

REVIEW PAPER

Exploring the Zone of Improving Soil Properties by Using Rice Husk Ash

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ABSTRACT

As is widely known, India is still a developing country, and during the last 20 years, the demand for industrial and infrastructure projects has significantly increased. The most crucial element of every infrastructure project is the foundation. Verifying that the soil mass beneath a rigid foundation is strong enough to sustain the substructure's weight is crucial. However, this condition may not always be reached in some places due to the low shear strength of the soil. Clayey soil, which covers much of India, generally has poor geotechnical characteristics like weak shear strength, poor drainage, and considerable shrinkage. The unpredictable engineering properties of clayey soil can be reduced by using stabilizer additives or by replacing it with high-quality soil. Cement, lime, bitumen, calcium chloride, and other materials have shown outstanding performance in stabilizing expansive soils, despite the fact that they can sometimes be highly costly. Thus, research on improving soil characteristics through the use of waste materials and byproducts has yielded some very encouraging results. Utilizing waste materials to stabilize soil is not only cost-effective but also environmentally advantageous. The primary objective of this study is to ascertain whether using rice husk ash (RHA) and CaCl_2 may enhance the engineering properties of problematic clayey soil and make it suitable for use in foundations. To determine whether using waste products in soil is feasible and to identify potential solutions, a thorough literature analysis was conducted.

HIGHLIGHTS

- Waste management, green production, clayey soil in better way usage, Rice husk ash disposal.

Keywords: Soil, Clayey, RHA, expansive soils and CaCl_2

India is a developing nation, as is well known, and throughout the past 20 years, there has been a considerable increase in the need for infrastructure and industrial projects. The foundation is the most important component of any infrastructure project. It is important to make sure that the soil mass beneath a rigid foundation is robust enough to support the weight of the substructure. However, because of the soil's low shear strength, this requirement

might not always be met at some locations. The majority of India is covered in clayey soil, which typically exhibits poor geotechnical qualities such as significant shrinkage, poor drainage, and weak shear strength. The primary components of

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soil that preserve structural stability are strength characteristics.



Fig. 1: Major Soil Types in India (source – internet)

If we account mathematically the area covered by various types of soils may be tabulated as given in Table 1.

Table 1: Major soil types in India (source – internet)

Soil Types	%age of Total area
Alluvial soil	22.16
Black soil	29.69
Red soil	28.00
Laterite soil	2.62
Arid/Desert soil	6.13
Saline soil	1.29
Peaty/organic soil	2.17
Forest soil	7.94

Soil Stabilization

The primary component of clayey soil is a mineral known as montmorillonite, which has several flaws that must be fixed for engineering applications. Additional actions, such as stabilizing locally available soil through high compaction, can increase its qualities and demonstrate the cost-effectiveness of these materials. Swapping out the site’s materials for better ones with the use of certain appropriate chemicals that improve the soil’s engineering

qualities. RHA waste management by using it as a stabilizing agent.

By substituting high-quality soil or employing stabilizer additives, the unpredictability of clayey soil’s engineering qualities can be decreased. Although they can occasionally be very expensive, cement, lime, bitumen, calcium chloride, and other materials have demonstrated excellent results in stabilizing expansive soils. Thus, studies on using waste materials and byproducts to enhance soil qualities have produced some extremely positive findings. In addition to being economical, using waste products to stabilize soil is environmentally beneficial.

To date, the following strategies have been employed as corrective actions to get over the challenges:-

1. Mechanical techniques, such as compacting the soil using sand columns or drains.
2. By substituting different soil for the original soil.
3. Stabilization technique employing different stabilizer chemicals.

Because it uses the waste material as additives, the third approach is inexpensive and efficient, while the first two are extensive and hardly employed. Since soil stabilization is known to alter or improve the chemical, mechanical, or physical qualities of soil by adding various materials, it has become normal practice to employ waste materials in this process, which presents challenges for soil disposal. Because agricultural waste RHA is currently difficult to dispose of due to a lack of disposable land mass and is typically burned, which pollutes the air, the chemical stabilizer calcium chloride and waste product RHA are being employed in this study in consideration of the needs of the modern world.

