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Comparative Study of Moorum and Stabilized Black Cotton Soil by 15% Addition of FA and RHA

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ABSTRACT: The expansive soil causes numerous damages to the structures, especially to the buildings and pavements, in comparison with other natural hazards like earthquakes, floods, etc. Therefore, throughout the world these soils are considered problematic soils and represent several challenges for engineers. So as to use these soils in an effective way, an adequate treatment to the soil is required. The soil improvement increases continuously using different methods to improve the mechanical properties of different types of soil. One of the most economical and effective methods to strengthen black cotton soil is the addition of agricultural and industrial wastes such as RHA and FA to BC soils. In this study, the BC soil is stabilized using FA and RHA. The geotechnical properties, such as the Atterberg's limit, the unconfined compressive strength (UCS), the CBR value of the black cotton soil treated with RHA and FA are calculated for a mixing ratio of 15%. In addition, the different geotechnical tests are performed on moorum and the results are calculated and compared with the black cotton soil stabilized with RHA and FA. The results show significantly that BC soils stabilized with RHA and FA have almost the same properties as moorum.

KEYWORDS: Industrial waste, Rice husk ash, Fly ash, Black cotton soil, Moorum.

I. INTRODUCTION

A natural soil deposit is quite unlike any other material of construction known to man. Soil may be considered an incidental material obtained from geologic cycle vise goes on continuously in nature. Compacted soil are used in several geotechnical and engineering structure example highway embankment, earth dams highway and runway sub grades, land field barriers and many other structures. Compaction of soil is generally carried out to reduce permeability and increases the strength characteristic of soil which in turn increases the bearing capacity of foundation constructed over them. More recently, the high cost of waste disposal techniques have been sparked an interest in the possible use of waste material such as rice husk ash, fly ash, red mud, copper slag, shredded waste tyres, lime sludge, petroleum drilling waste etc. These materials may be added individually all in combination with soils in various geotechnical engineering works to reduce the quantum of waste required to dispose off. Utilization of waste material is being given prime importance all over the world.

The purpose of amending the soil with waste material is to increase strength, reduce deformability provide volume stability, lower permeability, minimize erodability, enhance durability and control variability. Use of waste helps in solving dual problem firstly a problem of disposal of waste and secondly leading in improvement in the properties of soil with economy the present study of paper shows the comparative strength achieved by a mix of 15% of Rice husk ash and Fly ash stabilized black cotton soil with soft moorum.

The various laboratory test taken with different proportion on a mix of Rice husk ash and Fly ash stabilized black cotton soil and it is found that the BC soil gets strength at 15% mix proportion with Rice husk ash and Fly ash. This stabilized soil is compared with soft moorum index properties. This investigation is done to study the change in index properties and strength characteristics of black cotton soil corresponding to different proportions of fly ash and rice

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husk ash. The objective of this study is to use upgraded black cotton soil by RHA and FA as a construction material in a deficit of soft moorum.

II. OBJECTIVE OF THE STUDY

The present work is aimed at comparing index properties of mix of 15% Rice husk ash and Fly ash stabilized black cotton soil to index properties of Moorum for assessing stabilized soil potential as construction material. To achieve the aim, work has been planned with the following objectives.

1. To determine index properties of mix 15% Fly ash and Rice husk ash stabilized black cotton soil and index properties of Moorum.
2. To assess compressive strength of mix 15% Fly ash and Rice husk ash stabilized black cotton soil and Moorum.
3. To study the improvement in C.B.R of mix 15% Fly ash and Rice husk ash stabilized black cotton soil and Moorum soil.
4. To compare the properties of 15% mix of FA and RHA stabilized BC soil with moorum.

III.LITERATURE SURVEY

Dayalan J1 studied the performance of stabilized soil are evaluated using physical and strength performance tests like specific gravity, atterberg limits, standard proctor test and California Bearing Ratio (CBR) test at optimum moisture content. From the results, it was found that optimum value of fly ash is 15% and GGBS is 20% for stabilization of given soil based on CBR value determined.

Tom Elias, Sonia George et al (2) the study is conducted to stabilize clayey soil using human hair fiber and to compare it with the classical method of lime stabilization.

