Physical properties of soil reinforced with rice straw ash

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Abstract— The main objective of present research is to find out the utilization of rice straw in the field of geotechnical engineering. Each and every soil have its own characteristics, some of the soil have good engineering properties. But some kind of soils requires extra treatment to increase their bearing capacity. One of the treatment methods is soil reinforcement which is very popular from ancient time. Here, in this research paper rice straw ash using for soil reinforcement and determining the physical properties of reinforced soil with rice straw ash at different proportion. Rice straw generally burn by farmers in their field in north India region which create a large amount of smog, thus the soil reinforcement with rice straw can be a good solution to minimize this pollution level.

Keywords— bearing capacity, foundation, physical properties, rice straw (parali), soil reinforcement.

I. INTRODUCTION

In India, there are different types of soil with different characteristics. Some soil good for engineering purpose and some of them good for agriculture purpose. According to the point of view of a geotechnical engineer, soil should have good characteristics which suitability to bear load of structure. The soils which have not good bearing capacity required extra treatment like soil reinforcement. In this research paper, soil reinforced with rice straw ash manufactured by a specified method which create less or negligible pollution. India produces a big amount of agricultural waste and agricultural by-products in different sectors. In northern India, mainly Haryana and Punjab region farming rice at large level and face a big problem of agricultural waste (rice straw) disposal. In that case most of farmers burn rice straw in their field after harvesting. This rice straw can use in the field of geotechnical engineering to improve the properties of soil. The reinforced soils analyse at different proportion of rice straw ash and determine the basic physical properties of soil after reinforcing with rice straw ash. In this research, some physical properties like optimum moisture content and maximum dry density, specific gravity, unified soil classification and Atterberg's limits etc.

II. PREVIOUS RESEARCH

B.C punmia[(1)] (2011) To improve performance of soil in the field of civil engineering some reinforcing material insert or mix with soil, this processes is known as soil reinforcement.

Aditya Kumar Anupam,Praveen Kumar and G D Ransinchung R[(2)] *et. al. (2013)* In the field of rice production, India is second largest country in all over the world. Thus there is a big problem to manage the rice crop residue. In this research, rice straw ash creating by burning use to stabilize the soil. Rice straw ash has good pozzolonic properties to improve the performance of soil. All the testing related to determine bearing capacity of stabilized soil done on different percentage of rice straw from 5 % to 35 % mixing with soil.

Surajit Munshi,Richi Prasad Sharma et. al. (2019) In the research the main objective to use rice straw practically in civil engineering field. The research conclude the good amount of silica present in the rice straw ash which improve the capability of soil.rice straw ash is a good mineral admixture in construction work also.

Junjun LIU, Chanjuan JIA and Chunxia HE et. al. (2012) the research found the good flexural properties of rice straw ash as compare to other agricultural waste which is very helpful to improve the performance of poor bearing capacity soil.

III. MATERIAL

Soil: The soil taken from a field situated in the region of Mathura Vrindavan. The location of field is nearby the campus of G.L Bajaj group of institutions campus Akbarpur Mathura. The physical properties of soil determined and find out the following results:

TABLE I

Physical properties of natural soil

Properties	values
Maximum dry density (gm/cm^3)	1.69
Optimum moisture content (%)	17.75
Liquid limit (%)	51.2

Plastic limit (%)	26
Plastic index	25.2
Specific gravity	2.65
Unified soil classification	Clay of high compressibity
Type of soil	Inorganic clays of plasticity plasticity, fat clay

Maximum dry density and optimum moisture content determined with the help of standard proctor test of natural soil found in field.

Rice straw Ash: The rice straw have rough outer epidermal. The elongation and tensile strength of rice straw is much better than wheat straw[3]. Water absorption and tensile strength of rice straw is385.2 % and 5.4 MPa respectively[3]. A specified method selected to convert rice straw into ash with negligible smog amount. This type of ash contains good pozzolonic properties which help to improve the performance of soil in the field of geotechnical engineering[4]. Rice straw ash contain 77% of silica oxide which is greater than the amount of silica oxide contain by cement[7].

