Soil Conditioning using Rice husk and Fly-ash

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Abstract— Increasing population and reduction of lands, construction of buildings and other civil works affect the soil properties and its parameters. Soil conditions must be sufficient to meet the required demands ahead. Effective techniques may be adopted for soil improvement and thus the various experiments are exercised here. The various tests have been conducted using solid waste products such as lime, fly ash, rice husk etc.Project proceeds taking soil sample into account, collected from the local areas which would be the black cotton soil. Since black cotton soil has been found in most of the areas rather than red soil. At first, natural soil sample without any addition of material is tested and then followed by mixing lime as 6%, fly ash as 9%, rice husk 12%. Also the tests like plastic limit, liquid limit, optimum moisture content, shrinkage limit test and unconfined compressive test are revised. Results have been found very best increasing the strength development with curing period 1, 7 and 28 days.The paper suggests the solid waste disposal as an economical approach to achieve the strength of black cotton soil. Attempts were made increasing the stability of the soil using lime, fly ash, rice husk with varied proportion

INTRODUCTION

Stabilising of soil means changing the properties of soil to obtain favourable outcome to meet the specified engineering requirements. Stabilization includes various method for modifying the properties of a soil to improve its engineering performance. Stabilization is being used for a variety of engineering works, the most common application being in the construction of road, air filled pavements and high rise building. Where the main objective is used to increase the strength or stability of soil and to reduce the construction cost by making based used of the locally available material. Methods for the stabilization are compaction and use of admixtures. Lime, Cement was commonly used as stabilizer for altering the properties of soils. From the recent studies it is observed that, solid waste materials such as fly ash, rice husk ash are used for this intended purpose with or without lime. To make black cotton soils suitable as a good substratum for construction usage improvement in existing properties are necessary. Different ways are available for enhancing engineering performances of soils are soil stabilization, soil reinforcement, etc. Admixtures like lime, cement were used traditionally for stabilization purposes. Recent studies shows Fly ash and Rice Husk alone or in combination with lime or cement can be used for effective stabilization of weak soils to a great extent.

This paper depicts the results of various alterations done with black cotton soil using rice husk ash and lime with varying proportion, with sole purpose of stabilisation of soil.

Methodology

Following are the test has been carried out. The test were carried out both on simple black cotton soil and stabilized black cotton soil by using combination of fly ash with lime and rice husk with lime.

TESTS:

After removing impurities like vegetation, stones etc. the soil was mixed with fly ash, rice husk and lime in varying proportion by (volume or) weight.

Following tests were conducted

1. Moisture content:-

The water contents required for attaining maximum dry density of the soil sample is known as optimum moisture content (expressed in percentage).

Apparatus:

Non-corrodible air-tight containers, Balance weight, Oven, etc.

Formulae:-

$$W = \frac{W2-W3}{W3-W1} X100$$

Apparatus: Air-tight container, 425 micron IS sieve, Oven, Rod of 3mm diameter, etc.

Formulae:-

Plastic limit = $\frac{mass\ of\ water}{mass\ of\ dry\ soil} x\ 100$

4.Liquid limit:-

It is the minimum water content at which soil changes its state from liquid state to plastic state. At the liquid limit, the clay is practically like a liquid, but possesses a small shearing strength.

Apparatus: Casagrande apparatus, Grooving tool, Flexible spatula, Air-tight container, 425 micron IS sieve, Oven, etc.

Formulae:-

liquid limit = $\frac{mass\ of\ water}{mass\ of\ dry\ soil} x\ 100$

5. Shrinkage limit:

Shrinkage limit (Ws) is the maximum water content at which a reduction in water content will not cause a decrease in the volume of a soil mass. It is lowest water content at which soil can still be completely saturated. If a saturated soil sample is taken (having water content more than the Shrinkage limit) and allowed to dry up gradually, its volume will go on reducing till a stage will come after which the reduction in the soil water will not result in further reduction in the total volume of the soil sample. The object of the experiment is to determine shrinkage limit, shrinkage ratio, and volumetric shrinkage.

