Stabilisation of soil using rice husk ash (RHA) and cement

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Abstract. Most of the soil available for infrastructure development is not suitable for construction. It is a real challenge to overcome the difficulties faced with the problematic soil. We need to get better of difficulties experienced with those soils. In India around The annual output of RHA is 31 million tons..It contains around 85%-90% silica which pollutes the environment and also causes health hazards.As it is producing in large amount every year, there is a need to reduce the environmental pollution with produced Rice Husk Ash(RHA). Generally properties of the RHA are similar to the properties of natural soil, we are making an attempt to mixing soil and Rice Husk Ash to it. As the RHA is a non cementitious material, in experiment has added cement to the soil. In this work, while the cement is kept at a constant amount of soil in percentage, the Rice Husk Ash is taken in various percentages like Five , Ten and fifteen percentages by the amount of the soil. The soil index traced out with soil samples were tested. The objective shows this work is the safe disposal of solid waste (RHA) on one side and increasing the stability of soil which is not suitable for construction to make it suitable.

1 Introduction

Numerous engineering tasks include soil stabilization, with the building of paved roads being the most popular. By utilizing materials that are easily available in the area, the main goals are to raise the durability or resilience of the earth and lower the cost of development. [1] . In use of RHA with cement for soil stabilization offers several advantages Experimental methods. It is economical and Echo-friendly that can be used for a variety of soil types. it is also reduced the need for imported materials and helps to promote sustainable deployment[2] .Rice Husk Ash (RHA) is obtained from a cultivation fields which has been generated form rice mills. about 10 tons of rice husk ash annually is the world[3]. The stabilization of soil is a process of improving the engineering properties of soil in order to enhance its strength, stability , durability . one effective method of soil stabilization is through the use of rice husk ash and cement[4].

1.1 Clay soil

Soil is the most important and widely used substance in the field of civil engineering. To ensure the structure's stability, the construction, foundations, bricks, and pavements should all give sufficient strength[5]. There are numerous types of soil around the world, each with its unique material properties, size, texture, and other features. Expansive soils have minerals able to take up water. They gain volume as they take in water.. They grow in size as they absorb more water. When expansive soils dry up, they contract, resulting in fractures in the soil[6].

Depending on the quantity of moisture in the earth, expansive soils can change volume by up to 30% or more. "Black soil" is another name for it[7]. The natural, very fine material known as soil comprises clay minerals. Given a molecular water film that surrounds the clay fragments, clays take on a plastic quality when wet, but when dried or burned, they take on a tough, fragile, and not made of plastic quality. Natural ceramics can have a wide range of hues due to impurities, including a reddish or brownish hue from iron oxides. [5].

The most typical cause of construction issues is clayey soils. The volume changes can be severe enough to harm a building or other structure. Cracked. Foundations, floors, and basement walls are frequently damaged by swollen soils. When there is a lot of movement in a building, it might lead to problems[8].

Clay is a fine-grained natural soil substance that contains clay minerals. Clays become plastic while wet due to a molecular film of water surrounding the clay particles, but they become hard, brittle, and non-plastic when dry or burned. Impurities can give natural clays a variety of colors, such as a reddish or brownish color from minuscule levels of iron oxide. [9].

1.2 Rice husk ash(RHA)

The RHA material that is made from processed rice. Approximately 110 million metric tons of husk are generated globally each year. About 78% of the mass of the crop gets used as rice during milling, with the remaining 22% separating rice and bran if the crop is obtained as husk[3]. The term "rice husks" (RHA) refers to the portion of the husk that is transformed into ash during the process of combustion and comprises around 75% natural substances that are volatile. The rice husk ash improves To reduce the pollution if environment by the solid waste. The proportion of the husk is paddy various from place to place in a range from 16 to 25% by weight of the grain[10]. The use of rice husk ash reduces carbon dioxide and other greenhouse gas emissions associated with cement production. This husk can also be used as a fuel for stream or power generation and other purposes. This husk is used as a source of electricity for the rice mills, supplying steam for the boiling procedure. RHA is created by burning rice husk at temperatures between 600 and 700C for two hours[4]. As a pozzolanic substance, rice husk ash has a variety of physical and chemical and features. For every 1000 kg of rice that is milled, around 22% of rice husk is created, according to the rice husk ash. RHA has a variety of uses, such as in the building sector as a pozzolana, as an oil the adsorption as an ingredient in sweeping systems, and as a suspending agent for porcelain enamels. RHA can be utilized by the building sector as a substitute for cement. [12].

