EFFECTS OF RICE HUSK ASH AND FLY ASH ON INDEX PROPERTIES OF BLACK COTTON SOIL

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Abstract – *There is a tremendous development of industrial and infrastructure projects in almost all parts of India, with industrial and agricultural waste having a negative impact on the environment leading to soil contamination, land pollution, etc. This paper presents the results of an experimental study, which was carried out to investigate the effects of using industrial and agricultural waste fly ash and rice husk ash to improve the strength and index properties of expansive soil. Fly ash, a solid, fine-grained material resulting from the combustion of coal dust in thermal power plants. Locally available soil collected from the Rotegaon area of Tal. Vaijapur Dist. Aurangabad. Samples were prepared by mixing the percentage of fly ash, rice husk ash and expansive soil as 5%, 10%, 15%, 20% and 25% dry weight. A series of experimental testing was performed on soil samples consisting of Atterberg limits, linear shrinkage and compaction tests. The results of this study are analyzed to illustrate the influence of the treatment of fly ash and rice ash on the properties of expansive soil. The results indicate a significant increase in strength and index properties with 15% blend of fly ash, rice husk ash and soil.*

Key Words: Fly ash, Rice Husk ash, Expansive soil, industrial waste2-6 etc.

1. INTRODUCTION *(Size 11 , cambria font)*

Clays generally have undesirable engineering properties. Soil can be considered as an ancillary material obtained from a geological cycle vise that continues continuously in nature. Compacted soil is used in several examples of geotechnical structures and engineering structures, such as road embankments, earth dams, highway and runway basements, terrain barriers and many other structures. Soil compaction is usually done to reduce permeability and increase the characteristic soil resistance, which increases the bearing capacity of the foundations built on top of it. In India, most of India's black cotton soils occupy an estimated area of 74 million hectares. These soils are generally found in Maharashtra, western Madhya Pradesh, Gujarat and parts of Andhra Pradesh, Tamil Nadu, etc. Disposal of solid waste in the landfill can be minimized if the waste has desirable properties they can therefore be used for various geotechnical applications. The goal of soil remediation is to increase strength, reduce deformability, stabilize volume, reduce permeability, minimize erodibility, improve durability and control variability. The use of waste helps to solve a double problem first of all a problem of disposal of waste and secondly leading to an improvement of soil properties with economy. A review of the literature indicates that industrial waste can be used in soil improvement. Industrial wastes such as fly ash, rice husk ash, especially those with pozzolanic properties are useful in this regard in the present study two industrial waste fly ash from the Parli thermal power plant and Jharsuguda rice husk ash, Orissa.

1. Soil:

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

2. 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.

3. 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

Laboratory Test

The designations for mixture soil and soil are detailed in Table 3.5 the soils are modified by using fly ash and rice husk ash. Soil is modified by using fly ash and rice husk ash in the range of 0-25%. Table-1 shows details of soil mix and symbols used for them.

Table -1: Symbol of Modified Soil and its proportions

Sample Table format

Symbol	Proportion Soil + Fly Ash + RHA
SFR0	100 : 0
SFR1	95 : 5
SFR2	90 : 10
SFR3	85 : 15
SFR4	80 : 20
SFR5	75 : 25

It is rarely possible to get purely cohesive soil, as little frictional element are always present in the soil, so it is decided to study the properties of cohesive frictional i.e. C – Φ soil. For improving the properties of cohesive frictional soil, improvement technique is used and the emphasis is given on the pavement construction. The sub grade on which the pavement is to be constructed should have stability and strength. The stability is influenced by soil texture, water content and density. Any soil that is to be used for embankment, should have required cohesion, impermeability and shear strength. When the same soil is used as the base for the foundation then it should possess sufficient compressive strength and shearing strength. In case of earthen dam, foundation of structure depends on the bearing capacity of soil and its stability of slopes and the shearing resistance of soil. To find the bearing capacity of soil the values of cohesion (c) and angle of internal friction (Φ) for the soil should be known. So the basic parameters required to be found out are c and Φ values, shear strength and compressive strength. In case of the embankments CBR value is required for designing the flexible pavements. Therefore, to assess the improvement in the above engineering properties of cohesive frictional soil by using soil improvement technique, Compaction test, Direct Shear test and CBR tests are carried out.

For finding out the value of liquid limit, the liquid limit test apparatus is used. For finding out the value of Cohesion (c) and angle of internal friction (Φ) for soil, the direct shear test is carried out. For finding out the value of California bearing ratio for soil, the California bearing ratio test apparatus is used. For compaction behavior Standard Proctor test is carried out which gives the values of Maximum Dry Density (MDD) and Optimum Moisture Content (OMC), for which the further samples are prepared for testing. Again it gives the effect of compaction on improved soil. By conducting Direct Shear test, the value of c and Φ are obtained. These are the two components, which contribute the shearing strength of a soil. The CBR test gives the CBR values of the soil specimen, which is required for the pavement design. After getting the CBR value, the pavement design is done by appropriate method.

