Stabilization of Clayey Soil With Rice Husk Ash And Fly Ash

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Abstract- *Clay soils are commonly stiff in dry state but lose their stiffness when saturated with water. Soft clays are characterized by low bearing capacity and high compressibility. Many researchers, all over the World are working, to evolve more effective and practical treatment methods, to alleviate the problems caused to pavements laid on clayey soils. Modification of clayey soil by Industrial waste and agricultural waste is a common method for stabilizing the swell-shrink tendency of expansive soil. Many stabilization techniques are in practice for improving the clayey soils in which the characteristics of the soils are altered or the problematic soils are removed and replaced which can be used alone or in conjunction with specific design alternatives. Additives such as rice husk ash which is collected from the brick manufacturing unit and fly ash is collected from the NTPC are used to alter the characteristics of the clayey soils. Thus, the effectiveness of using rice husk ash and fly ash in stabilizing clayey soil was investigated in the laboratory. The soil samples in natural state and when mixed with varying percentages of rice husk ash and fly ash were used for the laboratory tests that included atterberg limits tests, grain size analysis, standard Proctor compaction tests, unconfined compression tests and California bearing ratio tests.*

Keywords- clayey soil, fly ash, rice husk ash, standard Proctor compaction test, California bearing ratio.

I. INTRODUCTION

Clay soils are small particles and small spaces are pores between them. Clay soil tends to quick together causing water to fill up the air spaces. Since moisture does not drain from the soil well, clay soil is often too wet for plant roots to absorb oxygen .As a result, they rot. Adding humus to clay soil discourages the small particles from sticking so tightly together, resulting in larger spaces that drain water more easily and more air.

Comparing the different soils, sand, silt, clay and humus first on their ability to hold water: clay soils hold more water than sand or silt. Humus holds more water than sand or silt. For growing most things, clay holds too much water Whereas sand, silt and humus hold too little water.

Soil Stabilization is being used for a variety of engineering works, the most common application being in the construction of roads pavements and foundation works, where the main objective is to increase the strength or stability of soil. Soil improvement could either be by modification or Stabilization or both. Soil modification is the addition of a modifier (cement, lime etc.) to a soil to change its index properties.

Soil stabilization is the treatment of soils to enable their strength and durability to be improved such that they become totally suitable for construction beyond their original classification. Soil stabilization is a process by which certain materials are added to soil to improve its engineering properties. These materials may be classified as pozzolanic (fly ash, rice husk ash etc.), binder (lime, cement, cement kiln dust, lime sludge etc.) and inert (quarry dust, sand, ceramic dust etc.) are added to soil individually or combined. Soil stabilization is widely used in connection with road pavement and foundation construction.

Soil stabilization is the alteration of one or more soil properties,by mechanical or chemical means, to create an improved soil material possessing the desired engineering property. There are three purposes for soil stabilization. These include increasing strength of an existing soil to enhance its load-bearing capacity, permeability improvement and enhancement of soil resistance to the process of weathering, and traffic usage. The properties of soil vary a great deal at different places or in certain cases even at one place; the success of soil stabilization depends on soil testing. Various methods are employed to stabilize soil and the method should be verified in the lab with the soil material before applying it on the field. The process may include blending soils to achieve a desired gradation or mixing commercially available additives that may alter the gradation, change the strength and durability, or act as a binder to cement the soil. The main aim of stabilization is cost reduction and to efficiently use the locally available material. Most common application of stabilization of soil is seen in construction of roads and airfields pavement. Chemical stabilization is done by adding chemical additives to the soil that physically combines with soil particles and alter the geotechnical properties of soil.

1.2 OBJECTIVES OF THE STUDY

- To evaluate the properties of the clayey soils before and after stabilization with Rice husk ash and Fly ash.
- To use the agricultural waste rice husk ash is as a stabilizing material.
- The pozzolanic material of the fly ash is increases the strength properties of the clay- fly ash blend.
- The swell decreased with an addition of fly ash.
- To know the percentage of agricultural waste of can be utilized in the stabilization process.
- To evaluate the strength characteristics of the clayey soils for different blended materials with different percentage combinations
- To evaluate the changes in strength characteristics of treated and untreated soil specimens by California bearing ratio test.

