Parametric Study of Properties of Normal & Black Cotton Soil Stabilized With Rice Husk Ash & Fly Ash

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Abstract

This study is carried out for stabilization of soil using rice husk ash and fly ash with black cotton soil. The admixtures were varied by 5%, 10%, 15% for fly ash and for rice husk ash it is 4%, 8% and 12%. Different tests will be performed to check the properties of soil like swelling pressure, Plasticity index, liquid limit, specific gravity etc. for improved pavement works. It is concluded that the properties were enhanced with stabilized soil.
Keywords: Soil Stabilization, Fly-ash, Rice husk ash, Black Cotton Soil, Normal Soil

I. INTRODUCTION

Soil is very basic and important element in civil engineering field. Usually each structure depends on the type and characteristics of foundation which depends on type of soil. Basically the black cotton soil is rather a difficult one to use in foundation because of its shrinkage and swelling properties. There are many methods to make soil like black cotton soil stable for various constructions. Comparing to normal available soil, black cotton soil has a great impact on the behavior of foundations. Soil stabilization has two process it can be chemically of physical stabilization in here it is about chemical stabilization. Chemical stabilization is carried out by adding different chemicals in proportion to make soil stable while physical stabilization shows the solid materials which helps to improve the properties of soil. In this chemical stabilization we are using the fly-ash and rice husk ash these admixtures are categorized under chemical stabilization. Fly-ash and Ricehusk ash (RHA) will help to improve the important properties like plasticity, swelling and optimum moisture. Admixtures will be in powdered form which will be mixed in soil in various ratios to modify the properties and to study the change of soil properties. Proportion is being set to add a desire values which will help to add admixture in a more define way.

II. LITERATURE REVIEW

Many studies have been conducted for the work being carried on the study of industrial waste which can be used in soil stabilization methods for improving soil properties. Various soil mixes contained of fly-ash and rice husk ash has been studies by Keerthi Takkalapelli (2009) showing a desired mix proportion of fly-ash and rice husk ash for better swelling and shrinkage properties. E.J Yoder (1957) studied the soil stabilization in terms of highway research projects and showed the stabilization by chemically and physically admixtures. In the year 2012 a studied carried by the department of civil engineering in national institute of technology Rourkela showed the various percentage to add in every test for soil stabilization for example 10%,20% & 30%.

Brooks (2009) studied “soil stabilization with fly-ash and rice husk ash” and reported that the rice husk ash (RHA) content of 12% and a fly-ash content of 25% are recommended for strengthening the expansive sub grade soil while a fly-ash content of 15% is recommended for blending into RHA to form a swell reduction layer as fly ash is a waste material of industries obtained from thermal power plant by burning coal. Test performed like plasticity, shrinkage factor, liquid limit, optimum moisture content, specific gravity and swelling index shows a significant improvement in properties of soil in terms of swelling and shrinkage. Rice husk ash (RHA) is usually the cover of rice which is removed my mechanically or physically these husk are burned and converted into ash form which is better in workability towards soil.

III. METHODOLOGY

Black cotton soil and normal natural soil is used in this study which was mixed with fly-ash & Rice husk ash in different proportions with series of laboratory tests were conducted on every samples containing various percentage of fly-ash and rice husk ash i.e for fly-ash 5%, 10% and 15% in dry weight of soil. In terms of RHA the proportional which will be added are 4%, 8% and 12%. The tests which were conducted on black cotton soil and natural soil with fly ash & RHA will be according to the IS Codes of practices:

- Specific Gravity
- Liquid Limit
- Plastic Limit
- Shrinkage Factor
- Optimum Moisture Content
- Swelling Pressure

A. Fly-Ash

Fly ash is being used a material for soil stabilization here we obtained fly ash from Tarapur district Gujarat below its shown its chemical properties

B. Rice Husk Ash (RHA)

In this study Rice husk ash was brought up from rice mills in GIDC area near A.D.I.T campus Table I and II shows chemical properties of RHA and Fly Ash.

