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EFFECT OF RICE HUSK ASH AND FLY ASH ON SOIL STABILIZATION

ATUL GUPTA
Department of Civil Engg
MIET Mohri Shahbad
Kurukshetra, Haryana

ABSTRACT:
As we know, the bearing capacity of soil can be improved from various ground improvement techniques and one of the effective methods is using the Soil Stabilization. The degree of improvement in bearing capacity depends on various factors like degree of interaction between fly ash and rice husk ash with surrounding the soil, shape of footing, embankment variations in numbers and depth variation of embankment with footing. Keeping in view, it is planned to study the effect of fly ash and rice husk ash as a material in improving the characteristics of clay soil. The present investigation presents the result of laboratory tests using Standard Proctor Test, Unconfined Compression, test with an aim to increase the bearing capacity, shear strength of clay soil by using the different proportion of Fly Ash and Rice Husk Ash.

KEYWORDS- Bearing Capacity, Fly ash, Stabilization, Rice husk ash, Standard Proctor Test, Unconfined Compression Test.

INTRODUCTION

The wetting and drying process of a sub grade layer composed of clay soil result into failure of pavements in form of settlement and cracking. Therefore, prior to construction of a road on such sub grade, it is important either to remove the existing soil and replace it with a non-expansive soil or to improve the engineering properties of the existing soil by stabilization. Replacing the existing soil might not be a feasible option. Therefore the best available approach is to stabilize the soil with suitable stabilizers. Various types of soil stabilizers (i.e., fly ash, cement kiln dust, lime) and locally available materials (i.e., slate dust, rice husk ash) are being used for stabilization of soil. However, the selection of a particular type of stabilizer depends upon the type of sub grade soil and availability of stabilizers. Several researchers have reported the benefits of stabilizers for modifying the engineering properties of soil. Recognizing the benefits of stabilizer in improving the strength characteristics of soil, the present study has been undertaken to study the change in the index and strength properties of the clay soil by adding various proportions of fly ash (FA) and Rice husk ash (RHA). Furthermore, a through laboratory investigation has been conducted to determine the optimum amount of stabilizers.

CLAY SOIL CHARACTERISTICS

Clay is a naturally occurring aluminium silicate composed primarily of fine- grained minerals. Clay deposits are mostly composed of clay minerals, a subtype of phyllo silicate minerals, which impart plasticity and harden when fired or dried; they also may contain variable amounts of water trapped in the mineral structure by polar attraction which is responsible for the excessive swelling and shrinkage characteristics of the soil. Lightly loaded structures are not susceptible to damage as a result of the volume change in soil. It is so hard that the clods cannot be easily pulverized for treatment for its use in road construction. This poses serious problems as regards to subsequent performance of the road. Moreover, the softened sub grade has a tendency to up heave into the upper layers of the pavement, especially when the sub-base consists of stone soling with lot of voids. Gradual intrusion of wet clay soil

invariably leads to failure of the road. The roads laid on clay soil bases develop undulations at the road surface due to loss of strength of the sub grade through softening during monsoon. The physical properties of clay soil vary from place to place. 40 to 60% of the clay soil has a size less than 0.001 mm. Clay soil has very low bearing capacity and high swelling and shrinkage.

FLY ASH CHARACTERISTICS

Fly ash is a fine, glass powder recovered from the gases of burning coal through the production of electricity. These micron-sized earth elements consist mainly of silica, alumina and iron. When mixed with lime and water the fly ash from a cementations compound with property very similar to that of Portland cement. Because of this similarly, fly ash can be used to replace a portion of cement in the concrete, providing some discrete quality advantages. The concrete is denser resulting in a tighter, smoother surface with less bleeding. Fly ash is used in soil stabilization. Fly Ash is also known as Coal Ash, Pulverized Flue Ash. Fly ash closely resembles volcanic ashes used in production of the earliest known hydraulic cements about 2,300 years ago. Instead of volcanoes, today's fly ash comes primarily from coal-fired electricity generating power plants. These power plants grind coal to powder fineness before it is burned. Fly ash the mineral residue produced by burning coal- is captured from the power plant's exhaust gases and collected for use.