II. LITERATUREREVIEW

2.1 PREVIOUS RESEARCH PAPERS AND CONCLUSIONS

Soil stabilization is a procedure where we improve engineering properties of soil with the use of natural or synthesized admixtures. In the past many researchers have carried out their research work for improving the strength of clayey soil using different types of admixture at different percentages. A brief review of previous studies on clayey soil is presented in this section and past efforts most closely related to the needs of present work.

R. Ali (2012) studied by the effect of marble dust and bagasse ash on the stabilization of expansive soils. Expansive soils are always characterized by their high expansion, high moisture content, high compressibility, high shrinkage on drying along with wide polygonal cracks and sufficient swelling on wetting. Expansive soils (problematic soil) are present in different parts of the world and extensively found in many locations particularly in Pakistan. In KPK province we select five different sites and collect soil sample and determine their index properties. While selecting sites we visually inspect the soil and collect soil sample from area having wide cracks in soil in dry condition. From the index properties of all the soil samples, soil were classified as expansivesoil having liquid limit greater than 50% and plasticity index greater than 30%.

Erdal Cokca (2001): Effect of Fly Ash on expansive soil was studied by Erdal Cokca; FLY ASH consists of often hollow spheres of silicon, aluminum and iron oxides and unoxidized carbon. There 1 Research Scholar,eshwari_28@yahoo.co.in 2 Assistant Professor, robinson@iitm.ac.in 3. Professor, srgandhi@iitm.ac.in Indian Institute of Technology Madras, Chennai-36 .Fly Ash India 2005, New Delhi Fly Ash Utilization Programme (FAUP), TIFAC, DST, New Delhi – 110016 are two major classes of Fly Ash, class C and class F. The former is produced from burning anthracite or bituminous coal and the latter is produced from burning lignite and sub bituminous coal. Both the classes of Fly Ash are puzzolans, which are defined as siliceous and aluminous materials. Thus Fly Ash can provide an array of divalent and trivalent cations (Ca2+,Al3+,Fe3+etc) under ionized conditions that can promote flocculation of dispersed clay particles. Thus expansive soils can be potentially stabilized effectively by cation exchange using Fly Ash. He carried out investigations using Soma Fly Ash and Tuncbilek Fly Ash and added it to expansive soil at 0-25%. Specimens with Fly Ash were cured for 7days and 28 days after which they were subjected to Oedometer free swell tests. And his experimental findings confirmed that the plasticity index, activity and swelling potential of the samples decreased with increasing percent stabilizer and curing time and the optimum content of Fly Ash in decreasing the swell potential was found to be 20%. The changes in the physical properties and swelling potential is a result of additional silt size particles to some extent and due to chemical reactions that cause immediate flocculation of clay particles and the time dependent puzzolanic and self-hardening properties of Fly Ash and he concluded that both high – calcium and low calcium class C Fly Ashes can be recommended as effective stabilizing agents for improvement for improvement of expansive soils.

S.Bhuvaneshwari and S.R. Gandhi: A study was carried out by S.Bhuvaneshwari and S.R. Gandhi on the effect of engineering properties of expansive soil through an experimental programme. Infrastructure projects such as highways, railways, water reservoirs, reclamation etc. requires earth material in very large quantity. In urban areas, borrow earth is not easily available which has to be hauled from a long distance. Quite often, large areas are covered with highly plastic and expansive soil, which is not suitable for such purpose. Extensive laboratory / field trials have been carried out by various researchers and have shown promising results for application of such expansive soil after stabilization with additives such as sand, silt, lime, Fly Ash, etc. As Fly Ash is freely available, for projects in the vicinity of a Thermal Power Plants, it can be used for stabilization of expansive soils for various uses. The present paper describes a study carried out to check the improvements in the properties of expansive soil with Fly Ash in varying percentages. Both laboratory trials and field tests have been carried out and results are reported in this paper. One of the major difficulties in field application is thorough mixing of the two materials (expansive soil and Fly Ash) in required proportion to form a homogeneous mass.

