IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Experimental Study on Stabilization of Black Cotton Soil using Rice Husk Ash

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Abstract: Infrastructure projects such as highways, railways, water reservoirs etc, requires earth materials in very large quantity. One of the most important aspect for construction purposes to improve the soil strength is stabilization. Soil stabilization regime improves engineering properties such as volume stability, strength and durability various researches and have shown promising results for application of such expansive soils after stabilization with additives such as lime, fly ash, demolished concrete etc..In this project we used rice husk ash as an additive to the expansive soil . Extensive laboratory/ field trail shave been carried out by Sieve analysis, liquid limit, plastic limit, California bearing ratio, heavy compaction test.

***Index Terms* – Black Cotton Soil, California Bearing Ratio(CBR), Stabilisation, Rice Husk Ash.**

I. INTRODUCTION

Soil is one of the most important engineering materials. The geotechnical properties of a soil such as its grain-size distribution, plasticity, permeability and shear strength etc. can be assessed by proper laboratory testing. Soil alone has very specific properties that may not be appropriate for different types of constructions. construction. This is due to hot climate and poor drainage conditions associated with these soil formations. These soils inhibit the moisture from the surface in monsoon and summer season by means of evaporation. Owing to these reasons, the soil possesses cyclic swell-shrink behavior, low strength, high moisture content, volume change in soil, differential settlement etc. These failures may result in longitudinal and transverse cracking of pavements, surface distress, rutting of surface and deep cutting in foundations. To overcome these circumstances in the soil, it should be treated and stabilized in best way.Thus the geotechnical engineers are required to improve the various unsuitable soils by stabilizing it by chemical or mechanical method. One such unsuitable soil is black cotton soil.

Soil stabilization means the improvement of stability or bearing capacity of the soil by the use of controlled compaction, proportioning and/or the addition of suitable admixture or stabilizers. Broadly, it refers to any chemical or mechanical treatment given to a mass of soil to improve or maintain its engineering properties. Soil stabilization is widely used in road, pavement and foundation construction to improve the Strength, Volume stability and Durability of the soi

II. LITERATURE REVIEW

[A] **Vishal Ghutke, Pranita Bhandari, Vikash Agrawal (2018) "Stabilisation of soil by using RiceHusk":** In this study the stabilization of soil is done by using rice hush at 4%, 8%,12% and determined the Liquid limit, Plastic Limit, MDD.

[B] **Kiran R.G., Kiran L (2015) "Analysis of strength characterstics of black cotton soil using bagasse and additives as a stabilizer":** There was increased strength values and the CBR and UCS values also increased. If the stability of soil is inadequate for supporting the loads of wheels, the oil properties should be improved by soil stabilisation technique. Soil stabilisation is the modification of one or more soil properties by mechanical or any chemical methods to create an improves strength of soil.

[C] **Harshita Bairagi, R.K. Yadav, R Jain (2014) "Effect of jute fibres on engineering characterstics of black cotton soil":** On adding the jute fibres to the soil , a decrease in its swelling behavior is observed. The CBR is seen to increase and unconfined compressive strength increases. As jute is an ecofriendly fibre its application on black soil engineering land is of extreme importance and increases its properties tremendously.

III.MATERIALS CHARACTERIZATION

3.1Black Cotton Soil

Black soils, generally called black cotton soils, and internationally named as 'tropical black earths' or 'tropical chernozems' are been formed by weathering of the Deccan lava in parts of Maharashtra, specific areas in Madhya Pradesh, Gujarat and a few places in Andhra Pradesh and Tamil Nadu.

Table 3.1 Engineering properties of black cotton soil

Properties	Value
Natural Water Content	29.67%
Specific gravity	2.37
Liquid limit	50%
Plastic limit	27.68%
OMC	18.5%
MDD	1.72g/cc

3.2 Rice Husk Ash

Rice Husk Ash is obtained from the burning of rice husk. The husk is a by-product of the rice milling industry. Rice husk is also known as rice hull. Rice husks are the hard protecting outer cover of grains of rice. In growing season rice husk act as protecting cover, after that it can be use as building materials, insulation materials, fertilisers, fuel or gasoline. It includes sililca and lignin. The hull is mostly indigestible to humans. About 20 million tons of RHA is produced annually. This material causes environment threat, when this material is dumped it causes damage to the land and surrounding area.