Table - I
Chemical Properties of RHA

Component	*(%)*
Silicon Dioxide (SiO_2)	*20-60*
Aluminium Oxide(Al_2O_3)	*5-35*
Iron Oxide (Fe_2O_3)	*10-40*
Calcium Oxide (CaO)	*1-12*
Lignite Oxide (LOI)	*0-15*
Magnesium Oxide (Mgo)	*3.5*
Alkali	*1.0*
SO_3	*1.5*

Table – II
Chemical properties of Fly ash

Constituent	*(%)*
Silica (Sio_2)	*90.23*
Alumina (Al_2O_3)	*2.54*
Carbon	*2.23*
Calcium Oxide (CaO)	*1.58*
Magnesium Oxide (Mgo)	*0.53*
Potassium Oxide (KaO)	*0.39*
Ferric Oxide (Fe_2O_3)	*0.21*

C. Normal Natural Soil

Normal Natural Soil was brought A.D.I.T college premises the properties of soil is shown below

D. Black Cotton Soil

Black cotton soil used in this study was brought by tarapur village (Gujarat) as it contains high plasticity and expansive in nature. Physical characteristic of Normal and Black Cotton soil is shown in Table III.

Table - III
Physical Characteristics of Normal and Black Cotton soil

Description	*Normal Natural Soil*
Specific Gravity	*2.298*
Liquid Limit	*27%*
Plastic Limit	*26.88%*

Shrinkage Factor	19%
Optimum Moisture Content	2.16%
Swelling Pressure	22%
Description	Black Cotton Soil
Specific Gravity	2.89
Liquid Limit	24%
Plastic Limit	33.33%
Shrinkage Factor	23%
Optimum Moisture Content	8.4%
Swelling Pressure	31.25%

E. Test Results

Various tests were performed on Normal and black cotton soil mixed with fly-ash and rice husk ash in different percentages to the mixes as per IS code of practice. Results of various tests are shown in Table IV, V, VI, VII.

Table – IV
Tests performed on Normal soil with fly ash

Sr.No	Tests	NS+0% FA	NS+5%FA	NS+10%FA	NA+15%FA
1	Specific Gravity	2.59	2.37	2.46	2.40
2	Liquid Limit	31.7	34	25	27
3	Plastic Limit	28.57	26.57	15	18
4	Shrinkage Factor	19.44	18.22	15.22	17.28
5	Optimum Moisture Content(OMC)	19.3	19.8	21.2	23.5
6	Swelling Pressure	10	7.8	5.7	3.73

Where NS=Normal Natural Soil, FA=Fly-ash

Table - V
Tests performed on Black Cotton soil with fly ash

Sr.No	Tests	BCS+0% FA	BCS+5%FA	BCS+10%FA	BCS+15%FA
1	Specific Gravity	2.89	2.62	2.1	2.4
2	Liquid Limit	32.7	28	21	22.6
3	Plastic Limit	33.33	25	14	25
4	Shrinkage Factor	19.9	19.7	20.1	22.36
5	Optimum Moisture Content(OMC)	19.7	20.55	16.7	23.55
6	Swelling Pressure	10	11.2	10.2	15.2

Where BCS=Black Cotton Soil, FA=Fly-ash & RHA=Rice Husk Ash

Table - VI
Tests performed on Normal soil with Rice Husk Ash

Sr.No	Tests	NS+0% RHA	NS+4%RHA	NS+8%RHA	NA+12%RHA
1	Specific Gravity	2.59	2.19	2.09	1.87
2	Liquid Limit	31.7	8.7	5.06	14.04
3	Plastic Limit	28.57	8.73	7.4	12.5
4	Shrinkage Factor	19.79	22.1	23.5	33.1
5	Optimum Moisture Content(OMC)	19.71	20.1	22.54	29.89
6	Swelling Press	10	8.9	5.71	4.5

Table - VII
Tests performed on Black Cotton soil with Rice Husk Ash

Sr.No	Tests	BCS+0% RHA	BCS+4%RHA	BCS+8%RHA	BCS+12%RHA
1	Specific Gravity	2.89	2.37	2.46	2.40
2	Liquid Limit	32.7	34	25	27
3	Plastic Limit	28.57	26.57	15	18
4	Shrinkage Factor	19.9	18.22	15.22	17.28
5	Optimum Moisture Content(OMC)	19.71	19.8	21.2	23.5
6	Swelling Pressure	10	7.8	5.7	3.73

IV. RESULTS AND DISCUSSIONS

As shown below the graphs are provided according to the test conducted with admixture to show each improvement in respective property of soil