TABLE III
Properties of rice straw ash

Properties	**values**
Silica oxide (%)	78
Loss on ignition	1.42
Specific gravity	2.4
Surface area (m^2/g)	0.356

IV. METHOD

First of all rice straw collect in a air tight bag at 4° C to maintain the original characteristics. Then before starting tests in laboratory cut the roots residue of rice straw and wash out the dirt with the help of fresh water. Cut the rice straw in the length of 2 inch to work with it easily and clarified it with 50% sodium hypochlorite. Before the oven drying at 105°C for 24 hours, wash with distilled water to avoid any chemical reaction. Grind these dried rice straw and mixed it with the soil of low bearing capacity [4]. The ash obtain by this process can replace 10 to 25 % amount of ordinary Portland cement [4]. In this research the soil reinforcement method is same as the cement soil stabilization. The cement replace in three different proportions as 10%, 20% and 30% rice straw ash by the weight of soil. Rice straw ash mixed with soil thoroughly in different ratio to prepare the sample and determine the physical properties of soil after mixing with rice straw ash. Here, in this research maximum dry density, optimum moisture contains liquid limit, plastic limit, plasticity index and modified soil classification of reinforced soil. Determined physical properties of reinforced soil compare with the properties of natural soil. For the calculation of the weight of rice straw ash use following process:
Weight of rice straw ash = percentage providing for rice straw ash as compare to soil weight X weight of air dried soil sample
The different value of rice straw ash followed for the experimentation as 0%, 10%, 20% and 30%.

V. RESULT AND DISCUSSION

In the research, analyze the different physical properties of soil with and without mixing of rice straw.

TABLE IIIII
Comparison between physical properties of soil at different proportion of rice straw ash

Physical properties	Natural soil	10% RSA	20% RSA	30% RSA
Maximum dry density (gm/cm^3)	1.69	1.72	1.74	1.75
Optimum moisture content (%)	17.75	17.00	16.5	15.1
Liquid limit (%)	51.2	48.4	43.2	38.6
Plastic limit (%)	26	25	24.1	22
Plastic index	25.2	23.4	19.1	16.6
Specific gravity	2.65	2.67	2.69	2.71
Unified soil classification	Clay of high compressibity	Clay of low compressibity	Clay of low compressibity	Clay of low compressibity
Type of soil	Inorganic clays of plasticity plasticity, fat clay	Inorganic clays of low to medium plasticity	Inorganic clays of low to medium plasticity	Inorganic clays of low to medium plasticity

After the mixing of rice straw ash the soil converted into low plasticity soil from high plasticity soil which is more useful for construction purpose. Clay with low plasticity are more useful for foundation, rolled earth dams, canal section, roadways fills and surfacing as compare with clays with high plasticity.

VI. CONCLUSIONS

According the chart given by WAGNER 1957, clay with low to medium plasticity have good shearing strength when compacted and saturated as compare to clay with high plasticity. Such type of soil also have good workability as construction material in the comparision with fat clays.

Above analysis represent that the reinforcement by rice straw ash improve the compressibility characteristics of soil. Thus rice straw produced by mentioned method can use as reinforcement material for soil. It is well known that farmers burnt the rice crop residue in their fields because it has no cost, so the utilization of rice straw can minimize the burning of rice residue in open field which is a major issue for environment. Cement stabilization is a tradition method for soil stabilization because of good pozzolonic properties and imrove the physical properties of soil. Rice straw ash also contain good pozzolonic characterstics and also improve the physical properties of soil. So rice straw ash is agood supplement for cement.

The properties of soil increased dramatically by mixing with ash produced by rice straw. The use of this ash is good in both manners as following

i. Improve the bearing strength of soil on in foundation construction and in slope stability as well
ii. Reduce the air pollution which caused by the rice straw burning in open fields.

The use of rice straw ash in construction will also cost effective.

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