International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES),(UGC APPROVED)
Impact Factor: 5.22 (SJIF-2017),e-ISSN:2455-2585
"A National Conference on Recent Trends in Civil Engineering-II"
Volume 5, Special Issue 03, March-2019.

# A Review Study on Stabilization of Black Cotton Soil by Admixtures

Shivam[1], Er. Harshil Bhatt[2]

[1]*B. Tech Scholar, Department of Civil Engineering, Vivekananda Institute of Technology, Jaipur, Rajasthan, India*[1]
[2]*Assistant professor, Department of Civil Engineering, Vivekananda Institute of Technology, Jaipur, Rajasthan, India*[2]

***ABSTRACT-Expansive soil is which possess poor shear strength with high swelling and shrinkage. The behavior of the soil under the application of loads changing its physical and engineering properties. When the expansive soil is exposed to variation in climatic condition leads to increase or decrease in swelling and shrinkage ratio. These variations can be minimized by admixtures such as Quick lime, Marble Dust, Kota- Stone Slurry, Rice Husk Ash and Fly Ash. The present study deals with evaluation of physical and engineering properties of expansive soil which is mixed with admixtures in a varying proportions and the results by comparing it with standard codes and practices. The experimental study also revealed that with the increase of percentage of different admixtures like Quick lime, Fly Ash, Marble Dust, RHA and Kota Stone Slurry there is an increase in Maximum dry density values where as there is considerable reduction in optimum moisture content for the given soil by conducting standard proctor test also with the conduction of CBR test by varying the percentage of admixtures like Lime, Marble Dust, RHA, Kota Stone Slurry and Fly ash in the soil mix, there is a gradual increase in the CBR values with the increase in percentage of stabilizers.***

***Keywords: Strength, CBR, Soil stabilization, admixtures, physical properties of soil, unconfined compressive***

## I.INTRODUCTION

Soil stabilization is the improvement of strength or bearing capacity of soil by controlled compaction, proportioning and addition of suitable admixtures or stabilizers. Soil is a naturally occurring material which are stabilized to increase the strength, durability and increase in design life of the engineering project. There are so many methods to stabilize the soil and the method should be analyzed in the laboratory initially with soil material before applying it on the field conditions. The basic property of the soil should have good strength and load bearing capacity so that external loads can be transferred to the below layers effectively without undergoing any structural failure. Stabilization of soil should be cost-effective, long-term physical and chemical alteration of soil will enhance their physical properties which can improve shear, unconfined compressive strength and permanently lower the soil's permeability to water.
The major Principles of Soil Stabilization are to evaluate the soil properties. To decide lacking property of soil, choosing the effective method for the stabilization of soil mix sample. Gradation of the soil is also a very important property which is considered where the soil may be well-graded which is desirable as it has less number of voids and sounds stable but has more voids thus, it is better to mix different types of soils together to improve the soil strength properties. Advantages of soil stabilization are Effective utilization of locally available soils and other suitable stabilizing agents. It is more economical both in terms of cost and energy to increase the bearing capacity of the soil in embankment construction leads to increase in workability and durability. Soil stabilization is also done for soil water-proofing thus preventing water from entering into the soil layers and also used to prevent erosion of soil in dry weather conditions. By stabilizing the existing soil layer, cost associated with excavation of the existing soil, removing it from the site and replacing it with suitable materials can be eliminated. Soil stabilization is used in many sectors of the construction industry, Roads, parking lots, airport runways, building sites, landfills, dam cores, impervious liners are feasible based on both economical and service life considerations. Water infiltration weakens the underlying soil and variable vehicular wheel loads moving on the surface layer will damage the pavement structure. The use of chemical stabilization in roadway design speaks directly to these issues of long-term life-cycle stability of the soil. Stabilization of soil can be done by adding additives or without additives, the following are major methods of soil stabilization:

1. **Mechanical Stabilization**

Mechanical stabilization is a methodology which improves selection engineering properties of soil without addition of agents or binding particle energy.

**2. Soil – Fly Ash Stabilization**

It is used in many projects to improve the strength characteristics of soil. Fly ash can be used to stabilize bases or sub grades.

**3. Soil-Lime Stabilization**

Quicklime and lime kiln dust can also be used to dry wet soils at construction sites, reducing downtime and providing an improved working surface.

4. **Soil-Mable Dust Stabilization**

It is a process by which a controlled amount of Marble Dust is thoroughly mixed with an existing soil or aggregate material to form a stable base or wearing course.

5. **Soil - RHA Stabilization**

It is a by- product of rice milling it is used as a soil stabilizer is an alternative to the final deposition to the environmental benefits.

