organo-silane molecules. Terrasil

forms Si-O-Si bonded nano-siliconize surfaces and converting water loving Silanol groups to water repellent Alkyl Siloxane groups in soil.

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

Table -1: Chemical Composition Of Terrasil

Physical properties	VALUE
Free swell value	40%
Specific gravity	2.46
Plastic limit	31.83%
Liquid limit	76%
Classification as per is:1498-1970	CH
MDD	1.46 g/cc
OMC	28.5%
CBR value (4 days soaked)	1.93%
UCS value	1.765Kg/cm^2

Table -2: Properties of Parent Soil

3. METHODOLOGY

3.1 FREE SWELL INDEX

About 100-150gm of soil was dried in oven, four cylinders were taken to determine the optimum percentage of Sand. In first cylinder Soil+10% Sand was placed, second cylinder soil+20% sand was placed, in third cylinder soil+30% sand was placed and later on that was filled with distilled water and it was kept for 24hrs. After 24hrs the decrease in swell was measured for different cylinders. The least was fixed as optimum percentage for sand.

3.2 UNCONFINED COMPRESSIVE STRENGTH

Calculate the volume of the mould. Take about 100-150gm of soil sample. Add 30% Sand and 3% Cement by the weight of soil to the dry soil sample. Mix the sample with sand and cement properly. Taking 1:200 proportion of Terrasil and water, dilute the Terrasil into water and prepare the solution in OMC water mix it properly. Add the solution to dry mix of Soil, Sand and Cement properly. Put the wet sample into mould in three layers each layer is compacted with sufficient no of blows, after each layer scratch the surface with spatula such that there should be proper bond between above layer and bottom layer. Trim the above surface and make the surface of the specimen level. Roll the specimen such that it should obtain uniform shape. Place the specimen into the machine and start the test. Note down the dial gauge reading and strain reading. Calculate the compressive strength of the specimen.

3.3 CALIFORNIA BEARING RATIO

About 5 kg samples was prepared by mixing Soil+30%Sand+3%Cement. Mix the sample properly such that cement and sand should be equally gets distributed. Take the CBR mould apply oil inside the mould properly such that there should no difficulty in removing the sample. Prepare a solution of Terrasil mixed with water, add that solution to the mix sample and mix it properly. Place the sample into the mould in 5 layers each layer being compacted for 56no of blows. Remove the collar and trim the soil sample and make it level. Prepare another solution of Terrasil mixed with water for curing of the surface. The rate of application of Terrasil for curing is 3Kg/m^2. Apply to one surface and make it dry for 45mins to 60mins in natural sun light. After that turn the mould and apply solution to another face and keep it in sunlight for same 45mins to 60mins. After drying, keep the specimen for 7days air drying. After 7days of air drying place the mould into bucket of water and keep it for 4days. After 4 days remove the mould from bucket and keep it inclined for 30-45 mins. Such that all the water present in the mould comes out. After that place the mould into CBR apparatus and test the sample. Note down the penetration and dial gauge reading for further calculation.

4. RESULTS AND DISCUSSION

4.1 FREE SWELL INDEX

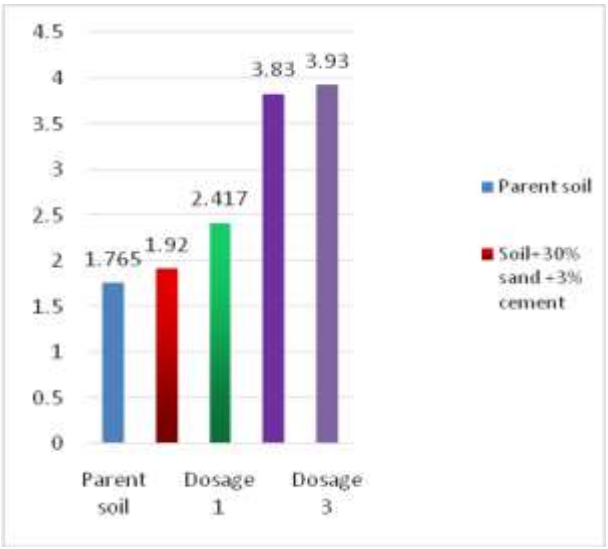
DOSAGE	VOLUME OF SOIL IN KEROSENE	VOLUME OF SOIL IN WATER	FREE SWELL INDEX
Parent Soil	10	14	40 %
Soil+10%Sand+ 3%Cement	10	12	20 %
Soil+20%Sand+ 3%Cement	10	12	20 %
Soil+30%Sand+ 3%Cement	10	11	10 %

Table -3: Result of Free Swell Index

4.2 UCS TEST

DOSAGE	UCS VALUE
Soil+30%Sand+ 3%Cement	1.92 KG/CM2
Soil+30%Sand+ 3%Cement+ 0.6KG/M3 TERRASIL	2.417 KG/CM2
Soil+30%Sand+ 3%Cement+ 0.75KG/M3 TERRASIL	3.83 KG/CM2
Soil+30%Sand+ 3%Cement+ 1KG/M3 TERRASIL	3.93 KG/CM2