By resolving the waste materials’ disposal issue, using this kind of trash to stabilize clayey soil will improve its geotechnical qualities while simultaneously protecting the environment. This study’s main goal is to determine whether employing RHA and $CaCl_2$ that can improve the engineering qualities of troublesome clayey soil and qualify it for usage in foundations.

A detailed literature review was carried out for judging the feasibility of the use of waste products



in soil to know possible options that can be worked out.

LITERATURE REVIEW

The purpose of this study conducted by Kumar et al is to ascertain how the electrical characteristics of black cotton are impacted by the sawdust and rice husk ash mixture. In contrast to sawdust ash, which was added to cotton soil at a weight percentage of 6%, varying concentrations of rice husk ash (depending on the weight of black dirt) were added to the soil for all mixed models at 0, 3, 6, 9, 12, and 15%. Tests including the Atterberg Limits, Specific Gravity, Particle Size Distribution, Standard Proctor Test, Unconstrained Compressive Strength (UCS), and California Bearing Ratio (CBR) are used to assess the electrical characteristics of soils and their mixtures. The findings demonstrated that the electrical qualities of black cotton were significantly enhanced by the addition of 9% wheat hull and 6% wood ash.

Kumar Vishal *et al.* (2022) Stabilizing soil is a process used in civil engineering to improve and enhance the soil's engineering qualities so that it can support large loads without failing. The current study examined the behavior of soil at various proportions after adding sisal fiber (varying proportions of 0.5%, 0.75%, and 1%; varying lengths of 20 mm and 40 mm) and rice husk ash (fixed proportion of 10%). Subsequently, various soil properties, including OMC, MDD, CBR value, and UCS value, were ascertained.

Chandrakaran and associates (2021) The soil utilized in the trials had simply been treated with nylon fiber and fly ash. First, the techniques for figuring out the best fly ash to utilize in untreated soil. Furthermore, the optimal amount of nylon fiber (0.25 and 0.5) was applied at various fly ash percentages (10, 20, 30, and 40). A compressive strength test was used to quantify strength and a supervised test was conducted to find the ideal percentage. The ideal percentages for fly ash (from heavy soil) and nylon fiber are 20 percent and 0.25 percent, respectively. At one-, seven-, and twenty-day application intervals, the impact of a positive percentage on the plastic qualities and compressive strength of the cultivated soil was examined. According to this study, the soil stabilized with nylon fibers and fly ash has more

strength, and when fly ash and nylon fibers are combined, the soil tillage strength also increases.

In 2019, Kumar and colleagues The stabilization method of the soil can improve the engineering strength features of costly clayey soils, such as bearing capacity and compaction characteristics. Controlled compaction using mechanical equipment, the use of appropriate admixtures such as cement, fly ash, lime, and gypsum, or the reinforcement of the soil with shredded tires, crumb rubber, plastic waste, etc., can all increase these qualities. Today, however, gypsum is utilized to improve the geotechnical qualities. Thus, gypsum and calcium chloride have been utilized in this study to enhance the different strength characteristics of natural soil. Investigating the strength characteristics of natural clayey soil reinforced with varying percentages of gypsum by soil weight and a set amount of calcium chloride as a binding agent is the aim of this research work. Both natural soil and reinforced soil with different weight percentages of gypsum (2%, 4%, 6%, and 8%) and a fixed percentage of calcium chloride (1%), are subjected to a battery of tests in the Standard Proctor test, Free Swell Index, and California Bearing Ratio (CBR).

Goud, P. Bharath, and associates (2018) The goal of the current study was to determine how well various proportions of copper slag and rice husk ash stabilized soil. Vane shear, California Bearing Ratio (CBR), Atterberg limits, free swell index (FSI), and compaction experiments are conducted on the mixed proportion of BC soils, copper slag, and rice husk ash. There aren't many studies on the use of rice husk ash and copper slag together to stabilize soil. It was discovered that the ideal mixture was 64% BC+30% CS+6% RHA. The FSI of RHA+CS-treated soil dropped sharply from 100% to 20.4%. The maximum dry density of the treated soil changed somewhat. According to the unsoaked CBR test, the ideal mix's strength was 12.7%.