Pandian et.al. (2002): Studied the effect of two types of Fly Ashes Raichur Fly Ash (Class F) and Neyveli Fly Ash (Class C) on the CBR characteristics of the black cotton soil. The Fly Ash content was increased from 0 to 100%. Generally the CBR/strength is contributed by its cohesion and friction. The CBR of BC soil, which consists of predominantly of finer particles, is contributed by cohesion. The CBR of Fly Ash, which consists predominantly of coarser particles, is contributed by its frictional component. The low CBR of BC soil is attributed to the inherent low strength, which is due to the dominance of clay fraction. The addition of Fly Ash to BC soil increases the CBR of the mix up to the first optimum level due to the frictional resistance from Fly Ash in addition to the cohesion from BC soil. Further addition of Fly Ash beyond the optimum level causes a decrease up to 60% and then up to the second optimum level there is an increase. Thus the variation of CBR of Fly Ash-BC soil mixes can be attributed to the relative contribution of frictional or cohesive resistance from Fly Ash or BC soil, respectively. In Neyveli Fly Ash also there is an increase of strength with the increase in the Fly Ash content, here there will be additional puzzolonic reaction forming cementitious compounds resulting in good binding between BC soil and Fly Ash particles

Phanikumar 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. The effect of Fly Ash is akin to the increased compactive effort. Hence the expansive soil is rendered more stable. The untrained shear strength of the expansive soil blended with Fly Ash increases with the increase in the ash content.

E.A. Basha, (2003), was identify the ‘‘Effect of the cement- rice husk ash on the plasticity and compaction of soil. Sabat [9] had studied the stabilizing effects of bagasse ash and lime sludge on compaction (standard Proctor) properties, UCS, CBR and swelling pressure of an expansive soil. All properties were tested after 7 days of curing. The effects of compaction delay, molding water content on CBR of the stabilized soil were studied. The economy of the stabilization was also studied. He had not studied, other engineering properties including durability of the stabilized soil along with the effects of curing period on the properties for which tests were conducted. From the review of the literature, the stabilizing effects of RHA and lime sludge on engineering properties of expansive soil were not found.

A.N. Ramakrishna, and A.V. Pradeep Kumar (2006), was studied“ Stabilisation of black cotton soil using rice husk ash and cement”. R.S. Sharma et.al (2008), studied the “Engineering behaviour of a remolded expansive clay blended with lime , calcium chloride and rice- husk ash”. A.K. Sabat, and R. P. Nanda (2011), was studied the“Effect of marble dust on strength and durability of rice husk ash stabilised expansive soil‟. D.K.Rao, P.R. T. Pranav, and M.Anusha, wsa studied about Stabilisation of expansive soil with rice husk ash, lime and gypsum- an experimental study.

F O Okafor and U N Okonkwo (2009), was discuss about Effects of rice husk ash on some geotechnical properties of laterite soil. E B Oyetola and M Abdullah (2006),was defined The use of rice husk ash in low-cost sandcrete block production. Ali F Haji, A Adnan and Chew K C (1992), discuss about Geotechnical properties of a chemically stabilized soil from Malaysia with rice husk ash as an additive. Monica Malhotra (2013) studied by Expansive soils always create problems more for lightly loaded structures than moderately loaded structures. By consolidating under load and changing volumetrically along with seasonal moisture variation, these problems are manifested through swelling, shrinkage and unequal settlement. From the results it is clear that a change of the expansive soil texture takes place. When lime & fly ash are mixed with the expansive soil, the Plastic limit increases by mixing lime and liquid limit decreases by mixing fly ash, which decreases plasticity index. As the amount of fly ash & lime increases there is apparent reduction in modified dry density & free swell index and increase in optimum moisture content. It can be concluded that the mixing lime & fly ash in specific proportion with the expansive soil is an effective way to tackle the problem of shrinkage, swelling and unequal settlement.

