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# STABILIZATION OF CLAYEY SOIL USING SUGARCANE BAGASSE ASH AND RICE HUSK ASH: REVIEW

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**ABSTRACT**

*High cost of traditional stabilizers like lime, cement, bitumen etc. and problem of disposal of agricultural industry waste resulted into investigation of potential of agricultural industry waste in stabilizing the clayey soils. Treatment of clayey soil using sugarcane bagasse ash and rice husk ash is very simple, economical and pollution controlling and also solves the problem of their disposal. As per chemical analysis of sugarcane bagasse ash it exhibits certain pozzolanic properties as it is rich in oxides of silica and aluminum. Rice husk ash also is a very good pozolona as contain good amount of amorphous silica which can be used as stabilizer.*

*Paper describes the trial study of effectiveness of sugarcane bagasse and rice hush ash to stabilized clayey soils. Rice husk ash and sugarcane bagasse ash were mixed in the clayey soil in different proportions and various geotechnical characteristics were investigated through unconfined compression test, compaction test. Result shows that addition of sugarcane bagasse ash and rice husk ash has significant effect on geotechnical characteristics of clayey soil, which shows the effectiveness of these agricultural industry waste in stabilizing the clayey soil and encourages their bulk utilization.*

***Keywords: clayey soil, Geotechnical characteristics, Rice husk ash, Sugarcane bagasse ash.***

## I. INTRODUCTION

Soil can be defined as the upper layer of the earth consisting of air, water and solid particles is generally produced by disintegration of rocks. It is the cheapest construction material available in the most part of country but it properties vary from point to point specially in case of clayey soil. They cause great engineering problems due to high compressibility, water holding capacity, low strength, low bearing capacity and being active. Due to all these problem clayey soil offers problem in construction of pavements, embankments, foundations and many other structures. So it is very much necessary to treat these soils. These properties can be improved through the process of soil stabilization using different type of stabilizers. Use of stabilizer for improving the durability and strength of soil is not new as in past natural oils, plant juice, animal dung etc. have been used across the world. The oldest record is use of straw stabilized mud or clay blocks was found in greece back in 4600 BC and then spread in other part of the world.

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So, as clayey soils have undesirable engineering properties. They show low shear strength on wetting and under physical disturbances. Clayey soils are normally associated with volumetric changes when subjected to change in water content because of seasonal water fluctuations. Furthermore, problems of high compressibility can cause severe damage to civil engineering construction. Therefore, these soil must be treated before commencing the construction operation to achieved desired properties. Different methods are available to improve the engineering properties of such soil these consist of mainly densification, chemical stabilization, reinforcement and techniques of pore water pressure reduction.

Scientific techniques have been introduced in recent years which proves to be very effective in increasing the strength and durability of clay. Stabilized soils proves to be very useful construction material especially if locally available industrial or natural materials are used. Treatment of clayey soil using sugarcane bagasse ash and rice husk ash is very simple, economical and pollution controlling.

Bagasse is the fibrous residue generated after the juice has been extracted from the sugarcane plant and generally deposited as waste and it clutter the environment. About one third portion of the sugarcane convert into bagasse after the extraction of juice which is utilized as a fuel for the generation of steam which eventually results in bagasse ash. This ash is normally dumped in waste landfill which create environment problems. When this bagasse is left in open it ferments and decays, which when inhaled in large doses can result in respiratory disease known as bagassiosis. However, this bagasse ash is a pozzolanic material which is very rich in oxides of silica and aluminium which can be used for stabilization of clayey soil. This result in solving the disposal problem of bagasse ash and proves to be a cheap stabilizer which in long run helps to have overall economy in the construction.

Rice husk is the outer most layer of protection of encasing of a rice grain. It is slightly larger than the grain of rice. It is light weight having a ground bulk density of around 340 kg per meter cube to 400 kg per meter cube. During milling about 78% weight is received as rice and rest 22% weight of paddy as husk. This husk is useful fuel in rice mills to generate steam. This husk consists of 75% of volcanic organic matter and rest 25% get converted into ash during the firing process known as rice husk ash (RHA). This RHA is a very good super pozzolana as it contains good amount of amorphous silica which can be used as a stabilizer to enhance the durability and strength of clayey soils.

Stabilizers with pozzolanic properties can bind soil particles together and reduce the water absorption by clay particles thus results into increase in durability and strength of clayey soil.

**Use of soil stabilization**

The soil stabilization techniques are mainly used for

1. To improve the strength of soil.
2. To reduce the permeability and compressibility of soil.
3. To increase the bearing capacity of soil.
4. To increase the CBR vale of soil.
5. To reduce the shrinkage and swelling tendency of soil.