Table -4: Result of UCS Test



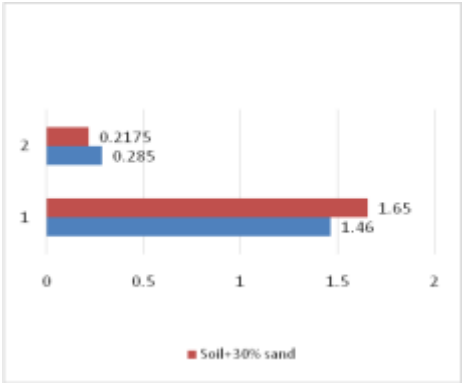
Graph-1: variation in strength

Figure-1: UCS specimen

4.3 STANDARD PROCTOR TEST

DOSAGE	MDD in g/cc	OMC in %
Parent soil	1.42	28.5 %
Soil+30%Sand+ 3%Cement	1.65	21.75 %

Table -5: Result of Standard Proctor

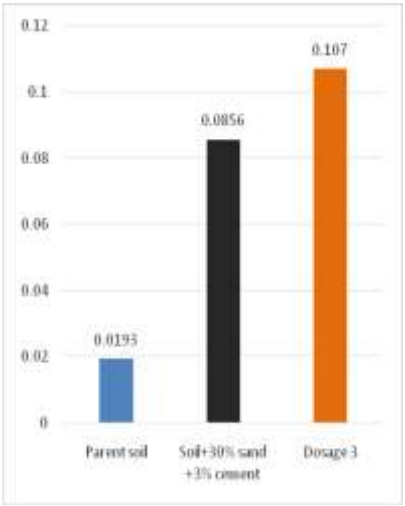


Graph-2: variation in MDD and OMC

4.4 CBR RESUT

DOSAGE	Cbr value
Soil+30%Sand+ 3%Cement	8.56 %
Soil+30%Sand+ 3%Cement+ 1KG/M3 TERRASIL	10.78 %

Table -6: Result of CBR



Graph-3: variation in CBR result

5. CONCLUSION

1 .**Free swell test**: - The free swell of parent soil was observed to be 40%, later when Sand was added to target the soils from 10% to 30% Sand at 10% interval and with minimum quantity of cement i.e. 3%. The value of swell for 10% and 20% Sand was found to be 20% and the value of swell for 30% Sand was found to be 10% which was least among all the values. So we have observed that increase in amount of Sand decreases the value of swell.

2. **Liquid limit**: - The liquid limit value of parent soil was found to be 76%. Later on the soil was modified with 30%Sand and 3%Cement then the value of liquid limit was observed to be 54%. The modified sample was treated with different dosages of terrasil i.e. (0.6Kg/m^3,0.75Kg/m^3,1 Kg/m^3). By this combination of 30%Sand, 3%Cement and 0.75 Kg/m^3 terrasil, liquid limit got reduced to 50.9%.

3. **Standard proctor test**: - The MDD and OMC of parent soil was found to be 1.42g/cc and 28.5% respectively. It has been observed that MDD of soil increases in addition of 30% Sand to the parent soil i.e. 1.65g/cc and also the OMC decreases from 28.5% to 21.75%.

4. **Unconfined compression test:** - The compressive strength of parent soil was found to be 1.765kg/cm^2. Soil was modified with 30%Sand and 3%Cement the compressive strength increases to 1.92kg/cm^2. The modified sample was treated with different dosages of terrasil, it was found to be the Compressive strength increases with increase in dosage of terrasil. Dosage 3 gives the maximum value of compressive strength i.e. 3.93g/cm^2.

5. **California bearing ratio:** - The CBR value of parent soil was found to 1.93%. The CBR value of modified soil (Soil+30%Sand+3%Cement) was observed to be 8.6%. The modified sample was treated with different dosages of Terrasil. 1 Kg/m^3terrasil gives the maximum value of CBR 10.7%.

This study shows that treatment of soil with (Sand, Cement and Terrasil) provides substantial and durable benefits when used as stabilizing agent for Black cotton soil. There is significant change in the swelling behavior as well the compressive strength of Black Cotton soil which proves as a worthy stabilizer for Black Cotton soil.

Scope of Further Studies

1) Use of Terrasil in stabilizing the Black cotton soil need to be explored in broader ways. Like use of Lime and Terrasil as a stabilizing agent.

6. REFERENCES

1. **Lekha B. M, GouthamSarang, Chaitali N Ravi Shankar** (2011). A laboratory investigation on black cotton soil stabilized with nontraditional stabilizer IOSR Journal of Mechanical and Civil Engineering (IOSRJMCE) e-ISSN: 2278-1684, p-ISSN: 2320- 334X PP 07-13.

2. **Y. Keerthi, P. DivyaKanthi, N. Shyam Chamberlin, B. Satyanarayana** (April 2013), Stabilization of Clayey Soil using Cement Kiln Waste, International Journal of Advanced Structures and Geotechnical Engineering ISSN 2319-5347, Vol.02, No. 02.

3. **B M Lekha, S Goutham and A U Ravi et.al** (2013) experimentally investigated the "Stabilization of Black Cotton soil using nano-chemical".

4. **Raheman Patel, Sagar, Sunil, Tippanna** et.al (2018) studied the effect of "Soil Stabilization using Terrasil and Zycobond chemical".

5. **IS: 2720 (Part II) – 1973**, Determination of Water Content.

6. **IS: 2720 (Part IV) – 1985**, Determination of Grain Size Analysis.

7. **IS: 2720 (Part V) – 1985**, Determination of Liquid and Plastic Limit.

8. **IS: 2720 (Part VIII) – 1987**, Determination of Water Content – Dry Density Relation Using Light Compaction.

9. **IS: 2720 (Part XVI) – 1997**, Laboratory Determination of CBR.

10. **IS: 1498 – 1987**, Classification and Identification of Soils for General Engineering Purposes.