Laxmikant Yadu (3) shows that addition of FA and RHA reduces the plasticity index (PI) and specific gravity of the soil. The moisture and density curves indicate that addition of RHA results in an increase in optimum moisture content (OMC) and decrease in maximum dry density (MDD), while these values decrease with addition of FA. The addition of stabilizers (i.e., FA and RHA) increases UCS and CBR values, indicating the improvement in the strength properties of the soil. Based on the CBR and UCS tests, the optimum amount of FA and RHA was found to be as 12% and 9%, respectively. The literature survey shows that the black cotton soil can be stabilized with FA, GGBS, human hair fiber and RHA with a waste material.

IV.PROPOSED METHODOLOGY

Material Used

1. Moorum:

The moorum soil is an accumulation or deposit of earth material derived naturally from the disintegration of rock that can be excavated readily with power equipment in the field by mechanical means. Moorum which is a fragmented weathered rock naturally occurring with varying proportions of silt and clay. It is considered as a low grade marginal material for road construction. The moorum is collected from hilly area near Aurangabad.

2. Soil:

The locally available soil collected from Rotegaon area Tal.Vaijapur Dist. Aurangabad and soil is collected from a depth of 1.5 meter from the ground surface.

3. Fly Ash

Fly ash is a fine powder thrown out as a waste material in huge quantities at the thermal power plants using pulverized coal for raising steam in the boiler. It is finally discharged either as a dry powder or in the form of a wet mass or slurry.

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4. Rice Husk Ash:

Rice milling generates a by-product known as husk. This surrounds the paddy grain. During the milling of paddy about 78% of the weight is received as rice. Rest of 22% of the weight of paddy is received as husk. This husk is used as a fuel in the rice mills to generate steam for boiling process. This results in rice husk ash (RHA). This RHA contains around 85% to 90% amorphous silica. So for every 1000 Kgs of paddy milled, about 220 Kgs (22%) of husk is produced and when this husk is burnt in the boilers, about 55kg of RHA is generated

MIX PREPARATION:

Soil sample has been stabilized with 15% Addition of FA and RHA.

The mix has been prepared with different percentage such as 5%, 10%, 15%, 20% and 25% dry weight of black cotton soil with FA and RHA.

Experimental Tests:

In the laboratory the different tests are conducted on moorum. Similarly the tests conducted on soil samples and industrial wastes like Fly Ash and Rice Husk Ash with 15% addition. The different tests conducted are as given below

1. Consistency limits
2. Standard Proctor test,
3. Direct Shear test,
4. Unconfined Compressive strength test
5. Laboratory Soaked CBR test

1. Consistency limits:

The consistency of a fine-grained soil refers to its firmness and varies with the soil moisture content. A gradual increase in water content makes the soil go from solid to semi-solid plastic to liquid. Water contents in which the consistency changes from one state to another are called consistency limits (or Atterbergs limits).

2. Standard Proctor test:

Compaction is that the method of densifying the soil by reducing air voids. The degree of compaction of a given soil is measured in terms of its dry density. The dry density is maximum in the optimum water content. A curve is established between the moisture content and the dry density to obtain the maximum dry density and optimum moisture content.

3. Direct Shear test:

The test is carried out on a soil sample confined in a metal box of square cross-section which is split horizontally at mid-height. A small clearance is maintained between the two halves of the box. The soil is sheared along a predetermined plane by moving the top half of the box relative to the bottom half. The box is usually square in plan of size 60 mm x 60 mm

4. Unconfined Compressive strength test:

The unconfined compressive strength is that the load per unit area at that the cylindrical specimen of a cohesive soil falls in compression. Unconfined compression test imposes uniaxial compression conditions on a soil sample and is used for determining the un-drained shear strength of saturated cohesive soil. The test is performed on a cylindrical sample with a height to diameter ratio of 2: 1. The sample is placed between the plates of a mechanical load frame with none covering or lateral support. Load and deformation readings taken till the failure of the sample or a strain 20% which one is smaller. It is not always possible to check the bearing capacity test on the field. Sometimes it is cheaper to collect the undisturbed soil sample and check it for its strength in the laboratory.