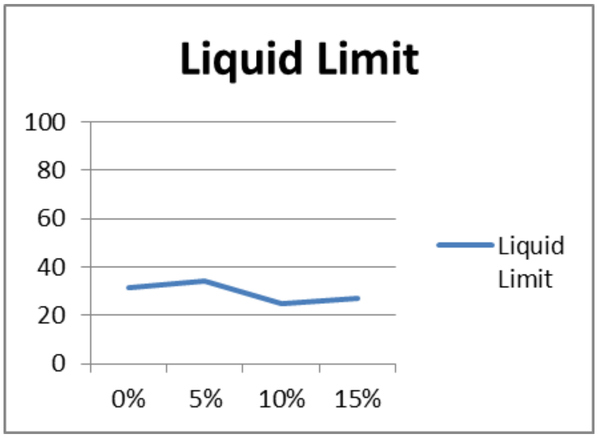

Fig. 1: Liquid Limit of normal soil NS+FA

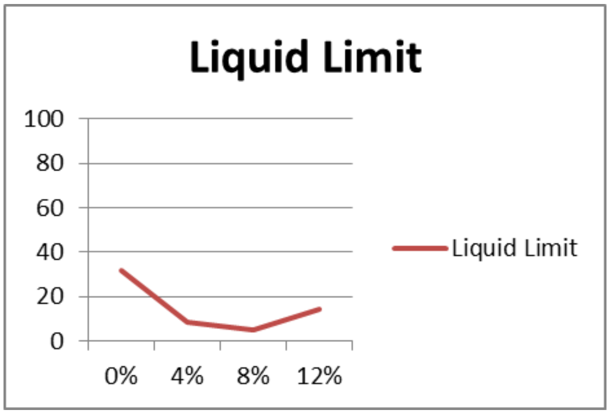

Fig. 2: Liquid limit of NS+RHA

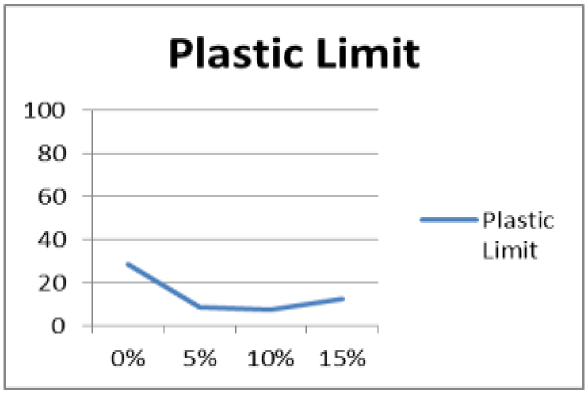

Fig. 3: Plastic Limit of NS+FA

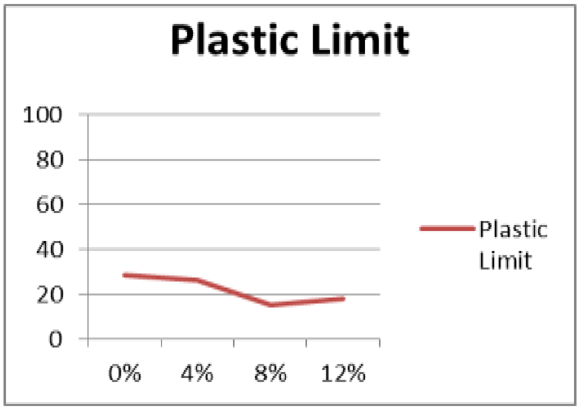

Fig. 4: Plastic Limit of NS+RHA

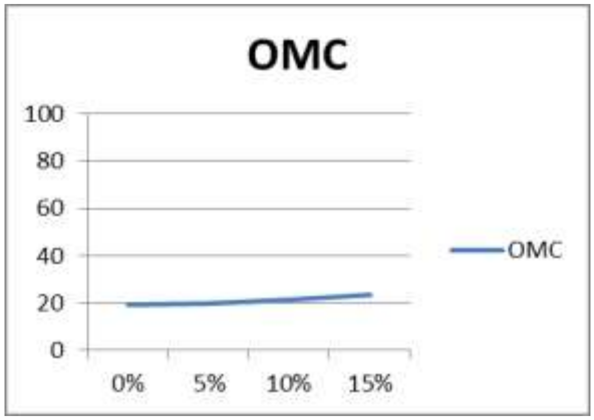

Fig. 5: OMC of NS+FA

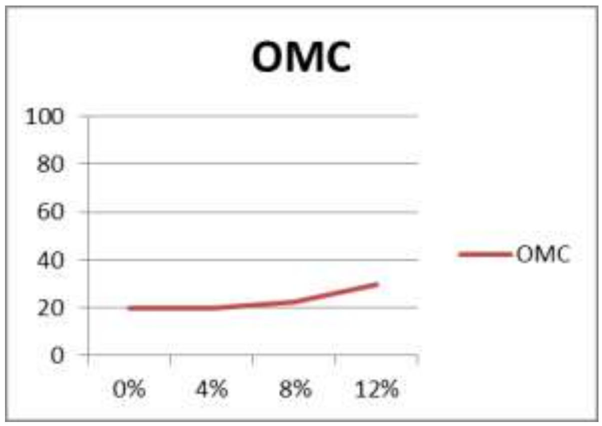

Fig. 6: OMC of NS+RHA

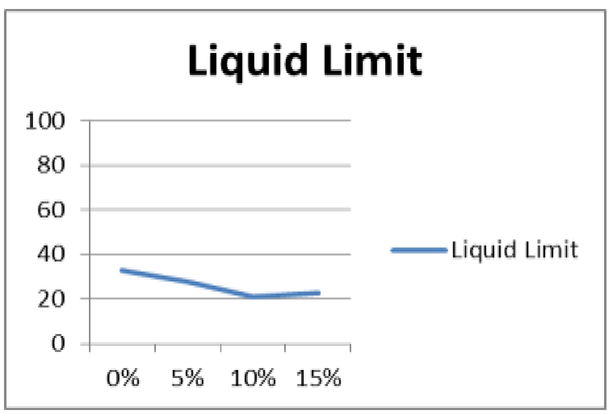

Fig. 7: Liquid Limit of BCS+FA

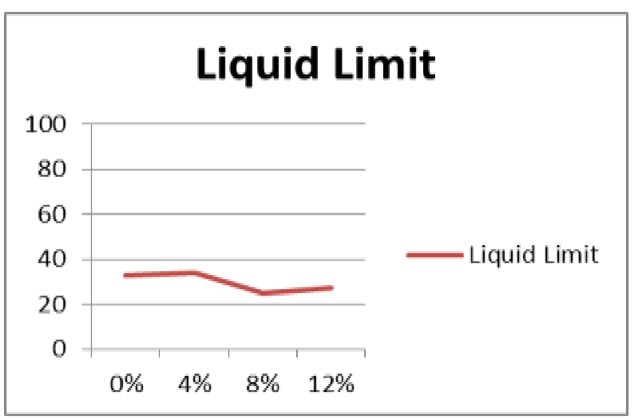

Fig. 8: Liquid Limit of BCS+FA

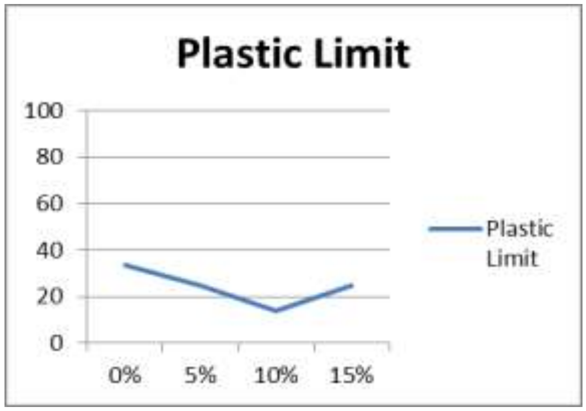

Fig. 9: Plastic Limit of BCS+FA

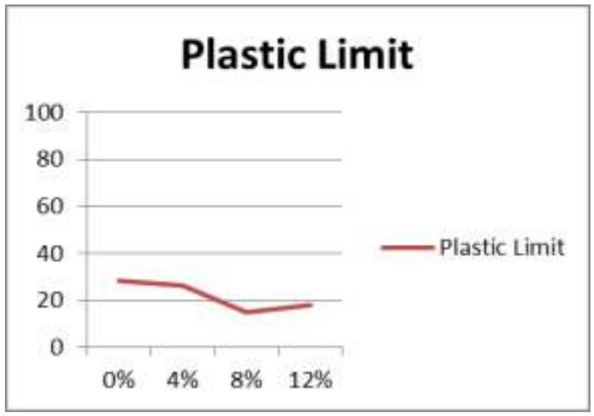

Fig. 10: Plastic Limit BCS+RHA

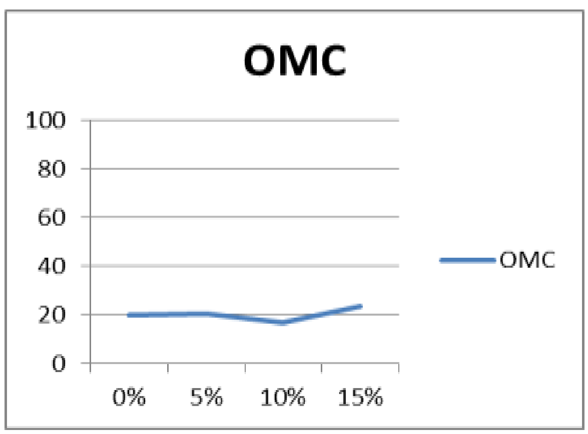

Fig. 11: OMC of BCS+FA

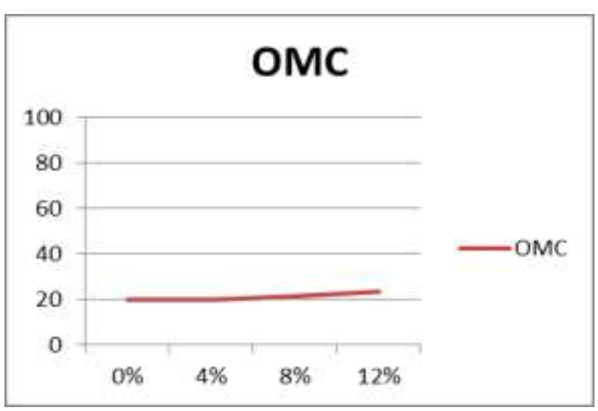

Fig. 12: OMC of BCS+RHA

- Optimum Liquid Limit value was obtained with 10% of Fly ash as shown in Fig. 1 and 7.
- Optimum Liquid Limit value was obtained with 8% of Rice Husk ash as shown in Fig. 2 and 8.
- Optimum Plastic limit value was obtained with 10% fly ash as shown in Fig.3 and 9.
- Optimum Plastic limit value was obtained with 8% rice husk ash as shown in Fig.4 and 10.