1.3 Cement

A material used in building is cement. that hardens, solidifies, and sticks to other materials, such as particulates (fine, coarse), sand, and bind them together. Hence it is also called as binder. Fine aggregates mixed with sand and gravel produces mortar, coarse aggregates with a combination of sand and water produces concrete.Concrete with a reinforced steel is know as reinforced concrete. The cement which is normally used is contain based on lime or calcium silicate. According to how quickly cement sets, they can be categorized as dynamic or non-hydraulic. in the presence of water. The composition of cement are calcium, silicon, aluminium, iron and other ingredients.Some types White concrete, sulfate-reduced cement, Oregon pozzolana cement, ash cement, and regular cement from Portland resisting cement ,low heat Portland cement, rapid hardening cement ,quick setting cement etc…The cement are classified as grades such as 33,43 53. The physical properties of cement are soundness, fineness, strength, consistency, setting time, heat of hydration, loss of ignition, bulk density, specific gravity. The following are the tests conducted on cement in the lab are: fineness test, strength test, soundness test, consistency test, setting time test, heat of hydration test, tensile strength test, chemical composition test.

2 Methodology and tests

This paper's primary goal is to assess the soil characteristics found in the research field. soil analysis was conducted for naturally occurring soil that contains a liquid limit. plastic limit, standard proctor test and UCS, and then compared to the test results for the soil which is mixed with 5,10 and 15 respective percentages of RHA with addition of cement 8%.For the three different selected proportions of RHA, tests are conducted to notice the changes in the soil i.e. UCS, the amount of liquid limit, the plastic limit, and the typical proctor test.

2.1 Liquid limit

A LL test is one of the more popular soil management techniques. The the quantity of moisture which both sides of a soil will flow together together the bottom of a depressive disorders with typical dimensions for an extent of 12 in. (12.7 mm), dividing the two halves, has been arbitrarily stated as the proportion of humidity that this line represents. This is done by decreasing twenty-5 times to a fatal of 0.3937 in. (10 mm) at a rate of a pair drops/second. The standard used internationally is 1985-IS 2720. The liquid limit of a soil is the amount of water at which it behaves similar to a liquid but has a restricted shear strength. The Casagrande water limit mechanism needs around 25 blows to flow and seal the groove. It can be difficult to acquire exactly 25 strikes on a test; between below 5 strikes were recommended.

2.2 Plastic limit

The boundary of plastic was created by Swedish scientist A. Atterberg as one of his limitations. The limit for plastic is one of the more frequently applied Atterberg Limits, in addition to the liquid limit.These two assessments are used to categorize soil across the world. The earth reaches the plastic limit when it starts to act like a plastic substance.Another name for it is "the level of moisture at which the substrate changes from flexible to semi-solid." An object made of plastic that was previously moulded into an outline will maintain that shape. shape. If the moisture content is below the plastic limit, the material is solid or non-plastic. The liquid limit, which is the moisture content at which the soil behaves like a liquid, will be achieved when the moisture content exceeds the plastic limit.Soil starts to behave like plastic once it reaches a particular moisture level. A proportion of the weight of the oven-dry soil is used to express the consistency at the soil's plastic limit, which lies among the plastic and semisolid stages. When stretched into a thread with a diameter of 3 mm, a soil melts due to its moisture content. Ground glass plate or another equivalent appear, per IS: 2720.

2.3 Regular proctor examination

In geotechnical engineering, soil compaction is the process of applying a force to a soil that results in densification as air is forced out of the pores between the soil grains.The dirt is typically compressed by large machines to induce compaction. The dirt is placed in lifts, or layers, while filling or backfilling an area. The first fill layers' capacity to be efficiently compacted will depend on the condition of the natural material being covered. Unsuitable material could compress over time underneath the weight of the environment fill if it is left into effect and backfilled, leading to settling cracks in the fill or any buildings it supports. The upper limit dry unit weight and ideal water content are strongly influenced by the soil type, which includes particle size distributions, soil grain form, the specific gravity of soil particles, and the quantity and kind of clay minerals present. It also has a significant impact on when and how to compress materials. Heavy machinery was used to compact the dirt. In gravel and sand, the vibrating apparatus forces the soil particles to reorient into a denser structure. A sheep foot roller is often employed in silts and clays to make small areas of severe shearing, which squeezes air out of the soil. The in-situ soil density is measured and contrasted with the highest possible density determined by a laboratory test in order to determine the level of permitted compaction. The Proctor Group compression test is the most popular laboratory test, and there are two approaches to calculate the highest density. Proctor has been modernized and is now more frequently used.