Apparatus: Evaporating dish, Shrinkage dish, Mercury, Oven, Balance weight, Spatula, 425 micron IS sieve, Glass plates, etc.

Formulae:-

Shrinkage limit =$(W - \frac{V-Vd}{Md})$ x 100

2. Specific gravity:-

Specific gravity (G) is the ratio of the weight of a given volume of soil solids at a given temperature to the weight of an equal volume of distilled water at that temperature. It is used for determination of void ratio and particle size.

Apparatus: Pycnometer, Balance weight, Glass rod, Distilled water, etc.

Formulae:-

Sp.gravity=$\frac{W2-W1}{(W2-W1)-(W3-W4)}$

3. Plastic limit:-

The plastic limit (WP) is the water content where soil transitions between brittle and plastic behaviour.

6. Unconfined Compressive Strength test:-

The unconfined Compressive strength is defined as the maximum unit stress obtained within the first 20% strain**.** The unconfined compression test is used to measure the shearing resistance of cohesive soils which may be undisturbed or remoulded specimens.

Apparatus:

Compression device of any suitable type, Sample ejector, Strain measuring dial gauge with 0.01 mm graduation, Stop watch, Oven, Balance, Split mould 3.5 cm diameter and 7 cm long, etc.

Formulae:-

$$Qu = \frac{failure\ \ load\ (P)}{corrected\ \ area\ at\ failure\ (Ac)}$$

7. Moisture Content:-

The water contents required for attaining maximum dry density of the soil sample is known as moisture content. This method is use to determine the percentage of water in a sample by drying the sample to a constant weight

RESULTS AND DISCUSSION

We know that the behaviour of a black cotton soil is to absorb water, being swelled and shrink. Therefore, it is necessary to alter the properties of soil. So, we performed various tests on black cotton soil such as Moisture content, Atterberg's limit, unconfined compressive test. On the basis of these tests we obtained results.

The following subsections present and discuss the significant findings from the data collected in this study. The data summarized for these parameters includes all data collected during testing and study of the work.

Following are the test results of black cotton soil without adding any admixture are given below:-

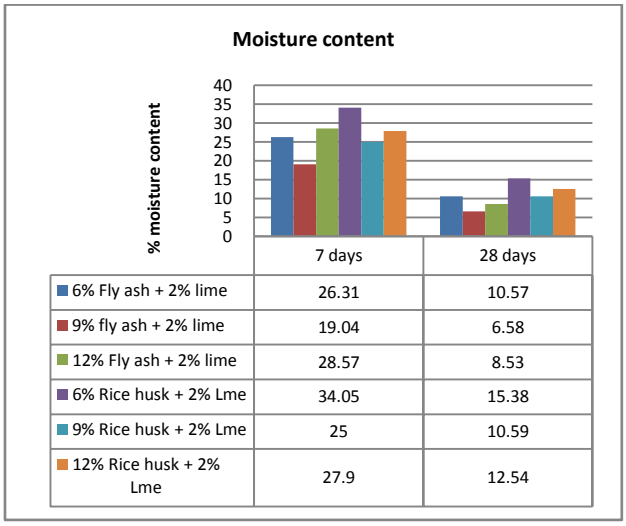
Table No. I : Test results of simple soil

Test	Result
Moisture content	24.2%
Specific gravity	2.1
Plastic limit	36.9%
Liquid limit	45.54%
Shrinkage limit	17.81%
Unconfined compression test (Kn/m^2)	170

1. Moisture Content:-

This method is use to determine the percentage of water in a sample by drying the sample to a constant weight. The water content is expressed as the percentage, by weight, of the dry sample. The Moisture Content of simple black cotton soil was found to be 24.2%.