Table -3.2: Basic constituent of RHA

Constituents (%mass)	Percent Content
Fe_2O_3	0.21
SiO_2	90.23
CaO	1.58
Al_2O_3	2.54
MgO	0.53
Carbon	2.23
KaO	0.39

IV. EXPERIMENTAL PROCEDURE

4.1 Specific Gravity Test (IS-2720-PART-3-1980)

The "specific gravity" of soils and soil solids refers to the mass of solids in the soil compared to the mass of water at the same volume.

Procedure:

Dry the pycnometer and weigh it with its cap(W_1).Take about 200 g to 300 g of oven dried soil passing through 4.75mm sieve into the pycnometer and weigh again(W_2).Add water to cover the soil and screw on the cap. Shake the pycnometer well and connect it to the vaccum pump to remove entrapped air for about 10 to 20 minutes. After the air has been removed, fill the pycnometer with water and weigh it (W_3).Clean the pycnometer by washing thoroughly. Fill the cleaned pycnometer completely with water upto its top with cap screw on. Weigh the pycnometer after drying it on the outside thoroughly (W_4).

The Specific gravity of soil solids (Gs) is calculated using the following equation.

$$\text{Sp.Gravity(Gs)} = \frac{(W_2 - W_1)}{((W_2 - W_1) - (W_3 - W_4))}$$

4.2 Grain Size Distribution (IS: 2720 (Part 4) – 1985)

Grain size analysis or sieve analysis is a practice or procedure used (commonly used in civil engineering) to assess the particle size distribution (also called gradation) of a granular material by allowing the material to pass through a series of sieves of progressively smaller mesh size and weighing the amount of material that is stopped by each sieve as a fraction of the whole mass.

Procedure:

200 gm of soil sample is taken and is soaked with water. The soil specimen is then sieved through 75 micron sieve and washed with water under tap of high pressure. The material is washed until the clean water pass through the soil. The material retained on the sieve and is dried in oven and weighed. It is then sieved through the mechanical sieve shaker for about ten minutes and retained material on each sieve is collected and weighed. The material which is retained on the pan is equal to the total mass of soil minus the sum of all the masses

of material retained on all sieves. The curve for the soil is drawn in the semi-logarithmic graph and particle size distribution curve is obtained.

4.3 Liquid Limit Test (IS 2720 (PART 5)-1985)

Liquid Limit (LL or W_L) - the water content in percent of a soil at the arbitrarily defined boundary between the semi-liquid and plastic states. The liquid limit (LL) is conceptually defined as the water content at which the behaviour of a clayey soil changes from plastic to liquid.

Procedure:

Soil sample was passed through 425 micron sieve .About 120 gm of soil sample passing through the 425 micron sieve was taken and mixed thoroughly with distilled water in the evaporating dish.After the formation of uniform paste ,a portion of paste was placed in the cup and was leveled so as to have maximum depth of about 10mm.A groove cut in the soil in the cup ,using grooving tool .The handle was rotated at the rate of 2 revolution per second and the number of blows necessary to close the groove for a distance of 13mm noted .10gm of soil near the closed groove was taken to determine its water content .The same operation repeated by altering the water content of the soil .For four to five reading of water content range , from 10 – 40 blows are obtained .A graph plotted between number of blows, N on a logarithmic scale and water content, w on the natural scale. From the graph the liquid limit was determined by reading the water content corresponding to 25 blows on the flow curve.

4.4 Plastic Limit Test (IS 2720 (PART 5)-1985)

The moisture content at which any increase in the moisture content will cause a semi-solid soil to become plastic. This limit is defined as the moisture content at which a thread of soil just crumbles when it is carefully rolled out to a diameter of 1/8 inch.