RICE HUSK ASH CHARACTERISTICS

Rice milling generates a byproduct know as husk. This surrounds the paddy grain. During milling of paddy about 78% of weight is received as rice, broken rice and bran. Rest 22% of the weight of paddy is received as husk. This husk is used as fuel in the rice mills to generate steam for the parboiling process. Pozzolanas are materials containing reactive silica and/or alumina which on their own have little or no binding property but, when mixed with lime in the presence of water, will set and harden like cement. Pozzolanas are an important ingredient in the production of alternative cementing materials to Portland cement (OPC). Alternative cements provide an excellent technical option to OPC at a much lower cost and have the potential to make a significant contribution towards the provision of low-cost building materials and consequently affordable shelter. Pozzolonas can be used in combination with lime and/or OPC. When mixed with lime, pozzolanas will greatly improve the properties of lime-based mortars, concretes and renders for use in a wide range of building applications. Alternatively, they can be blended with OPC to improve the durability of concrete and its workability, and considerably reduce its cost of the agricultural wastes; rice husk has been identified as having the greatest potential as it is widely available and, on burning, produces a relatively large proportion of ash, which contains around 90% silica. About one tone of husk is produced from five tons of rice paddy and it has been estimated that some 120 million tones of husk could be available annually on a global basis for pozzolana production.

EFFECT OF WATER CONTENT

It is a well-known fact that water is the worst enemy of road pavement, particularly in expansive soil areas. Water penetrates into the road pavement from three sides viz. top surface, side beams and from sub grade due to capillary action. Therefore, road specifications in expansive soil areas must take these factors into consideration. It saturates the sub grade soil and thus lowers its bearing capacity, ultimately resulting in heavy depressions and settlement. In the base course layers comprising of Water Bound Macadam (WBM), water lubricates the binding material and makes the mechanical interlock unstable. In the top bituminous surfacing, raveling, stripping and cracking develop due to water stagnation and its seepage into these layers. In expansive soil areas, unpaved beams pose the maximum problem as they become slushy during rains, as they are most neglected lot. Development of alligator cracks and

extensive depression as well as upheavals respectively in bituminous surfacing in clay soil.

OBJECTIVE OF WORK

As we know, the bearing capacity of soil can be improved from various ground improvement techniques and one of the effective methods is using the Soil Stabilization. The degree of improvement in bearing capacity depends on various factors like degree of interaction between fly ash and rice husk ash with surrounding the soil, shape of footing, embankment variations in numbers and depth variation of embankment with footing. Keeping in view, it is planned to study the effect of fly ash and rice husk ash as a material used in different proportions in improving the characteristics of clay soil. The present investigation presents the result of laboratory tests using Standard Proctor Test, Unconfined Compression, test with an aim to increase the bearing capacity, shear strength of clay soil by using the different proportion of Fly Ash and Rice Husk Ash.

EXPERIMENTAL DEVELOPMENTS

STABILIZATION BY USING FLY ASH

Phani kumar and Sharma (2004) A similar study was carried out by Phanikumar and Sharma and the effect of fly ash on engineering properties of expansive soil through an experimental programme. The effect on parameters like free swell index (FSI), swell potential, swelling pressure, plasticity, compaction, strength and hydraulic conductivity of expansive soil was studied. The ash blended expansive soil with fly ash contents of 0, 5, 10, 15 and 20% on a dry weight basis and they inferred that increase in fly ash content reduces plasticity characteristics and the FSI was reduced by about 50% by the addition of 20% fly ash. The hydraulic conductivity of expansive soils mixed with fly ash decreases with an increase in fly ash content, due to the increase in maximum dry unit weight with an increase in fly ash content. When the fly ash content increases there is a decrease in the optimum moisture content and the maximum dry unit weight increases.

Sharma (2012) studied the Stabilization of a Clayey Soil with Fly Ash and Lime: A Micro Level Investigation. Clayey soils usually have the potential to demonstrate undesirable engineering behavior, such as low bearing capacity, high shrinkage and swell characteristics and high moisture susceptibility. This study reports the improvement in the strength of a locally available cohesive soil by addition of both fly ash and lime. Analysis using X-ray diffraction, scanning electron microscopy, coupled with energy dispersive spectroscopy, thermal gravimetric analysis, zeta potential and pH value test was carried out in order to elucidate the stabilization mechanism. The micro level analysis confirmed the breaking of montmorrillonite structure present in the untreated clay after stabilization. In the analysis, it was also confirmed that in the stabilization process, pozzolanic reaction dominated over the cation exchange capacity.