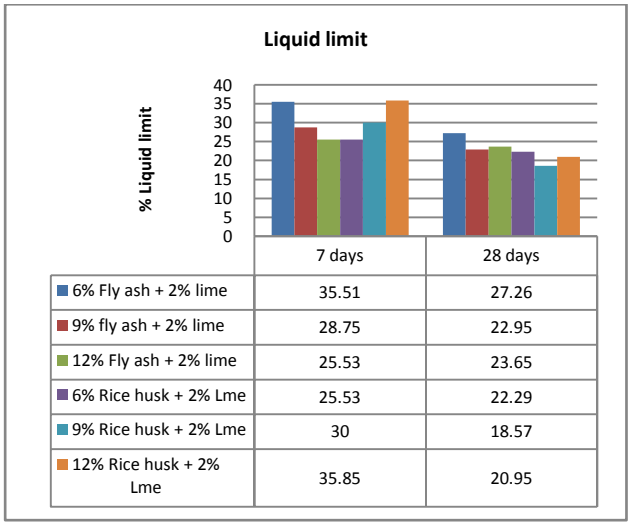
From the following graph No.1 we observed that, after addition of 9% Fly Ash + 2% Lime, the Moisture Content is reduced up to 6.58%, and after the addition of 9% Rice Husk + 2% Lime, the Moisture Content is reduces to 10.59%., at the end of 28 days curing.



Graph No.**1** Moisture content of fly ash+2%lime & Rice husk +2%lime Mixed with Soil

2. Liquid Limit:-

Clayey soil does have a very small shear strength at the liquid limit and the strength decreases as water content increases; the transition from plastic to liquid behaviour occurs over a range of water contents. The liquid limit of simple black cotton soil was 45.54%.



	7 days	28 days
6% Fly ash + 2% lime	35.51	27.26
9% fly ash + 2% lime	28.75	22.95
12% Fly ash + 2% lime	25.53	23.65
6% Rice husk + 2% Lme	25.53	22.29
9% Rice husk + 2% Lme	30	18.57
12% Rice husk + 2% Lme	35.85	20.95

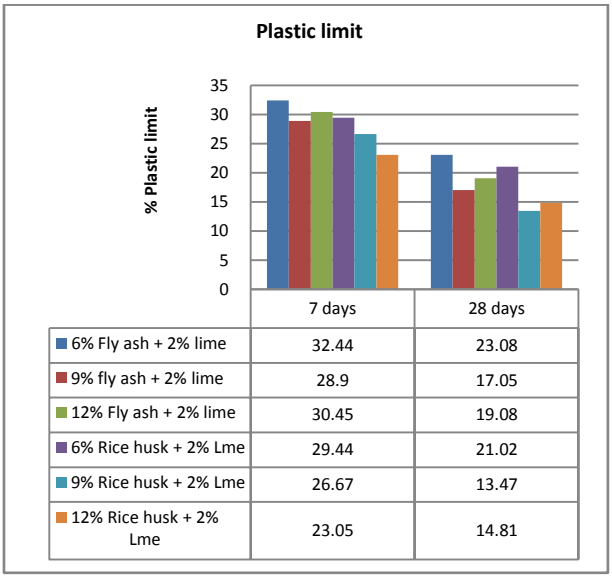
Graph No.**2** Liquid limit of Fly ash+

2%lime & Rice husk +2%lime Mixed with Soil

From the graph no.2 we observed that, after addition of 9% Fly Ash + 2% Lime Liquid limit is reduced to 22.95%, and after the addition of 9% Rice Husk+ 2% Lime, Liquid limit is reduces to 18.57%, at the end of 28 days curing.

3. Plastic Limit:-

A thread of soil is at its plastic limit when it begins to crumble when rolled to a diameter of 3 mm. The Plastic limit of simple black cotton soil was 36.9%.



	7 days	28 days
6% Fly ash + 2% lime	32.44	23.08
9% fly ash + 2% lime	28.9	17.05
12% Fly ash + 2% lime	30.45	19.08
6% Rice husk + 2% Lme	29.44	21.02
9% Rice husk + 2% Lme	26.67	13.47
12% Rice husk + 2% Lme	23.05	14.81