5. Laboratory Soaked CBR test:

These tests are carried out on natural or compacted soils in water soaked or un-soaked conditions and the results so obtained are compared with the curves of standard test to have an idea of the soil strength of the subgrade soil.

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The Index properties of moorum found out in the laboratory are as:

Table 1: Index properties of moorum

| Sr. No. | Property | Moorum |
|---------|--|--------|
| 1. | Specific Gravity | 2.73 |
| 2. | Atterbergs Limits : % | |
| | Liquid Limit | 42 |
| | Plastic Limit | 19.40 |
| | Plasticity Index | 22.60 |
| 3. | Maximum Dry Density (KN/m ³) | 16.67 |
| | Optimum Moisture Content (%) | 16 |
| 4. | Unconfined Compressive Strength (KPa) | 180.24 |
| 5. | California Bearing Ratio % (soaked) | 9.80 |

Table 1 shows liquid limit of moorum as 42, plasticity limit as 19.40 and the plasticity index as 22.60. The dry density obtained in the laboratory test of moorum is 16.67 KN/m³. The unconfined compressive strength and soaked CBR value of moorum is found to be 180.24 KPa and 9.80%.

The Various tests performed on mix of BC Soil+15% addition of FA and RHA in the laboratory are as:

Table 2: Consistency Limit Test with Soil +FA+RHA

| Sr. No | Property | Soil + Fly Ash +Rice Husk Ash mix | | | | | |
|----------|-------------------------------|-----------------------------------|------------------|------------------|------------------|------------------|------------------|
| | | SFR ₀ | SFR ₁ | SFR ₂ | SFR ₃ | SFR ₄ | SFR ₅ |
| | Proportion | | | | | | |
| | Soil : Fly Ash :Rice Husk Ash | 100:00 | 95:5 | 90:10 | 85:15 | 80:20 | 75:25 |
| 1 | Atterberg's Limits (%) | | | | | | |
| | Liquid Limit | 72.46 | 66 | 63.05 | 59.8 | 57.1 | 55.25 |
| | Plastic Limit | 30 | 30.6 | 30.75 | 30.25 | 29.8 | 30.7 |
| | Plasticity Index | 42.46 | 35.4 | 32.3 | 29.55 | 27.3 | 24.55 |

The index property of black cotton soil +FA+RHA have been tested in the laboratory with different proportions as 5%, 10%, 15%, 20% and 25% the liquid limit for 15% addition of mix is found as 59.8, plastic limit as 30.25 and plasticity index as 29.55. As the plasticity index is more the soil is considered to be tends to clay.

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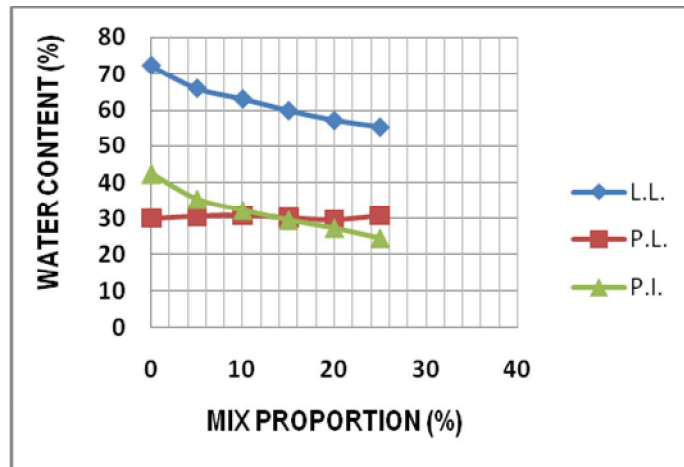


Fig. 1: P.I. Values of Soil-FA-R.H.A mix

The effect of addition of mix of Fly ash and Rice husk ash reduces the plasticity index. The various proportion of addition of FA and RHA to soil is presented in Table-2. It is found that as the percentage of Mix soil increases, the Liquid Limit of soil mix is reduced. As the percentage of Mix soil is increased up to 15% the liquid limit of soil mix is reduced by 17.47%.