## III. METHODOLOGY

**STABILIZATION BY LIME:-** Harshil Bhatt, Manisha Meena, Dr. Ajay Bindlish from Department of Civil Engineering, Rajasthan Technical University, Kota, Rajasthan, India has conducted experimental study on behavior of expansive soil with quick lime. Lime is most useful chemical stabilizing agent. In the study, expansive soil was taken from Borkheda, Kota, Rajasthan and stabilized with quick lime. The expansive soil was treated with different percentage of quick lime 2, 4, 6, 8, 10 and specimens were cured for 3days. For the improvement of engineering properties of soil following tests were performed: Index properties, Standard proctor, Unconfined compression strength. The result shows plasticity index decrease from 21.19 to 14.68, compaction parameters maximum dry density decreases from 1.69 kg/cm3 to 1.58 kg/cm3 and optimum moisture content increases from 18.35% to 22.11%, By the increment % of quick lime unconfined compressive strength is increasing up to 8% on the further increment of lime its decreases. The value of differential free swelling for soil is 47.06% and after increment of lime percentage in soil the value of DFS is decreases up to 3.64%. The value of swelling pressure of soil is 1.14kg/cm$^2$, when 10% lime added into soil, the value of swelling pressure is decreases up to 0.12kg/cm$^2$. The California bearing ratio for expansive soil is 2.12%. Further adding of 10% lime, the value of CBR % is increases up to 7.97%.

**STABILIZATION BY RICE HUSK ASH:-** P Vandana Rao, G Sudheer Kumar , G Prasanna Kumar has conducted an experimental study on behavior of expansive soil with Rice Hush Ash. Rice milling generates a byproduct know as husk. This surrounds the paddy grain. During milling of paddy about 78 % of weight is received as rice, broken rice and bran. Rest 22 % of the weight of paddy is received as husk. This husk is used as fuel in the rice mills to generate steam for the parboiling process. This husk contains about 75 % organic volatile matter and the balance 25 % of the weight of this husk is converted into ash during the firing process, is known as rice husk ash (RHA). This RHA in turn contains around 85 % - 90 % amorphous silica and 10%-15% iron oxide. Large silica content in rice husk ash makes it a good pozzolanic material and can be used for soil stabilization. The high angularity and friction angle of rice husk contribute to excellent stability and load bearing capacity.

Aparna Roy (2014), has presented a study which gives details about soil which is stabilized with different percentages of Rice Husk Ash and a small amount of cement. The results obtained show that the increase in RHA content increases the Optimum Moisture Content but decreases the Maximum Dry Density. Also, the CBR value and Unconfined Compressive Strength of soil areconsiderably improved with the Rice Husk Ash content.

Ashango and Patra (2014), had studied the static and cyclic properties of clay subgrade stabilized with RHA and Portland slag cement. The optimum percentage of RHA was found to be 10% and Portland slag cement as 7.5% for stabilization of expansive soil. They concluded that the stabilized expansive soil was found suitable for subgrade of flexible pavement as, there was significant increase in strength and the stabilized soil was durable Marble Dust.

Based on the laboratory test carried out on soil rice husk ash mix. Based on the compaction characteristics it is found that, with increase in percentage of RHA, MDD decreases and OMC increases. Based on the UCS test, the optimum percentage of RHA obtained was 10%.The UCS value of the soil increased from 30 KN/m2 to 74.02KN/m2 for 10% RHA. The percentage improvement in strength was 147%. Based on the CBR test, the optimum percentage of RHA obtained was 10%.The CBR value of the soil increased from 1.18% to 2.97 % for 10% RHA. The percentage improvement in strength was 152%. From test result it is observed that, RHA can be used as a soil stabilization material.