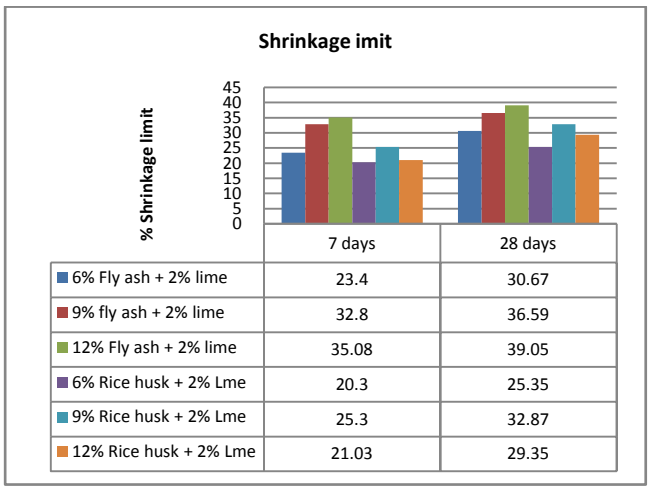
Graph No.**3** Plastic limit of fly ash+2%lime & Rice husk +2%lime Mixed with Soil

From the graph.3 we observed that, after addition of 9% Fly Ash+ 2% Lime, Plastic limit is reduced to 17.05%, and after the addition of 9% Rice Husk+ 2% Lime, Plastic limit is reduces to 13.47%, after 28 days of curing.

4. Shrinkage Limit:-

A shrinkage limit test gives a quantitative indication of how much moisture can change before any significant volume change and to also indication of change in volume. The Shrinkage limit of simple black cotton soil was 17.81 %.

From the following graph 4 we observed that, after addition of 12% Fly Ash+ 2% Lime, Shrinkage limit is increases to 39.05%, and after the addition of 9% Rice Husk+ 2% Lime, Shrinkage limit is increases to 32.57%, after 28 days of curing.

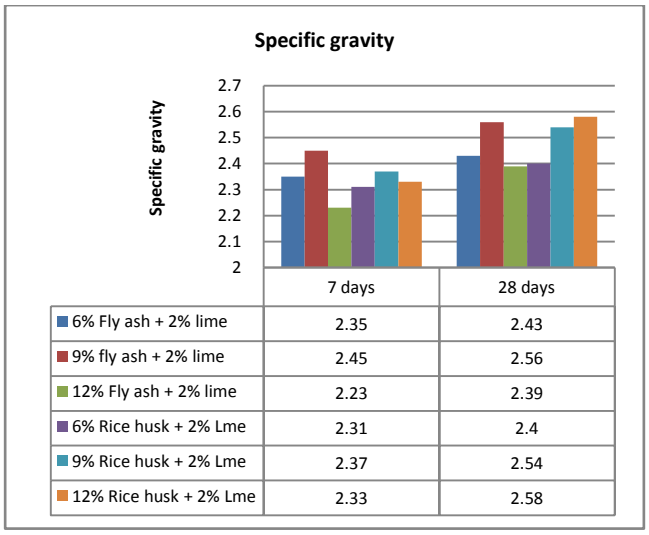


	7 days	28 days
6% Fly ash + 2% lime	23.4	30.67
9% fly ash + 2% lime	32.8	36.59
12% Fly ash + 2% lime	35.08	39.05
6% Rice husk + 2% Lme	20.3	25.35
9% Rice husk + 2% Lme	25.3	32.87
12% Rice husk + 2% Lme	21.03	29.35

Graph No.**4** Shrinkage limit of fly ash+2%lime & Rice husk +2%lime Mixed with Soil

5. Specific Gravity:-

Specific gravity (G) is the ratio of the weight of a given volume of soil solids at a given temperature to the weight of an equal volume of distilled water at that temperature, both weights being taken in air. Specific gravity varies with temperature and pressure. The Specific gravity of simple black cotton soil was 2.1.