OMC & MDD Test:

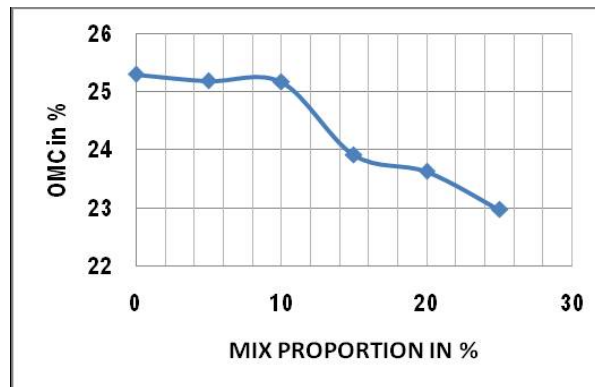


Fig. 2: OMC Values of Soil-FA-R.H.A mix

It has been observed from Fig. 2 that the OMC of soil without modification is found to be 25.30%. After modification with 5%, 10%, 15%, 20% and 25% of fly ash and rice husk ash mix, the OMC is found to be reduced by 0.43%, 0.51%, 5.45%, 6.60% and 10.17% respectively. The probable reason for reduction in optimum moisture content of soil by addition of fly ash in comparison with original soil may be proper rearrangement of soil particles of modified mix which may be reducing the voids.

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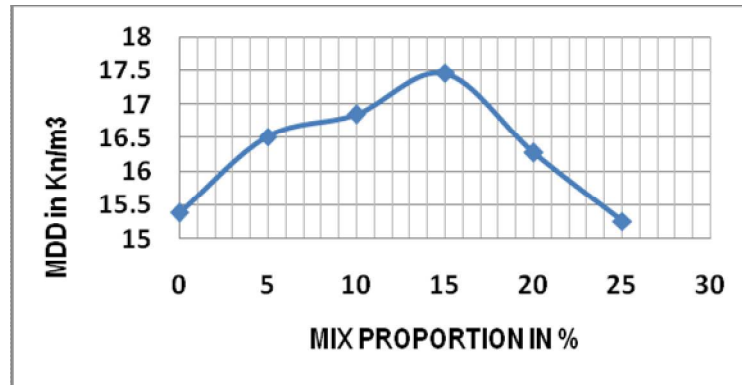


Fig. 3: MDD Values of Soil-FA-R.H.A mix

From Fig. 3 after modification by 5%, 10%, 15%, 20% and 25% by fly ash and rice husk ash, the maximum dry density is found to be increased for 15% mix proportion after that it starts reducing as the mix proportion increases. The probable reason for initially increase in maximum dry density of soil by addition of fly ash and rice husk ash in comparison with original soil may be proper rearrangement of modified soil mix and improved binding capacity. The probable reason for reduction in maximum dry density after 15% mix proportion is light weight of rice husk ash in comparison with original soil.

Unconfined Compressive Strength Test:

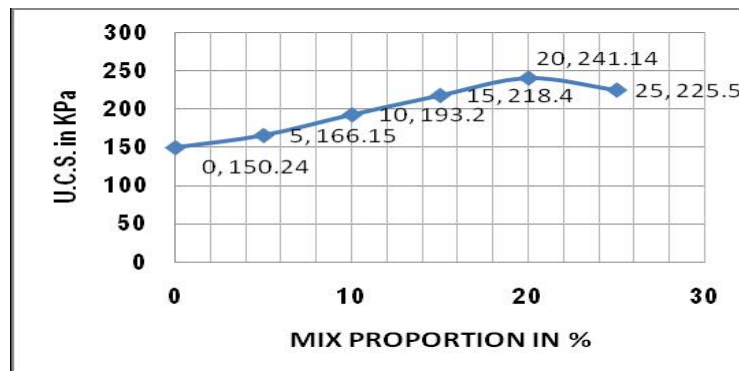


Fig. 4: Unconfined Compressive strength values with Soil-FA-R.H.A mix

The test were performed on samples compacted at OMC and MDD. The unconfined compressive strength of soil, without modification is found to be 150.24 KPa. After modification with 5%, 10%, 15%, 20% and 25% of rice husk ash, the value of unconfined compressive strength is increased by 20.01%, 41.67%, 60.78%, 76.61% and 70.23% respectively.