In the laboratory tests are conducted on soil samples and industrial wastes like Fly Ash and Rice Husk Ash separately. Similarly the laboratory tests are performed on soil + fly ash and soil + rice husk ash. 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 and

The observations, results and discussion based on the experimental work

Consistency limits for mix (Soil + Fly Ash+ Rice Husk Ash)

The effect of Mix soil addition in varying proportion with soil has been studied and the variation in consistency limits for various mixes are presented in Table-2 and chart-1. From the 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%.

Table -2: Consistency limits

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	100:0	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

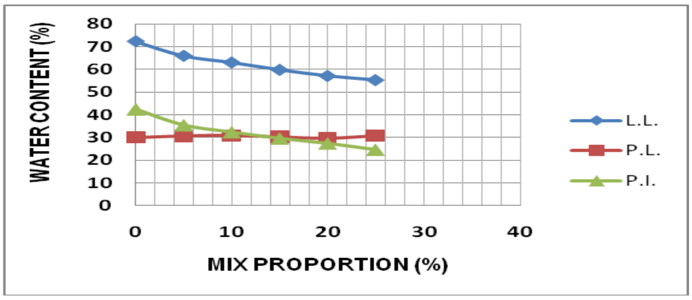

Chart -1: Effect of Addition of Fly Ash and Rice husk ash on Atterbergs Limit for Soil

Soil has been modified by addition of Soil, FA and RHA in the range of 5 to 25%. The liquid limit, plastic limit and plasticity index of Soil, without modification is found to be 72.46%, 30% and 42.46% respectively. After modification with 5%, 10%, 15%, 20% to 25% of Mix Soil the liquid limit is found to be reduced by 8.91%, 12.98%, 17.47%, 21.19% and 23.75 respectively. The probable reason for reduction in liquid limit of modified soil may be the use of non plastic material for modification.

From the Table 02 it is also found that the value of plastic limit is increases as increase in percentage in Mix soil. As the percentage of Mix soil is increased upto 15% the value of plastic limit is reduced by 0.83%. For further increase in Mix Soil, there is less reduction in plastic limit value.

Similarly the value of plasticity index is also reduced by increase in percentage of Mix soil. As the Mix soil percentage is increased upto 15%, value of plasticity index is reduced by 30.40%

The reduction in plasticity index is found due to use of non-plastic material Mix soil for modification.

The result shows that on addition of FA + RHA as the percentage of FA + RHA increases the liquid limit of the mix decreases and plastic limit increases. The above results indicate that the expansion characteristics are reduced on addition of FA + RHA.

Effect of FA + RHA addition on Maximum Dry Density for soil

The Standard Proctor's test for soil with fly ash and rice husk ash mixes are performed and effect of addition of fly ash and rice husk ash with soil for MDD is present in Chart-02

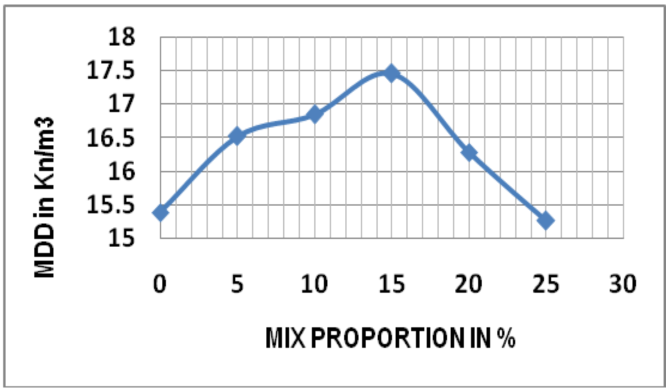

Chart -2: Effect of addition of Fly Ash and Rice husk ash on MDD

The maximum dry density soil without modification is found to be 15.38 kN/m^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.

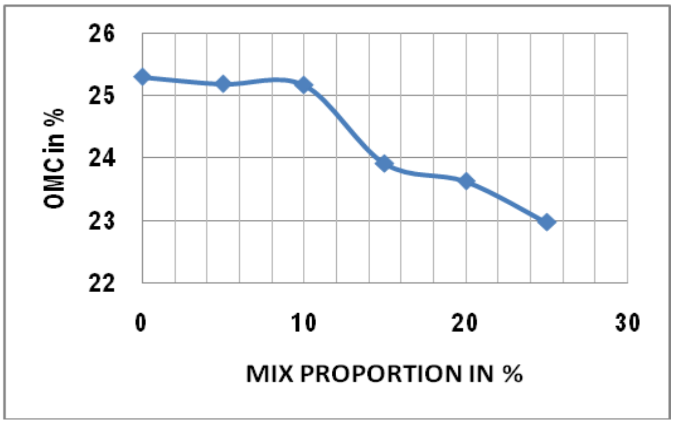

Chart -3: Effect of addition of Fly ash and Rice husk ash on OMC

The Optimum moisture content 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 optimum moisture content 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.

Unconfined compressive strength

The unconfined compressive strength test results for various combination of soil with fly ash and rice husk ash are presented in Table 03. The results in graphical form are also presented in Chart 04. Shear strength is the principal engineering property which controls the stability of soil mass under the load. It governs bearing capacity, stability of slope etc. The test is conducted in laboratory on unconfined compression machine as per IS: 2720 part 10-1973.