- OMC optimum was obtained at 10% fly ash as shown in Fig.5 and Fig. 11.
- OMC optimum was obtained at 8% rice husk ash as shown in Fig.6 and Fig. 12.

As in all graphs the value obtained are the modified one to gain better results from the desired admixtures.

V. CONCLUSION

Based on the laboratory test conducted on black cotton soil and normal natural soil mixed with fly-ash and rice husk ash in proportion of 5%,10% and 15% for fly-ash and for rice husk ash it is 4%,8% and 12% with all the test performed the conclusion can be drawn:

- Liquid limit of black cotton soil with fly ash changed from 37.2% to 22.6% while in case of rice husk ash it changed to 32.7% to 27%, where in case of normal soil it updates both in fly ash as well as rice husk ash. In terms of fly ash it changed to 31.7% to 27% and for rice husk ash 31.7% to 14.04% .plasticity of both soil was also changed in comparison to fly ash and rice husk ash . Plasticity was dropped to 14% for black cotton soil which will be helpful in construction basis. Shrinkage value improved which can help in water holding and releasing property for swelling too. This comparison showed many results regarding improving properties of both soil so that an ease can be develop to work upon both soil in maximum conditions. Above results indicates that the degree of expansiveness reduced to low. From this research it can be concluded that fly-ash and rice husk ash has a characteristics potential to improve the properties of soil like black cotton soil and natural normal soil and to make it suitable in many foundation applications.

REFERENCES

[1] S Rajput and R K YAdav, "Effect of Fly-Ash on Geotechnical Characteristics of Black Cotton Soil" IJIRST –International Journal for Innovative Research in Science & Technology| Volume 2 | Issue 03 | August 2015 ISSN (online): 2349-6010.

[2] R M Brooks, "Soil Stabilization with fly ash and Rice husk Ash", ISSN: 2076-734X,EISSN: 2076-7366 Volume 1, Issue 3(December 2009), International journal of research and reviews in applied sciences.

[3] Principals of Soil Stabilization july, 1957 No.23 by E.J. YODER PURDUE UNIVERSITY LAFAYETTE INDIANA

[4] Soil stabilization methods and materials by Gregory paul makusa, Department of civil, Environmental and natural resources engineering, Lunea University of technology, Sweden

[5] IS 2720 : Part XL : 1977 Method of Test for Soils – Part XL : Determination of Free Swell Index of Soils.