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CBR Test:

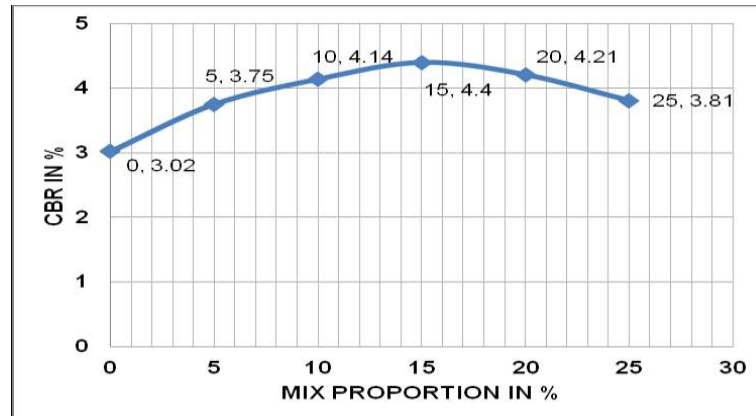


Fig. 5: Soaked CBR Values with Soil-FA-R.H.A mix

The California bearing ratio of soil without modification is found to be 3.02 %. The CBR is a measure of resistance of a material to the penetration of standard plunger under controlled density and moisture conditions. After modification with 5%, 10%, 15%, 20% and 25% of fly ash and rice husk ash mix, the value of California bearing ratio is increased by 24.17%, 37.09%, 45.69%, 39.40% and 26.15% respectively.

V. RESULT AND DISCUSSION

The Various tests such as Consistency limits, Compaction Test, UCS and soaked CBR tests were carried out confirming to IS 2720 guidelines on stabilized black cotton soil samples at different proportions with fly ash and rice husk ash and compared with properties of Moorum.

By addition of 15% of fly ash and rice husk ash in black cotton soil, the value of liquid limit, plastic limit and plasticity index of modified soil is reduced due to use of non-plastic material for modification. The value of maximum dry density of modified soil is increased due to proper rearrangement of modified soil mix and due to improved binding capacity. The value of unconfined compressive strength of soil by addition of 15% fly ash is increased.

The Summary of geotechnical properties of Moorum and Stabilized Black Cotton Soil by 15% Addition of FA and RHA result is tabulated in Table 3.

Table 3: Comparative Index properties of Soil, Moorum, and Soil+15% (FA+RHA)

| Sr. No. | Property | Soil | Moorum | Soil+15%(FA+RHA) |
|---------|--|-------|--------|------------------|
| 1. | Specific Gravity | 2.7 | 2.74 | 2.56 |
| 2. | Atterberg's Limits : % | | | |
| | Liquid Limit | 72.46 | 42 | 59.80 |
| | Plastic Limit | 30 | 19.40 | 30.25 |
| | Plasticity Index | 42.46 | 22.60 | 29.55 |
| 3. | Maximum Dry Density (kN/m ³) | 15.38 | 16.67 | 17.46 |
| | Optimum Moisture Content (%) | 25.3 | 16 | 23.92 |
| 4. | Unconfined Compressive Strength (KPa) | 150.2 | 180.2 | 218.4 |
| 5. | California Bearing Ratio % (soaked) | 3.02 | 9.80 | 4.4 |

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The Table 3 is comparative statement of index properties of soil, moorum and soil+15% (FA+RHA). The moisture content 23.92 at which maximum density occurs 17.46 KN/m^3 is called the optimum moisture content (OMC). As the compaction effort is increased, the maximum density generally increases and the OMC decreases. The MDD of mix soil is found as 17.46 KN/m^3 .

VI. CONCLUSION

The work presented in this paper is therefore concluded as follows from the experimental studies on black cotton soil, moorum and Soil+15%FA+15% RHA as,

1. The tremendous increased industrial waste and agricultural waste i.e. FA and RHA can be utilized in stabilization of black cotton soil and reduces problem of dumping of wastes.
3. The UCS of the soil stabilized with 15% FA and RHA mix gives more strength as moorum.
2. The practical consideration of the stabilized soil by 15% with fly ash rice husk ash mix is recommended to be used for road which got properties as murum.
4. The study concluded that is to use upgraded black cotton soil by FA and RHA as a construction material in a deficit of moorum.

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