2.4 Test for unconfined compression

Because it is one of the simplest and most affordable methods for determining crushing strength, the test for unconfined compression is by far the most popular type of shear in the soil analysis. The technique is typically used to recover cohesive, saturated ground from thin-walled test jars.For dry stones or brittle clays, the test of unconfined compression is ineffective because the materials will crumble in the absence of lateral confinement. The sample is forced out of the sampling tube to undergo a without restriction compression test. A cylindrical sample of dirt has a length-to-diameter ratio of around 2, and the ends are cut to be fairly flat. The user loads a sample of soil onto a metal plate in a loading frame, then elevates lowest level. In the unconfined stress test, we presume that no water in the pores is lost form the specimen during setup or shearing. A saturated sample won't fluctuate in quantity, amount of water, or void ratio throughout the test; it will stay saturated. More crucially, low pore water pressures (produced by menisci developing between particles on the specimen surface) establish an efficient confining tension that binds the specimen together. Since pore pressures cannot be measured in an unrestricted compression test, the actual stress is unknown. Therefore, in an unconfined test, the untapped shear force is expressed as the total pressure.

3 Test outcomes and analysis

The Table 3.1 shows displays the soil's parameters, including its liquid limit (LL), plastic limit (PL), plastic index (PI), optimum moisture content (OMC), and compressive strength.

3.1Test results and discussion:

Tabulated in 3.1 shows the properties of soil contain the LL , PL , PI , OMC optimized water content etc finally with compressive strength . All the properties are expressed in the percentage

Table 3.1 Characteristics of clayey soil

s. no	characteristics of Soil	Value
1	Liquid Limit (LL)	63.2%
3	Plastic Limit (PL)	27.23%
4	Plastic Index (PI)	35.97%
6	Optimum Moisture Content (OMC)	21.6%
7	Dry Density maximum limit (MDD)	1.74 g/cc
8	Type of Soil	CH
9	Unconfined compression strength	72 kN/m^2

3.1 Results of LL(liquid limit)

Figure 1 The LLof the moisture level of soil ceases to flow like water. The moisture limit of the soil alone was found to be 64.2%. and reach to the 75%

As per the results of an experiment, the liquid limit value increases for every 5% increase in RHA from 5% to 15%. The LL of soil cement mixture in addition at 5% ,10% and 15% of RHA is increased to 66.1%, 69.3%, and 75.4% respectively.

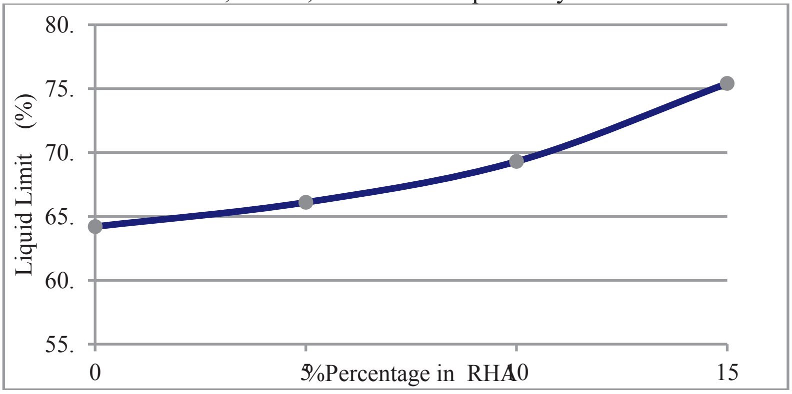


Fig.1 Graph showing Liquid Limit v/s percentage of RHA

3.2 Results of plastic limit

The PL is the LL content at which a 3.2mm in soil thread diameter start to breaking . The plastic limit of the soil alone was found to be 28.23%. Plastic limit value increased for every 5% increase in RHA from 5%,10% and 15%. The PL of the soil cement mixture in addition of 5%,10% and 15% of RHA is found to be increased to 28.6%,31.4% and 37% respectively. With the addition of RHA, values climbed from 28.6% to 31.4% and the 37% in the Plastic limit. It demonstrates that clayey soil's flexibility is growing. Figure 2 interprets the between plastic limit and Rice husk At 27.8 plastic limt starts and reach to the intermediate Limit of 28.5 % and maximum of 37% it linear variation to 7 % of the Rice husk but changed to maximum.