**STABILIZATION BY KOTA STONE SLURRY:-** Amit Kumar Jangid, Jitendra Khatti, Dr. Ajay Bindlish was conducted experiment to find out behaviour of black cotton soil with different percentage of Kota stone slurry is mixed from 5% to 30% in black cotton soil. The engineering parameters are also determined by conducting tests. For studying the behaviour of black cotton soil with different percentage of Kota stone slurry, the Atterberg's limits (Liquid Limit, Plastic Limit, Plasticity Index), standard proctor test, differential free swelling index, swelling pressure and wet sieve analysis tests are conducted. With increasing the quantity of Kota stone slurry in black cotton soil, the resulting mixture turned gradually medium plasticity clay (CI) to low plasticity clay (CL) and the plasticity index of black cotton soil decreases 10.81%. The Optimum moisture content and maximum dry density is found on 15% Kota stone slurry. The differential free swell index decreases with increasing the percentage of Kota stone slurry. When 30% Kota stone slurry is added in black cotton soil, the differential free swell index decreases about 91.5%. The UCS value increase with increasing the percentage of Kota stone slurry till 15%. The UCS value is maximum determined on 15% mix specimen but after 15% Kota stone slurry mix, the value of UCS decreases. The maximum dry density of black cotton soil is 1.725 kg/cm$^3$ determined but when fibre is mixed in 15% Kota stone slurry with black cotton soil mix specimen the maximum dry density is less than to 1.725 kg/cm3. The black cotton soil is having 07.983 N/cm$^2$ shearing strength, but this strength is improved by adding 15% Kota stone slurry in black cotton soil. The mix specimen 15% Kota stone slurry with black cotton soil is having 10.732 N/cm$^2$ shear strength which is 34.43% more than to shear strength of the black cotton soil. Same as when 1.5% fibre is added in 15% Kota stone slurry with black cotton soil mix specimen, the shear strength is 26.15% is increased from 15% Kota stone slurry mix specimen. Hence, it is also cleared that the 1.5% fibre may be used to improve the shear strength parameter of black cotton soil with 15% Kota stone slurry.

**STABILIZATION BY MARBLE DUST:-** Parte Shyam Singh, Yadav R K investigated the effect of marble dust on index properties of black-cotton soil a series of laboratory experiments have been conducted on black-cotton soil samples mixed with 0% to 40% of marble dust by weight of dry soil. The test results showed a significant change in Consistency limits of samples containing marble dust. The liquid limit would decrease from 57.67% to 33.9%. The plasticity index decreased from 28.35% to 16.67% and shrinkage limit Increased from 8.06% to 18.39% with the addition of marble dust from 10% to 40% of the dry Weight of the black-cotton soil. Also the differential free swell decreased from 66.6% to 20.0%. Showing appreciable decrease in swelling behaviour. From this laboratory investigation it is concluded that the waste material like marble dust generated from stone industries has a potential to modify the characteristics of expansive clay like black-cotton soil. There is significant improvement in the index properties of the black-cotton soil on addition of marble dust into it. The expansive behaviour of the clay has reduced to a great extent. Based on extensive laboratory tests conducted on black-cotton mixed with marble dust from 0% to 40% by weight of dry clay. The liquid limit values of the samples are decreasing with the inclusion of marble dust into the black cotton soils. It has been found that the liquid limit decreased from 57.67% to 33.90% on adding of 0% to 40% marble dust into it. There is significant reduction in plasticity index values from 28.35% to 16.67%. The shrinkage limit of the black-cotton has been increased by adding of 40% marble dust. The shrinkage limits increase from 8.06% to 18.39%. The differential free swell (DFS) has reduced from 66.6% to 20.0%. The results of plasticity Index, shrinkage limit and DFS indicates that the degree of expansiveness reduced from" very high'' to "low" from the above laboratory investigation it can be concluded that the industrial waste like Marble Dust has a potential to modify the characteristics.

**STABILIZATION BY FLY-ASH**:- Prof. Pratik Somaiya Prof. Yashwant Prof. Zala Rushikesh Dangar investigated to check the improvements in the properties of expansive soil with fly ash in varying percentages. As the locally available borrow soil has generally high plasticity (LL > 50) it was difficult to construction on it. They inclusion of different percentage of fly ash in natural soil generally resulted in some increasing in unconfined compressive stress. The unconfined compressive stress of natural soil without fly ash which was 114kN/$m^2$, increased to 123 KN/$m^2$ at 20% fly ash in natural soil showing 7.89 % improvement. A liquid limit was decreases with increases in percentage
of fly ash up 30% in natural soil which was 74.4%, decreased to 72.5%, showing 2.56 % decreased. Plastic limit was decreases with increases in percentage of fly ash up 30% in natural soil which was 38.4%, decreased to 32.93 %, showing 14.24 % decreased. Maximum dry density was increase with increases in percentage of fly ash up 30% in natural soil which was 1.68gm/cc, increase to 1.71gm/cc at 14% OMC showing 1.78 % increase. As per grain size analysis the percentage of gravel 1.11%, percentage of sand 9.89% and percentage of fines 89%.