Maharjan and Saliq (2015) investigated the stabilization of clay soil using fly ash and lime for construction work. Site survey usually takes place before the design process begins in order to understand the characteristics of subsoil upon which the decision on location of the project can be made. However, in most geotechnical projects, it is not possible to obtain a construction site that will meet the design requirements without ground modification. The current practice is to modify the engineering properties of the soils to meet the design specifications. Nowadays, soils such as, soft clays and organic soils can be improved to the civil engineering requirements. This state of the art review focuses on soil stabilization method which is one of the several methods of soil improvement.

STABILIZATION BY RICE HUSK ASH

Alhassan (2008) has studied the Potentials of Rice Husk Ash for Soil Stabilization Soil sample collected from Maikunkele area of Minna, classified as an A-7-6 lateritic soil on AASHTO classification was stabilized with 2-12% rice husk ash (RHA) by weight of the dry soil. Using British standard light (BSL) compaction energy level, performance of the soil-RHA was investigated with respect to compaction characteristics, California bearing ratio (CBR) and unconfined compressive strength (UCS) tests. The results obtained, indicates a general decrease in the maximum dry density (MDD) and increase in optimum moisture content (OMC) with increase in RHA content. There was also slight improvement in the CBR and UCS with increase in the RHA content. The peak UCS values were recorded at between 6-8% RHA, indicating a little potential of using 6-8% RHA for strength improvement of A-7-6 lateritic soil.

S.K. Roy and T.K. Roy (2009) Procurement of conventional materials in huge quantity required for construction of sub grade of road is becoming very difficult in many locations due to various problems. A huge quantity of waste materials generated needs land for disposal and from that generally creates problems for public health and ecology. So need has arisen for proper disposal of the waste materials. Utilizing these materials in the area of road construction after improving their characteristics suitably can provide useful solution of this problem. So keeping this in view, an experimental study was undertaken to explore the possibility of utilization of the alternative materials like rice husk ash by mixing with local alluvial soil by adding small percentage of lime for the construction of road sub grade as cost effective mix.

Soni and Dahale (2011) has application of solid waste (fly ash and rice husk) disposal for soil stabilization is significant project serves various benefits to the environment. The term solid waste includes all those solid and semi-solid materials that is carded by the community. Improper management of solid waste causes adverse effects on ecology which may lead to cause possible outbreaks of diseases and epidemics. FA is a waste product from thermal power plants and is available in form of fine dust. FA contains trace amounts of toxic metals (U, Th, Cr, Pb, Hg, Cd etc.), which may have negative effective on human health and on plants.

Jha and Gill (2016) has studied the effectiveness use of rice husk ash (RHA) as a pozzolans to enhance the lime treatment of soil. The present the influence of different mix proportions of lime and RHA on compaction strength, CBR values and durability characteristics of soil. The results show that addition of RHA not only improve the strength but also enhances the durability of lime stabilized soils

Bachchhas and Soni (2017) studied the stabilization of clayey soil using sugarcane Bagasse ash and rice husk ash. This paper describes the trial study of effectiveness of sugarcane Bagasse and rice husk ash to stabilization clayey soils. Rice husk and sugarcane Bagasse ash were mixed in clayey soil in different proportions and various geotechnical characteristics were investigated through unconfined compressive test, compaction test. Result shows that the addition of sugarcane Bagasse ash and rice husk ash has a significant impact on geotechnical characteristics of clayey soil, which shows the effectiveness of these agricultural industry wastes in stabilization of clayey soil and encourages their bulk utilization.

DEVELOPMENT OF THE TEST PROGRAM

The field test would be an ideal method for simulation of nay experimental study, it has been generally averted because it is expensive as well as time consuming. So as the substitute, carefully conducted model tests can be employed with advantage in order to obtain useful qualitative and sometimes quantitative results. Moreover, the laboratory testing has the advantage of better control over various parameters which may influence the problem under consideration. For example, it is possible in a model to undertake parametric study by keeping all other the variables as constant while the effect of one particular parameter is being studied.