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## II. LITERATURE REVIEW

Soil stabilization is a technique to improve the soil by using different stabilizers to enhance the properties of weak soil. Numerous methods are available for stabilizing soil. A brief review of literature on stabilization of soil with rice husk ash and sugarcane bagasse ash along with certain other materials is presented below.

**Jagdish Chand and Aditya Agarwal (Dec, 2013):** discussed about the use of rice husk ash and fly ash combination for the stabilization of highly compressible clay. Clay was stabilized by taking 5%, 10%, 15%, 20% and 25% of fly ash and rice husk ash and effect of stabilization on index properties like shrinkage limit, plastic limit, liquid limit, and compaction were studied.

A general decrease in shrinkage limit was observed when clay was stabilized using rice husk and fly ash. A large decrease in compression index and increase in stiffness was observed with increase in percentage of rice husk ash and fly ash as stabilizer. It was also observed that OMC increase and MDD decrease using rice husk ash while MDD increase and OMC decrease using fly ash. However, a general increase in shear strength was observed when soil was stabilized using rice husk ash and fly ash.

**Patrick barasa, Dr. Too, Kiptanui Jonah and S.M. Mulei:** discussed the use of sugarcane bagasse with lime to stabilize the clayey soil. Sugarcane bagasse ash mainly contain silica and potassium, aluminum and magnesium as minor component and exhibit pozzolanic properties. The research investigates the properties of clayey soil when stabilized with lime, sugarcane ash and combination of these two. Research mainly covered grading test, plasticity index (PI) and California bearing ratio (CBR). First varying percentage of lime (4%, 5%, 6%) of lime was used to stabilize clay soil and then plasticity index and CBR were determined. The same procedure was repeated for bagasse ash and finally the varying combination of lime and bagasse ash 1:4, 2:3, 3:2, and 4:1 were used.

The PI of soil decrease with increase in quantity of sugarcane bagasse ash, lime and lime to ash ratio. The addition of lime or bagasse ash help in reducing the swelling and shrinkage hence reduction in plasticity. CBR increased with increase in amount of lime added but decreased in case of sugarcane bagasse ash. The combination of lime and bagasse ash gives good result as per road design manual.

From the result it's been observe that sugarcane bagasse ash proves to be more effective when used in combination with lime as when used alone there was huge decrease in CBR value (drops from 11 to 2) although there was slight reduction in plasticity index (PI).

Addition of lime reduce linear shrinkage to a greater degree than the same percentage of bagasse ash. When the lime and bagasse ash were used in a combination of 4:1, the stabilization result confirms with the set standard of California bearing ratio, plasticity index and linear shrinkage with negligible swelling.

**Bharat Bhushan Jindal and Nirpinder jain:** discussed about the use of rice husk ash along with pound ash, cement and phosphogypsum for stabilization of fine soils. Phosphogypsum is another kind of waste calcium sulphate produced by fertilizer plant during production of phosphoric acid, a major constitute of many fertilizers. It contains many impurities which can contaminate the ground soil and ground water if not properly utilized. CBR test were conducted on the test samples with varying percentage of rice husk ash along with other

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and change in CBR value was noticed. It was found that CBR value increase significantly on addition of these materials. The CBR values were increased by 624%, 752% and 980 % on addition of 20% rice husk, 20% pond ash and 3% cement for 7 days, 14days and 28 days curing of sample respectively. Also the CBR values were increased by 672%, 787% and 1057 % on addition of 20% rice husk, 20% pond ash, 3% cement and 0.5% phasphogypsum for 7 days, 14days and 28 days curing of sample respectively.

**J.Choobbasti and H. Ghodrat(2010):** worked on clayey soil using lime and rice husk ash and the results indicate that adding lime and rice husk ash (RHA) causes increase in dry density and decrease in optimum water content. Stabilization of clayey soil with lime and rice husk results into decrease in liquid limit and plastic limit soil. There were sign of decrease in compressibility of soil. Stabilization using rice husk ash (RHA) and lime results into increase in shear strength of the soil.

**Chibuikem C. Okoro ,John Vongtman (2011):** focused on the consolidation characteristics of two soils stabilized with rice husk ash, lime and plastic waste. Three groups of specimens were prepared: the first group consisted of specimens prepared with 10% rice husk ash and 6% lime and then cured for 28 days; the second set of specimens was prepared with recycled plastic waste with a plastic to soil ratio (PSR) one; and the last group consisted of specimens prepared with raw soils and compacted at near optimum moisture content and maximum dry unit weight. The last group was considered a baseline to assess the effect of RHA, lime and plastic waste on the consolidation characteristics. Results showed that RHA, lime and plastic waste stabilization reduced the compressibility of soil. In addition, both the compression index (Cc) and swelling index (Cs) decreased due to RHA, lime and plastic waste stabilization. The percentage changes in Cc and Cs varied with the type of stabilizing agents.