Procedure:

About 30 gm of soil sample was mixed thoroughly with distilled water in an evaporating dish till the soil mass became plastic enough to be easily moulded with fingers. After the formation of mould the ball of soil mass of 8 gm was formed. The ball was then rolled between the fingers and the glass plate with just sufficient pressure to roll the mass into the thread of uniform diameter throughout its length. The rolling was done till the thread is of 3mm diameter. The soil was then kneaded together to a uniform mass and rolled again. This process of alternate rolling and kneading was continued until the thread crumbled under the pressure required for rolling and the soil could no longer be rolled into a thread. At the point of crumble, the satisfactory end point was considered. After the formation of crumble the sample was weighed. Then the sample was placed in the oven for drying for 24 hours at 105C.The dried sample was again weighed. The difference between the two weights gave the moisture content. The same procedure was performed for two more samples. The mean of the three readings gave the moisture content at plastic limit.

4.5 Proctor Compaction Test (IS: 2720 (Part 8) – 1983)

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. This method gives the determination of the relationship between the moisture content and density of soils compacted in a mould of given size with as 2.5 kg dropped from the height of 30cm.

Procedure:

Take a representative air-dried sample approximately 10kgs in a pan passing of IS sieve 19mm and mix water content to bring uniformly moisture content to the soil and the sample placed at a air tighter bag over a night. Weigh the proctor mould with base plate and fix the collar. Place the soil in the proctor mould in to 3 layers giving 25 blows per layer with 2.5 kg rammer falling through. Remove the collar trim the compacted soil even with the top of the mould by means of the straight edge and weight. Weigh the mould with soil and note in record. Repeat the same procedure for 5 points and lost weight will less than before point. Take soil sample into container and kept in oven for 24 hours to find OMC and MDD.

4.6 California Bearing Ratio Test (IS: 2720(Part 16)-1973)

CBR value of a soil is an index which is related to its strength, modulus of sub grade reaction, modulus of resilience and plasticity index. The index is highly dependent on the condition of material at the time of testing. CBR test performed on remoulded specimens who may be compacted either statically or dynamically.

Procedure:

6 kg of soil was taken and water of 29.8% by weight of soil was mixed thoroughly . The sample was prepared by dynamic compaction . The extension collar and base plate was fixed to the mould. The spacer disc was inserted over the base. The filter paper was placed on the top of the spacer disc. The soil was compacted in the mould using light compaction. In the light compaction the soil was compacted in 3 layers. Each layer was compacted using the 2.6 kg runner in 55 blows. After the compaction was completed the collar was removed and the soil was trimmed off.

The mould was placed with the surcharge weights on the penetration test machine. For the full contact of the piston on the sample the penetration piston was seated at the centre of the specimen with the smallest possible load. The stress and strain load gauge was set to zero. The load was applied on the piston at the penetration rate of about 1.25mm/min. The load readings at penetration of 0.5 , 1.0 , 1.5 , 2.0 , 2.5 , 3.0 , 4.0 , 5.0 , 7.5 , 10 and12.5 mm were recorded. The maximum load and corresponding penetration (for < 12.5 mm) were noted. From top three layer of soil 20-50 gm of soil was taken for determining the moisture content.

V. RESULTS & DISCUSSIONS:

5.1 Specific Gravity Test

Table 5.1 Specific Gravity Test Results for Black Cotton Soil with Rice Husk Ash

Sample taken	Specific gravity
100% BC Soil	2.37
95% BC Soil+5% RHA	2.30
90%BCSoil+10% RHA	2.29
85%BCSoil+15% RHA	2.27
80%BCSoil+20% RHA	2.26

5.2 Grain Size Analysis

Table 5.2 Grain Size Analysis for Black Cotton Soil

BLACK COTTON SOIL					
S.no	**Sieve size(mm)**	**Soil retained(gm)**	**% Retained**	**Cumulated % Retained**	**% Finer**
1	4.75	48	4.8	4.8	95.2
2	2.36	80	1.8	6.6	93.4
3	1.18	50	5.0	11.6	88.4
4	600 µ	600 µ	600 µ	600 µ	600 µ
5	425µ	425µ	425µ	425µ	425µ
6	300 µ	300 µ	300 µ	300 µ	300 µ
7	180 µ	180 µ	180 µ	180 µ	180 µ
8	PAN	405	40.5	100	0