Table -3:

Sr. No.	Property	Soil + Fly Ash + Rice Husk Ash					
		SFR0	SFR1	SFR2	SFR3	SFR4	SFR5
	Proportion Soil : Fly Ash : Rice Husk Ash	100:00	95:5	90:10	85:15	80:20	75:25
1	Unconfined compressive strength (kPa)	150.24	166.15	193.2	218.4	241.14	225.5

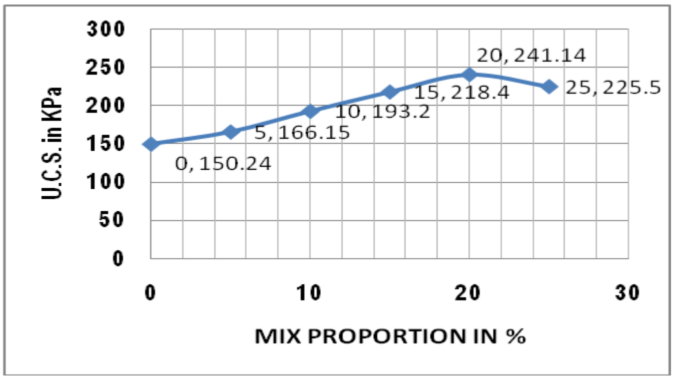

Chart -4: Effect of addition of Fly ash and Rice husk ash on UCS

The percentage of fly ash and rice husk ash mix is increased the value of unconfined compressive strength is also increased. The percentage of fly ash and rice husk ash mix is increased up to 20% the value of unconfined compressive strength is increased by 60.50%. Further if the percentage of fly ash and rice husk ash mix is increased up to 25% the value of unconfined compressive strength is increased by 50.09%.

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. The probable reason for increase in unconfined compressive strength of soil by addition of fly ash and rice husk ash in comparison with original soil may be due to binding capacity of the rice husk ash.

California bearing ratio value

The California Bearing Ratio test results for various combinations of soil + fly ash + rice husk ash presented in Table 4. Same results in graphical forms are also presented in Chart -5

Table -4: California Bearing Ratio

Sr. No.	Property	Soil + Fly Ash + Rice Husk Ash					
		SFR0	SFR1	SFR2	SFR3	SFR4	SFR5
	Proportion Soil : Fly Ash : Rice Husk Ash	100:00	95:5	90:10	85:15	80:20	75:25
1	California Bearing Ratio % (Soaked)	3.02	3.75	4.14	4.40	4.21	3.81

It is found the percentage of mix proportion of soil, fly ash and rice husk ash is increased the value of California bearing ratio is also increased. If the percentage of soil mix is increased up to 15% the value of California bearing ratio is increased by 45.69%.

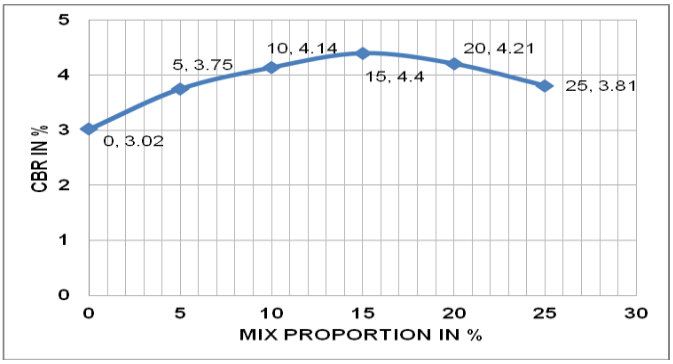

Chart -5: Effect of addition of Fly ash and Rice husk ash on CBR

The California bearing ratio of soil without modification is found to be 3.02 %. 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. The probable reason for increase in California bearing ratio of soil by addition of fly ash in comparison with original soil may be increase in the density of modified soil mix and rice husk ash may be due to binding capacity of the rice husk ash.

3. CONCLUSIONS

This fragment should obviously state the foremost conclusions of the exploration and give a coherent explanation of their significance and consequence.

1. Soil is modified with fly ash and rice husk ash by 5%, 10%, 15%, 20% and 25%. The value of CBR is found to be increased by 24.17%, 37.09%, 45.69%, 39.40% and 26.15%. The maximum increase in CBR is by addition of 15% fly ash and rice husk ash due to increase in the density of modified soil mix it leads to have more strength.

3.By addition of 15% of fly ash and rice husk ash in 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.

4. By addition of 15% fly ash and rice husk ash in soil, 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.

5. The optimum moisture content of soil by addition of 15% fly ash and rice husk ash is reduced due to proper rearrangement of soil particles of modified soil mix, which may be reducing the voids.

6. The value of unconfined compressive strength of soil by addition of 15% fly ash is increased. The probable reason for this may be due to increase in the density of modified soil mix.

8. The value of California bearing ratio of soil by addition of 15% fly ash and rice husk ash is increased due to increase in density of modified soil mix and due to binding capacity of rice husk ash.

9. From the practical consideration the modified soil mix (soil : fly ash: rice husk ash) 85:15 percentage is recommended to be used for road which got properties as murum.

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