Srikanth and colleagues (2017) One crucial factor in the construction industry is soil stability. Several stabilization strategies can be used for soil that is not sufficiently stable. Stabilization can improve the sub-grade's ability to support pavements and foundations by increasing the soil's shear strength and controlling its shrink-swell characteristics. There are several different stabilization methods.

This report's main objective is to investigate the viability of stabilizing soil with coir fiber and rice husk ash, reusing waste resources and offering a cost-effective and environmentally responsible way of soil stabilization.

Goud, P. Bharath *et al.* (2016) did a study to determine how well various proportions of copper slag and rice husk ash stabilized soil. Vane shear, California Bearing Ratio (CBR), Atterberg limits, free swell index (FSI), and compaction experiments are conducted on the mixed proportion of BC soils, copper slag, and rice husk ash. There aren't many studies on the use of rice husk ash and copper slag together to stabilize soil. The ratio of 64% BC+30% CS+6% RHA was determined to be the ideal blend. The FSI of RHA+CS-treated soil dropped sharply from 100% to 20.4%. The maximum dry density of the treated soil changed somewhat.

According to a study by Shon *et al.* (2016), adding calcium chloride to soil improves its strength and density. Additionally, it raises the surface tension of the liquid that is maintained in the soil matrix, which raises the system's suction pressure. Consequently, the cohesive energy between the particles rises, giving the particles more strength.

Hilbrich and McDonald (2016) used calcium chloride and F class fly ash to perform tests for suction, unconfined compressive strength, and triaxial compressive strength. Class F fly ash and the filter cake were used to achieve high strength. Specimens with 1.7% CaCl_2 + 10% fly ash showed the highest unconfined compressive strength and this strength was more stable. The same mix design samples (1.7% CaCl_2 + 10% class F fly ash) produced the greater suction value.

According to Bushman *et al.* (2015), calcium chloride has been employed as a dust suppressor, but because of its capacity to change material characteristics including strength, compressibility, and permeability, it is also known as a stabilizer. At a relative humidity of 95%, solid CaCl_2 can absorb 16.6 times its weight in water, essentially agglomerating and binding tiny particles together. It can absorb nearly as much water as its own weight, even in a setting with a relatively low humidity of 30%. Furthermore, during the water process, calcium chloride breaks down into Ca^{2+} ions, which results in ion exchange interactions with Na^+ and

K^+ ions that were first adsorbed on the surface of the clay particles.

Solid calcium chloride has a significant capacity to absorb water, according to Sayalak *et al.* (2015). Solid CaCl_2 can absorb 16.6 times its weight in water at a 95% relative humidity. It can absorb nearly as much water as its own weight, even in a setting with a comparatively low humidity of 30%. Furthermore, when water is present, calcium chloride breaks down into Ca^{2+} ions, which causes ion exchange interactions with the Na^+ and K^+ ions that were first absorbed on the surface of the clay particles. As a result, the soil will become stronger and less malleable.

According to Hausmann (2014), CaCl_2 has been widely used to prevent frost and dust in subgrade soil. The property of calcium chloride is hygroscopic. This indicates that it draws and retains water, which is influenced by temperature and relative humidity. When it absorbs moisture, it liquefies readily.

CONCLUSION

Individual studies utilizing RHA and CaCl_2 on various soils have been conducted in the past. In conjunction with RHA and CaCl_2 , numerous studies have been conducted employing industrial wastes such as rice husk ash, bagasse ash, stone dust, and other materials like cement and lime. Depending on the application, calcium chloride can be utilized in a variety of concentrations. It is a significant calcium salt with a wide range of domestic and commercial uses. Other researchers employed various compounds with fibers such as polyester and polypropylene. However, there hasn't been much research done on the combination of RHA and CaCl_2 . They have not yet been studied for their stabilizing effects on clayey soil in varying quantities.

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