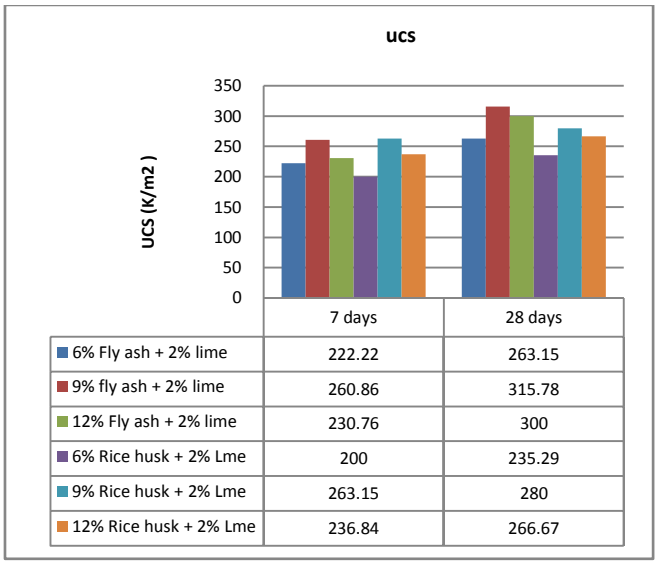
	7 days	28 days
6% Fly ash + 2% lime	2.35	2.43
9% fly ash + 2% lime	2.45	2.56
12% Fly ash + 2% lime	2.23	2.39
6% Rice husk + 2% Lme	2.31	2.4
9% Rice husk + 2% Lme	2.37	2.54
12% Rice husk + 2% Lme	2.33	2.58

Graph No.**5** Specific gravity of Fly ash+2%lime & Rice husk +2%lime Mixed with Soil

From the graph.5 we observed that, after addition of 9% Fly Ash+ 2% Lime, Specific gravity is increases to 2.56%, and after the addition of 12% Rice Husk+ 2% Lime, Specific gravity is increases to 2.58%., at the end of 28 days curing.

6. Unconfined Compressive Strength (UCS):-

An axial load is applied using either strain-control or stress-control condition. This test method provides an approximate value of the strength of cohesive soil in terms of total stresses.



	7 days	28 days
6% Fly ash + 2% lime	222.22	263.15
9% fly ash + 2% lime	260.86	315.78
12% Fly ash + 2% lime	230.76	300
6% Rice husk + 2% Lme	200	235.29
9% Rice husk + 2% Lme	263.15	280
12% Rice husk + 2% Lme	236.84	266.67

Graph No.**6** Unconfined compressive strength of Fly ash+2%lime & Rice husk +2%lime Mixed with Soil

Test result shows that UCS of soil at the end of 28 days curing for 9 % Fly Ash+2%lime, 9% Rice Husk+2%lime is 315.78KN/m^2, 280KN/m^2, respectively against the UCS of soil 170 KN/m^2 observed in the Graph No. **6**

CONCLUSION

Soil stabilization using Fly Ash, Rice Husk and Lime are an effective mean for

enhancing the engineering performance of Black Cotton Soil. Use of Fly ash , Rice Husk and Lime as a stabilizer in black cotton soil is suitable for NAGPUR region. Following are the conclusions based on the observations of the tests carried out on the soil:-

1. This study emphasis that Fly ash is a better additive as compared to rice husk.

3.It was observed that the liquid limit of the Black cotton soil has been decreased by 26% with the addition of 9% Rice Husk + 2% Lime. (From Graph No..2)

4. The plastic limit of the Black cotton soil has been decreased by 23% with the addition of 9% Rice Husk + 2% Lime. (From Graph No. 3)

5. Based on Unconfined Compressive Strength test, we decide 9% Fly ash + 2% lime is suitable for soil stabilization after 28 days curing.

6.The shrinkage limit of the black cotton soil has been increased by 21.24% with the addition of 12% Fly ash + 2% Lime. (From Graph No..4)

6. The specific gravity of the black cotton soil has been increase up to 2.56 with the addition of 9% Fly ash + 2%Lime. (From Graph No..5).

7. Use of Fly Ash and Rice Husk as an admixture for improving engineering properties of the soils is an economical solution for Vidarbha region of Maharashtra as it is available in large quantity.

2. Based on the Atterbergs Limits and UCS tests, the optimum amount of 9% Fly Ash + 2% Lime and 9% Rice Husk + 2% lime is suitable for soil stabilization.

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