MATERIALS USED

Sr. No.	Property	Value
1.	Soil type	CH
2.	Liquid Limit	62%
3.	Plastic Limit	23%
4.	Plasticity Index	34%
5.	Specific gravity of clayey Soil	2.58
6.	Specific gravity of Fly Ash	2.08
7.	Specific gravity of Rice Husk Ash	1.89
8.	MDD of clayey Soil ($\gamma d, max$)	1.57
9.	OMC of Black Cotton Soil	25%

EXPERIMENTS PERFORMED

1. STANDARD PROCTOR TEST 2. UNCONFINED COMPRESSION TEST

The tests were conducted on various combinations:-

Sample 1	CS-100% (3000g) + FA-0% + RHA-0%
Sample 2	CS -95% (2850g) + FA-0% + RHA-5% (150g)
Sample 3	CS-90% (2700g) + FA-0% + RHA-10% (300g)
Sample 4	CS-85% (2550g) + FA-0% + RHA-15% (450g)
Sample 5	CS-80% (2400g) + FA-0% + RHA – 20% (600g)
Sample 6	CS-85% (2550g) + FA-15% (450g) + RHA-0%
Sample 7	CS-80% (2400g) + FA-15% (450g) + RHA -5% (150g)
Sample 8	CS-75% (2250g) + FA-15% (450g) + RHA-10% (300g)
Sample 9	CS-70% (2100g) + FA-15% (450g) + RHA-15% (450g)
Sample 10	CS-65% (1950g) + FA-15% (450g) + RHA-20% (600g)

Sample 11	CS-75% (2250g) + FA-25% (750g) + RHA-0%
Sample 12	CS-70% (2100g) + FA-25% (750g) + RHA-5% (150g)
Sample 13	CS-65% (1950g) + FA-25% (750g) + RHA-10% (300g)
Sample 14	CS-60% (1800g) + FA-25% (750g) + RHA-15% (450g)
Sample 15	CS-55% (1650g) + FA-25% (750g) + RHA-20% (600g)
Sample 16	CS-65% (1950g) + FA-35% (1050g) + RHA-0%
Sample 17	CS-60% (1800g) + FA-35% (1050g) + RHA-5% (150g)
Sample 18	CS-55% (1650g) + FA-35% (1050g) + RHA-10% (300g)
Sample 19	CS-50% (1500g) + FA-35% (1050g) + RHA-15% (450g)
Sample 20	CS-45% (1350g) + FA-35% (1050g) + RHA-20% (600g)

CONCLUSIONS

The present experimental studies were carried out to find out the Stabilization of clay Soil by sing Fly Ash and Rice Husk Ash. Based on the experimental study, the following conclusion have been drawn,

1. The specific gravity of Fly Ash is 2.08 which is lighter than conventional earth material. This is going to be definitely advantageous in constructing light weight embankments over soft compressible soil.
2. Consumption of Rice Husk Ash in bulk quantity in the construction of road project can be made with reducing the accumulation hazard and environmental pollution of this waste.
3. Addition of Rice Husk Ash in increasing proportion with the alluvial soil decreases the maximum dry density of the mixed soil. However the optimum moisture content of the mixed soil increases gradually with the increased percentage of Rice Husk Ash
4. Mixing of FA and RHA in clay Soil improves the Compressive strength of soil when mixed in appropriate ratio. Experiments reveal that 15% Fly Ash and 5% Rice Husk Ash when mixed increases Compressive strength of soil by 2.284 kg/mm^2 . This Compressive strength is better than parent soil's strength (i.e. 1.41 kg/mm^2).
5. However, the best ratio of FA and RHA for improving the clay soil strength, as proved by experimental results is 0% FA and 5% RHA, which improves soil Compressive strength upto 2.688 kg/mm^2.

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SCOPE FOR FUTURE STUDIES

This paper focuses on soil strength only. The soil strength is increased by using various combinations of FA and RHA. Based on the experimental results, we can propose the following studies that can be done in future:

1. The study finds the best strength of a clay soil by using appropriate ratio of FA and RHA. Different percentages of FA and RHA can be used to increase soil strength of clay soil or any other type of

soil in future.

2 FA and RHA were used for increasing clay soil strength. Other waste materials like lime, sawdust, stabilizer, geo-synthetics materials, dust stone, industrial wastes, rubber tyre, etc can also be used for making appropriate mixture to increase soil strength of clay soil or any other soil.

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