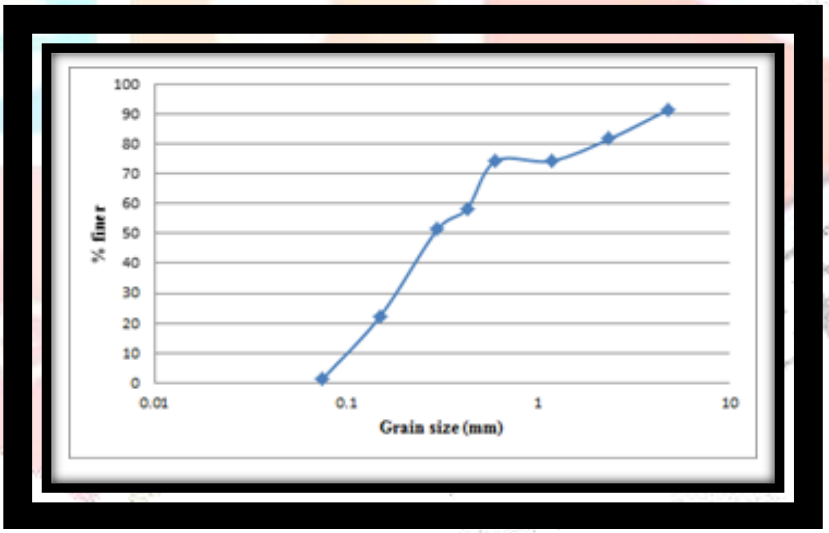

Fig 1: Gradation Curve for Black Cotton Soil

5.3 Liquid Limit Test

Table 5.3 Liquid Limit Test Results for Black Cotton Soil with Rice Husk Ash

Sample taken	Liquid Limit (%)
100% BC Soil	57.0%
95% BC Soil+5% RHA	54.8%
90%BCSoil+10% RHA	52.0%
85%BC Soil+15% RHA	51.0%
80%BCSoil+20% RHA	48.0%

5.4 Plastic Limit Test

Table 5.4 Plastic Limit Test Results for Black Cotton Soil with Rice Husk Ash

Sample taken	Plastic Limit (%)
100% BC Soil	35
95% BC Soil+5% RHA	33
90%BCSoil+10% RHA	32.8
85%BC Soil+15% RHA	30
80%BCSoil+20% RHA	26

5.5 Proctors Compaction Test

Table 5.5 Optimum Moisture Content and Maximum Dry Density Results for Black Cotton Soil with Rice Husk Ash

Sample taken	OMC	MDD (g/cc)	Sample taken	OMC	MDD (g/cc)
100% BC Soil	18.4%	1.82	100% RC Soil	17.4%	1.92
95% BC Soil+5% RHA	19.9%	1.74	95% RC Soil+5% RHA	16.4%	1.85
90%BCSoil+10% RHA	21.1%	1.61	90%RCSoil+10% RHA	16.20%	1.71
85%BC Soil+15% RHA	22.16%	1.55	85%RC Soil+15% RHA	16.16%	1.65
80%BCSoil+20% RHA	23.95%	1.51	80%RCSoil+20% RHA	15.95%	1.61

BC Soil- Black Cotton Soil, RHA- Rice Husk Ash

5.6 California Bearing Ratio (CBR) Test

Table 5.3 California Bearing Ratio Test Results for Black Cotton Soil with Rice Husk Ash

Sample taken	CBR Value @2.5mm Penetration	CBR Value@5mm Penetration
100% BC Soil	1.88	1.85
95% BC Soil+5% RHA	2.88	2.80
90%BCSoil+10% RHA	2.97	2.90
85%BC Soil+15% RHA	2.67	2.61
80%BCSoil+20% RHA	2.50	2.49

VI CONCLUSIONS

The properties of black cotton soil has been increased up to 15% replacement with RHA but later on decreases So we can finally conclude that RHA can be used as stabilizing agent for improving the properties of soil.

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