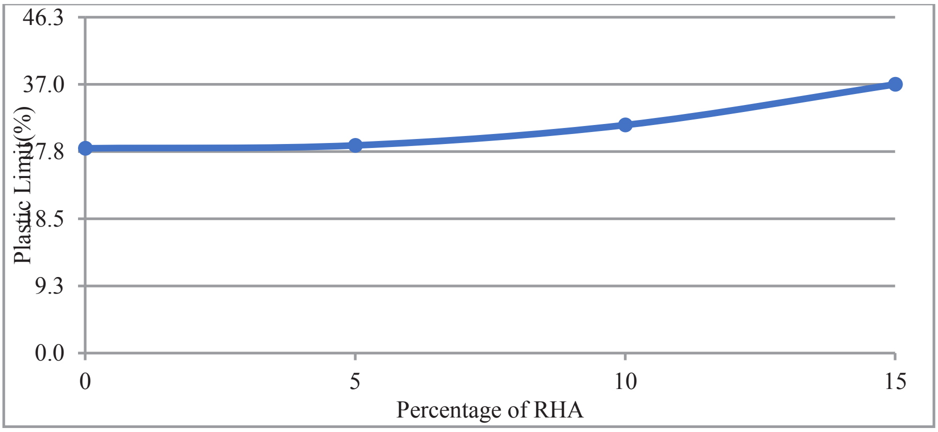
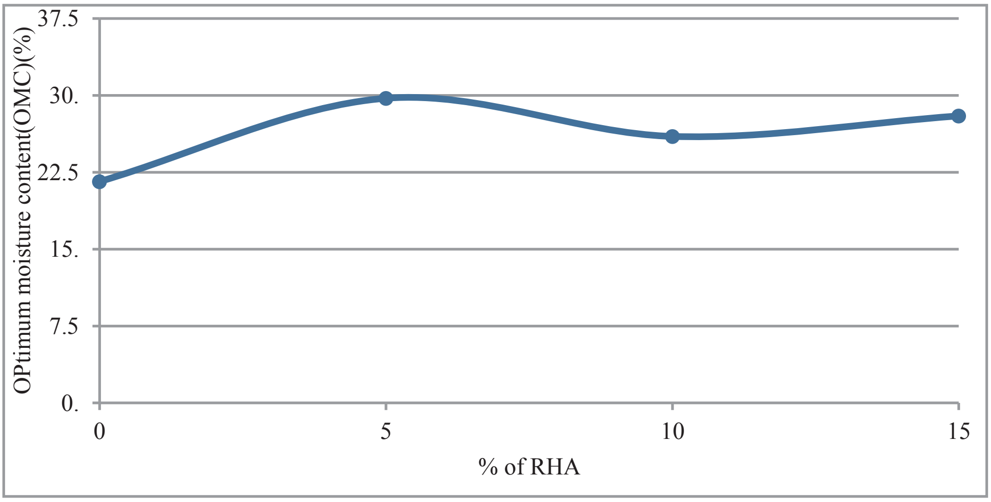


Fig.2 Graph of Plastic Limit v/s percentage of RHA

3.3 Results of Standard proctor test

3.3.1 Results of optimum moisture content

From a Standard proctor test it was found that the OMC(Optimum Moisture Content) value varies with every 5% extra adding of RHA i.e.,from 5% to 15%. It indicates that soil density is increasing. Figure 3The optimum moisture content of soil alone was 21.6%. The optimum moisture content of the soil cement mixture with addition of 5%,10% and 15% of RHA is found to be increased to 29.72%,and then decreased to 26% and again increased to



28% respectively.

Fig.3 Graph of Optimum Moisture Content v/s percentage of RHA

3.3.1 Results of maximum dry density

From standard proctored test every 5% addition of RHA, i.e., from5% to 15%, the OMC value decreases and increases while the MDD value increases and decreases respectively. Figure 4 The maximum dry density of the soil alone was found to be 1.74g/cc. The density of soilin ry condition of the soil RHA mixture in decreased to 1.3g/cc% respectively.