**1. Tests (Engineering properties) conducted on BLACK COTTON soil.**

1. Standard Proctors Compaction Test.
2. California Bearing Ratio Test.

TABLE 1: PHYSICAL PROPERTIES OF BLACK COTTON SOIL

| S.no | Properties | | Test Method | Average Method | Permissible Method |
|---|---|---|---|---|---|
| 1 | Color | | | Black | |
| 2 | Specific Gravity | | IS-2720 Part-3 (1980) | 2.65 | 2.6-2.75 |
| 3 | Moisture Content | | | 13.2% | - |
| 4 | Grain Size Distribution | Coefficient of Uniformity(Cu) | IS-2720 Part-4 (1985) | 3.25 | >1 |
| | | Coefficient of Curvature (Cc) | | 1.41 | Between 1-3 |

Table 2: ENGINEERING PROPERTIES OF BLACK COTTON SOIL

| S. No. | Properties | Test Method | Average Value | Permissible Value |
|---|---|---|---|---|
| 1. | Standard Proctor Compaction Test | Is:2720 (Part 29)-1975 | OMC = 17.8% | Up To 21% |
| | | | MDD= 1.71 gm/Cc | 1.6 To 2.1 |
| 2. | CBR Test(Soaked) | Is:2720 (Part-16)-1987 | 2.5 Penetration= 2.12 % | - |
| | | | 5.0 Mm Penetration =2.01 % | - |

## 5. RESULTS

After the experiments performed on the black cotton soil we get the results on standard proctor compaction test and CBR test. The values of OMC and MDD is 17.8 %, 1.71 gm/cc by performing the standard proctor compaction test respectively. The 2.5 mm penetration is 2.12 % and 5.0 mm penetration is 2.01 % by performing the California bearing ratio (CBR) test in soaked condition.

## 6. CONCLUSION

1. On conduction of CBR test by varying the percentage of admixtures like Lime, Fly Ash, Rice Husk Ash, Marble Dust and Kota Stone Slurry in the soil mix. There is an increase in the CBR values with the increase in percentage of stabilizers.
2. Fly ash is environmental friendly material and it can be used for construction purposes which also leads to increase in bonding properties of black cotton soil which also leads to reduction in swell and shrink behaviour of black cotton soil.
3. It is economical method for soil stabilization of Black Cotton soil where the raw materials are cheaper when compared to other methods of stabilization of soil.
4. A reduction in plasticity index causes a significant decrease in swell potential. This results confirm that the mix hardens. Such that it possesses less damage to the building in site due to settlement. when the soil is mixed with these percentage as compare to the soil strata.
5. From the economic analysis it is found that, a substantial save in cost of construction is possible by making use of two waste materials like Lime, Kota Stone, Marble Dust, RHA and Fly Ash can be utilized to strengthen the Black cotton soil.
6. It can be concluded that the soil treated with different admixtures can be utilized as a soil stabilizer which minimize the settlement problems and the same can reduce the environmental issues.

## REFERENCES

1. Prof. Pratik Somaiya Prof. Yashwant Prof. Zala Rushikesh Dangar(2013) "Stabilization of Expansive Soil Using Fly Ash" https://www.researchgate.net/publication/280153059
2. Parte Shyam Singh And Yadav R K "Effect Of Marble Dust on Index Properties of Black Cotton Soil" ISSN 2319-5991 www.ijerst.com Vol. 3, No. 3, August 2014 © 2014 IJERST. All Rights Reserved
3. Er. Amit Kumar Jangid, Er. Jitendra Khatti, Dr. Ajay Bindlish "A Study Of Engineering Properties Of Black Cotton Soil With Kota Stone Slurry"(2018) IJARSE, ISSN:2319:8354
4. Harshil Bhatt, Manisha Meena, Dr. Ajay Bindlish "Geotechnical Properties Of An Expansive Soil Stabilized With Quick Lime"© IJEDR 2018 | Volume 6, Issue 2 | ISSN: 2321-9939 **IJEDR1802084** International Journal Of Engineering Development And Research (Www.Ijedr.Org).
5. Er. Harshil Bhatt, Er. Raaj Sharma, Dr. Ajay Bindlish "Effect Of Lime On Swelling Pressure And CBR Value Of Expansive Soil (IJTIMES) Impact Factor: 3.45 (SJIF-2015), E-ISSN: 2455-2585 Volume 4, Issue 5, May-2018 IJTIMES-2018@All Rights Reserved 585
6. P Vandana Rao, G Sudheer Kumar, G Prasanna Kumar, "A Study On Stabilization Of Black Cotton Soil Using Rice Husk Ash" International Journal Of Research Sciences And Advanced Engineering Vol.2 (22), Issn: 2319-6106, Apr - Jun' 2018.
7. IS:2720 (Part 4)-1985 "Code of practice for Grain Size Analysis".
8. IS:2720 (Part 5)-1985 "Code of practice for Determination of Liquid and Plastic Limit".
9. IS:2720 (Part 29) -1975 "Code of practice for Standard proctor test".
10. IS:2720 (Part 16) – 1987: Code of practice for California Bearing Ratio test".