2.2 STABILIZATION

Using rice husk ash, flyash have been more attractive recently due to its promising results compared to other sources. Overview about the methods and the basis of application will be presented in this section. Soil stabilization is the process of improving engineering properties of the soil and thus making it more stable. Soil stabilization means the improvement of the stability or bearing power of the soil by the controlled compaction; proportioning and/or addition of suitable admixture or stabilizers. Soil stabilization is the alteration of soil to enhance their physical properties.

METHODS OF SOIL STABILIZATION

- Mechanical Stabilization.
- Soil Cement Stabilization.
- Soil Lime Stabilization.
- Soil Bitumen Stabilization.
- Thermal Stabilization.
- Chemical Stabilization.

III. METHODOLOGY

The methodology of this project is carried out by collection of brown clayey soil sample from proposed area and various tests on soil have been performed as per IS(2720) on raw soils and brown clayey soil with proportion of rice husk ash (RHA) and Stone Crushed dust. Based on test reports various discussions have been present as per the strength variations criteria.

The various physical properties of soil were assessed using methods below given in different parts of Indian standards (IS 2720). The specific gravity, grain size analysis, atterberg limits and shrinkage limits were derived as per the methods given in IS 2720: part 3(1980), IS 2720: part (1980), IS 2720: part 5(1980),IS 2720: part 6(1972) respectively. Compaction test as per IS 2720: part 7(1980) was performed to determine optimum moisture content and maximum dry density of the soil specimen.

In this chapter, a brief description of the experimental procedures adopted in this investigation and the methodology adopted during the course of study are briefly presented.

MATERIALS USED AND THEIR PROPERTIES

3.1 SOIL

Clay soils are small particles and small spaces are pores between them. Clay soil tends to quick together causing water to fill up the air spaces. Since moisture does not drain from the soil well, clay soil is often too wet for plant roots to absorb oxygen .As a result, they rot. Adding humus to clay soil discourages the small particles from sticking so tightly together, resulting in larger spaces that drain water more easily and more air.

Comparing the different soils, sand, silt, clay and humus first on their ability to hold water: clay soils hold more water than sand or silt. Humus holds more water than sand or silt. For growing most things, clay holds too much water whereas sand, silt and humus hold too little water.

3.2 FLY ASH

Fly ash is also typically use to stabilize the sub base or sub grade and should not be used for surfacing due to low resistance to abrasive action of traffic and machinery movements.

The source of the coal and the type of the coal burning process determine the fly ash properties, which further influences the performance of soil stabilization using fly ash. There are two class of fly ash; class „C‟ which is self-cementing and class „F‟ which is non-self-cementing. Class „C‟ is the result of the combustion of younger lignite or sub bituminous coal. In the presence of water, class „C‟ is fly ash will harden and gain strength over time. Class “F” fly ash is produced from burning harder, older anthracite and bituminous coal. This kind of fly ash contains less than 20%lime and thus glasey silica and alumina are the only pozzolans present in sufficient quantities soil stabilization using fly ash class ‟F‟ will be feasible only it additives such as Portland cement and quick lime, or hydrated cement added, when fly ash blended with water, result in the products that bind soil grains or increases the strength in the soil matrix.

The extent of leaching and harmfulness to humans of fly ash leachate is still not entirely known but is being investigated. Unlike soil stabilization using fly ash, environmentally, safe solutions are created by global road technology. For this project work the fly ash is collected from the NTPC Visakhapatnam, Andhra Pradesh.

TABLE 3.1 Chemical properties of Fly ash

Constituents	Percentage (%)
SiO2	55
Al2O3	20.3
Fe2O3	6.3
CaO	12
MgO	3.5
Alkali	1
SO3	1.5
Heavy Metals	Trace

3.2 RICE HUSK ASH

Rice husk is a potential material, which is amenable for value addition. The usage of rice husk either in its raw form or in ash form is many. Most of the husk from the milling is either burnt or dumped as waste in open fields and a small amount is used as fuel for boilers, electricity generation, bulking agents for composting of animal Manure, etc. The exterior of rice husk are composed of dentate rectangular elements, which themselves are composed mostly of silica coated with a thick cuticle and surface hairs. The mid region and inner epidermis contain little silica Jauberthie et al., confirmed that the presence of amorphous silica Is concentrated at the surfaces of the rice husk and not within the husk itself. The chemical composition of rice husk is similar to that of many common organic fibers and it contains of cellulose 40-50 percent, lignin 25-30 percent, ash 15-20percent and moisture 8- 15 percent.