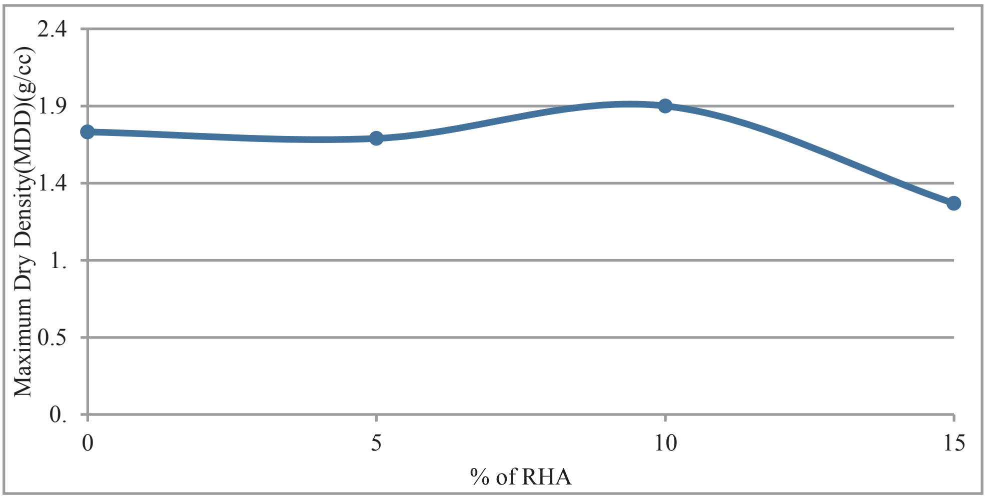


Fig.4 Maximum Density in dry condition v/s percentage showing in RHA

3.4 Results of Unconfined compressive Strength (UCS)

According to UCS, the shear strength of soil decreases and then increases with every 5% addition of RHA from 5% ,10% and 15%. From UCS the maximum shear strength of soil is attained at 15% of RHA with the amount of 101kN/$m^{2.}$

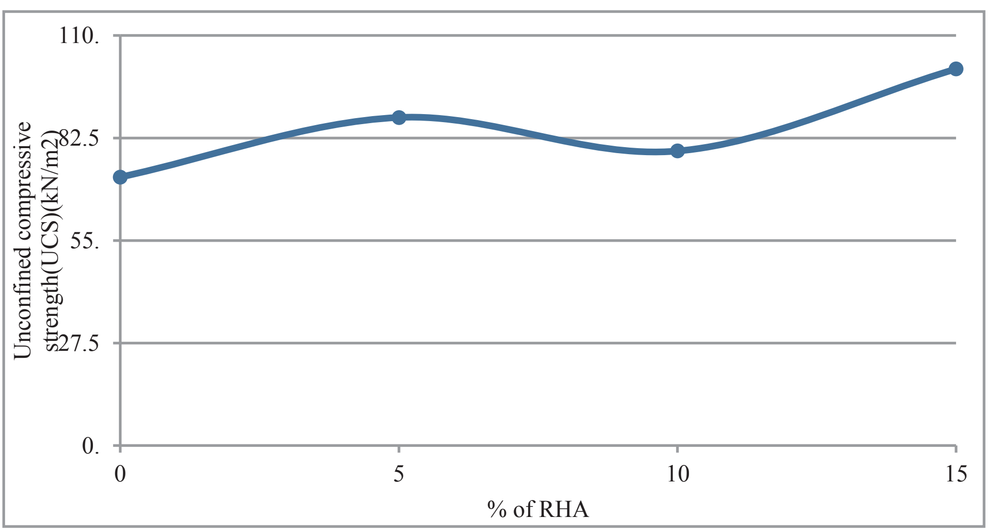


Fig.5 Graph of Unconfined Compressive Strength v/s percentage of RHA

4 Conclusion

All objectives of the expérimental investigation for the soil properties has been evaluated and satisfied the objectives of the study

- The LL and PL and Limit increased with gradually with increase % of increase in the Rice Husk Ash(RAH) which indicates increase with friction.
- The OMC obtained from samples was more than the OMC of natural soil which indicates increase in the density of soil.
- The highest Shear Strength and UCS is obtained for 15% RHA. Wich is good in test condition
- Therefore, it is concluded to use 15% RHA Among 5%,10% and 15% to stabilize the soil along with 8% of cement.

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