**Anil Kumar Sharma and P.V. sivapullaiah (Dec, 2011):** worked on the use of fly ash and ground granulated blast furnace slag (GGBS) to stabilized the expansive clayey soil. The investigator added some quantity of lime also to increase the pozzolanic reactions and to increase the PH. The geotechnical characteristics were investigated through the atterberg limit tests, compaction tests and unconfined compressive strength test.

Both OMC and MDD found to be decrease with the addition of GGBS. This is due to predominant effects of reducing clay content and increased frictional resistance respectively. It was observed that the strength of soil increases with increase in curing period with increase in GGBS content along with fly ash. Based on the result of this research investigator said that clayey soil can be effectively stabilized using fly ash and GGBS and can be used in high way embankment and it can provide fill material of comparable strength to most soils.

## III. OBJECTIVES OF STUDY

The high cost of traditional stabilizers and industrial waste disposal problem has led to intense global research towards economical utilization of industrial and agricultural waste for engineering purpose. The main objective of the study is:

1) To investigate the potential of using agricultural waste and industrial waste in the field of geotechnical engineering.

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2) To monitor the effect of different combination of sugarcane bagasse ash and rice husk ash on the engineering properties of clayey soil including compaction and unconfined compressive strength study.
3) To monitor the change in liquid limit, plastic limit, shrinkage limit, plasticity index, dry density resulting from various combination of stabilizers.
4) After monitoring all these aspects coming to certain conclusion regarding the use of sugarcane bagasse ash and rice husk ash to stabilized clayey soil.

## III. MATERIAL USED

**Soil:** The soil which will be used in the investigation will be local soil of Kurukshetra.

**Sugarcane bagasse ash:** Sugarcane bagasse ash will be taken from sar shadi laal sugar mill, Shamli (Uttar Pradesh).

**Rice husk ash:** It will be collected from Kohinoor food limited GT road Murthal (Haryana)

**Mixing proportions:** Soil, sugarcane bagasse ash, rice husk ash is to be mixed thoroughly to have a uniform and homogenous mixture. Sample will be prepared using different combination of rice husk ash, sugarcane bagasse ash and parent soil and different tests will be conducted on the prepared samples and result will be compared with the original clay sample. It's been planned to prepare 4 sample using different proportions. Details of sample are as following:

**Sample 1**

Parent clay –70%

Rice husk ash –10%

Sugarcane bagasse ash – 20%

**Sample 2**

Parent clay –60%

Rice husk ash –15%

Sugarcane bagasse ash – 25%

**Sample 3**

Parent clay –50%

Rice husk ash –20%

Sugarcane bagasse ash – 30%

**Sample 4**

Parent clay – 100%

## IV. TESTING PROGRAMME

The soil, rice husk ash and sugarcane bagasse ash collected from the different will be pulverized to break the lumps with wooden hammer and then dried in air under covered area. Then it was sieved through 2.35mm IS sieve and mixed thoroughly both individually and as per sample requirement time to time. For each test required

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quantity will be taken and dried in an oven at 105˚ C + 5˚ C or 105˚C - 5˚ C for 24 hours and then will be allowed to cool at room temperature.

On the prepared samples following test are planned to be conduct as per codal provisions:

1. **Grain size analysis:** grain size analysis will be done for each material respectively to have an idea about the grain size of the individual material that is being used in the investigation.
2. **Specific gravity:** specific gravity of all three materials i.e. soil, SBA and RHA will be find out as per given standard given in code. Specific gravity is needed to find certain other parameters like shrinkage ratio and unit weight.
3. **Liquid limit:** liquid limit test will be performed as per given in the code on the all four sample.
4. **Plastic limit:** plastic limit test will be performed as per given in the code on the all four sample as per codal provision.
5. **Standard Procter test:** standard Procter test will be performed as per given in the code on the all four sample as per codal provision.
6. **Unconfined compression strength test:** unconfined compressive strength test will be performed as per given in the code on the all four sample as per codal provision.
7. **California bearing ratio:** CBR test will be performed as per given in the code on the all four sample as per codal provision.

After all this work a comparative study of result of test for all samples will be done to come to certain conclusion regarding use rice husk ash and sugarcane bagasse as stabilizer to stabilized clayey soil.

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