After burning, most evaporable components are slowly lost and the silicates are left. No other plant except paddy husk is able to retain such a huge proportion of silica in it. Plants absorb various minerals and silicates from earth into their body.

The rice husk ash is collected from the brick manufacturing unit, East Godavari District, Andhra Pradesh.

IV. LABORATORY EXPERIMENTATION

The soil was initially air dried prior to the testing. The tests were conducted in the laboratory on the marine clay to find the properties of virgin marineclay.

- Grain sizedistribution
- Specificgravity
- Index properties –liquid limit, plasticlimit
- Compaction tests
- Penetration tests-California bearing ratiotest.
- Unconfined CompressionTest-Triaxial

V. RESULTS AND DISCUSSIONS

5.1GENERAL

In the laboratory, various experiments were conducted for different mixes of soil samples with rice husk ash and fl ash like Liquid Limit, Plastic Limit and Compaction, CBR and UCS tests were conducted with a view to determine the optimum combination of coir fibre and as bitumen in weak marine soil and CBR are conducted for durability studies.

The influence of the above said materials on the Index, Compaction and Strength properties were discussed in following sections. In the laboratory, all the tests were conducted per IS codes of practice.

In this chapter a detailed discussion on the results obtained from various laboratory tests done on untreated and treated clayey soil are presented.

Table 5.1: Results of unmodified soil sample

Soil test	Results of unmodified soil sample
Moisture content	7.10%
Specific gravity	2.52
Liquid limit %	23.5
Plastic limit %	11.6
Plastic index %	11.91
Dry density (G/CC)	1.61
C.B.R	3.078

Table 5.2: Results of soil sample replacement (R.H.A + FLY ASH)

Soil test	Modified sample (% R.H.A + % Fly ash)				
%	2.5%+2.5%	5%+5%	6%+6%	7.5%+7.5%	10%+10%
L.L	35.22	28.12	29.5	20.0	20.28
P.L	22.2	17.7	10.5	28.0	16.2
P.I	12.02	10.42	19.0	10.3	4.08
Dry density(g/cc)	1.67	1.58	1.55	1.52	1.56

Table 5.3: Results of soil sample replacement (R.H.A + FLY ASH)

Soil + R.H.A + Fly ASH		0%	5%	10%	12%	15%	20%
COMPACTION TEST	MDD (g/cc)	1.61	1.67	1.58	1.55	1.52	1.56
	OMC %	10.5	8.9	11.3	10.5	15.9	11.8
C.B.R VALUES	Unsoaked	3.07	7.31	4.67	4.41	1.79	6.56

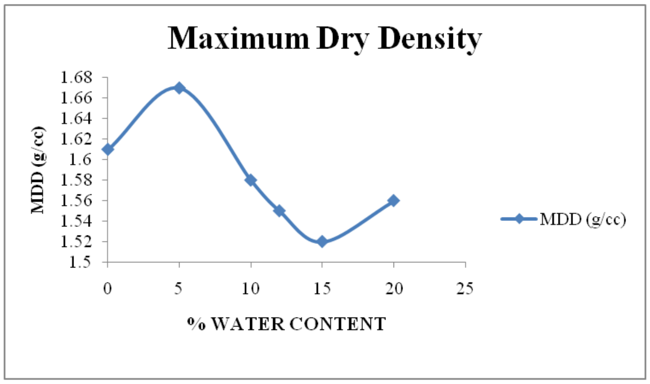

Fig 5.1. MDD values for different mixes of soil samples

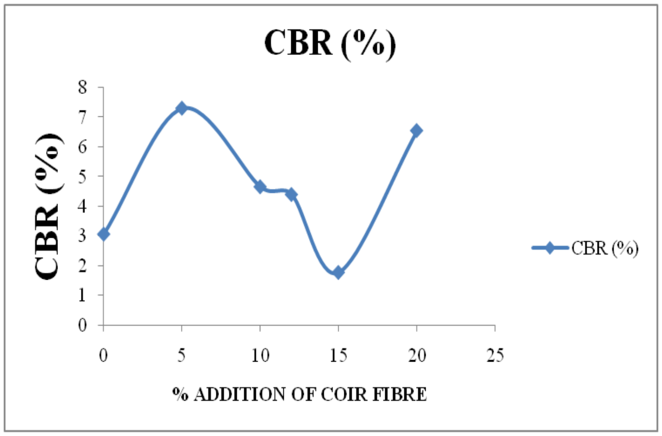

Fig 5.2.C.B.R values for different mixes soil samples

5.2 DISCUSSIONS:

- The liquid limit for replacements of 2.5%&2.5%, 5%&5% and 6%&6% of RHA & Fly ash increased by 49.87%, 19.65% and 25.53% respectively when compared with unmodified soil sample (0% replacement) or control specimen.
- The liquid limit for replacements of 7.5%&7.5% and 10%&10% of RHA&Flyash decreased by 14.87% and 13.7% respectivsely when compared with unmodified soil sample (0% replacement) or control specimen.
- The plastic limit for replacements of 2.5%&2.5%, 5%&5%, 7.5%&7.5% and 10%&10% of RHA & Flyash increased by 91.8%, 52.58%, 141.38% and 39.65% respectively when compared with unmodified soil sample (0% replacement) or control specimen.
- The plastic limit for replacements 6%&6% of RHA & Flyash decreased by 9.48%, respectively when compared with unmodified soil sample (0% replacement) or control specimen.
- The CBR Value for replacements of 2.5%&2.5%, 5%&5%, 6%&6% and 10%&10% of RHA & Flyash increased by 137.56%, 51.72%, 43.27% and 113.12% respectively when compared with unmodified soil sample (0% replacement) or control specimen.
- The CBR Value for replacements of 7.5%&7.5% of RHA&Flyash decreased by 41.85% respectively when compared with unmodified soil sample (0% replacement) or control specimen.
- The Maximum dry density for replacements of 5%&5%, 6%&6%, 7.5%&7.5% and 10%&10% of RHA&Flyash decreased 1.86%, 3.72%, 5.59% and 3.10% respectively when compared with unmodified soil sample (0% replacement) or control specimen.
- The Maximum dry density for replacements of 2.5%&2.5% of RHA&Flyash increased 3.73% respectively when compared with unmodified soil sample (0% replacement) or control specimen.
- The Optimum moisture content decreases with increase the maximum dry density. Optimum moisture content for replacements of 2.5%&2.5% of RHA&Flyash decreased by 15.24% respectively when compared with unmodified soil sample (0% replacement) or control specimen.
- Optimum moisture content for replacements of 5%&5%, 7.5%&7.5% and 10%&10% of RHA&Flyash dust increased by 7.62%, 51.43% and 12.38% respectively when compared with unmodified soil sample (0% replacement) or control specimen

VI. CONCLUSIONS

The following conclusions are made based on the laboratory experiments carried out in this investigation.

The following conclusions are made based on the laboratory experiments carried out in this investigation.

- From the laboratory studies, it is observed that the Soil chosen was a problematic soil having high swelling, and high plasticity characteristics.
- The values of CBR Test have taken gradual rise at 12%, 15% and 20%when compared to the unmodified soil sample.
- Up on the CBR Tests conducted on the combined material of Rice Husk Ash and Fly Ash, the Bearing strength was found to be increasing with the increase in the addition of percentage of material.
- We get to know the Bearing strength of the soil at 20%in comparatively low and other percentages of

replacement can work out well with the proposed replacement material.

From this present study we concluded that 15% and 20%of replacement of material gives good results for stabilization of sub grade soil

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