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Enhancing Subgrade Soil Stability with Cow Dung Ash and Rice Husk Ash

Dilawez Ansari[1], Anuj Verma[2]

[1]M. Tech Scholar, Department of Civil Engineering, Rajshree institute of Management and Technology, Bareilly, UP, India

[2]HOD of Civil Department, Rajshree institute of Management and Technology,Bareilly, UP, India

ABSTRACT

This abstract provides a concise summary of the review conducted on the subgrade soil stability enhancement through the application of cow dung ash and rice husk ash. The study focuses on investigating the effectiveness of utilizing cow dung ash and rice husk ash as stabilizing agents for subgrade soil. Various laboratory tests and field evaluations were carried out to assess the impact of these organic materials on subgrade soil properties and stability. The ashes act as pozzolanic materials, reacting with the soil particles and forming cementitious compounds that enhance the soil's mechanical properties. The increased stability is attributed to the improved shear strength, reduced plasticity, and enhanced compaction characteristics of the soil. The utilization of these organic ashes offers additional benefits, such as cost-effectiveness, environmental sustainability, and waste management. By repurposing agricultural waste products, the study contributes to the promotion of eco-friendly practices in construction and geotechnical engineering.

INTRODUTCION

Subgrade soil stability is a crucial factor in the construction and maintenance of transportation infrastructure. The performance of roads, railways, and airport runways heavily relies on the stability and strength of the subgrade soil. Traditional stabilization methods often involve the use of chemical additives, such as lime and cement, which can be costly and environmentally unsustainable. As a result, researchers have been exploring alternative and eco-friendly materials to enhance subgrade soil stability.

Cow dung ash and rice husk ash are two potential alternatives that have gained attention in recent years. Both materials are byproducts of agricultural and animal husbandry activities and are abundantly available in many regions. The utilization of these agricultural waste

products for subgrade soil stabilization can not only provide a cost-effective solution but also contribute to waste management and environmental sustainability.

Cow dung ash is obtained by burning cow dung, which is rich in organic matter. It contains various elements, including silica, aluminum, iron, calcium, and potassium. Rice husk ash, on the other hand, is the ash produced by burning rice husks, primarily composed of silica. Both materials have been found to exhibit pozzolanic properties, which can contribute to soil stabilization through cementitious reactions.

Several studies have investigated the potential of cow dung ash and rice husk ash as soil stabilizers individually. However, limited research has focused on their combined application and their comparative effectiveness in subgrade soil stabilization. Therefore, this review aims to analyze and synthesize the available literature on the use of cow dung ash and rice husk ash, individually and in combination, for enhancing subgrade soil stability.

The review will begin by discussing the properties and characteristics of cow dung ash and rice husk ash, including their chemical composition and pozzolanic nature. Furthermore, it will explore the geotechnical properties of subgrade soil, emphasizing the factors that influence its stability, such as compaction, shear strength, and permeability. Understanding these properties is essential to assess the effectiveness of the two ash materials in stabilizing subgrade soil.

The subsequent sections of the review will present an overview of studies that have investigated the use of cow dung ash and rice husk ash for subgrade soil stabilization. It will analyze the methodologies, experimental setups, and test results of these studies to evaluate the performance of the ash materials in enhancing subgrade soil stability. Special attention will be given to the comparative analysis between the individual applications and the combined use of the two materials.

The review will also discuss the potential mechanisms by which cow dung ash and rice husk ash contribute to subgrade soil stabilization. It will delve into the cementitious reactions and pozzolanic activity of the ash materials, highlighting their influence on the geotechnical properties of the stabilized soil.

By providing a comprehensive analysis of existing literature, this review aims to fill the knowledge gap and shed light on the effectiveness of cow dung ash and rice husk ash as alternative soil stabilizers for subgrade applications. The findings of this review will be valuable for researchers, engineers, and practitioners in the field of geotechnical

engineering, enabling them to make informed decisions regarding sustainable soil stabilization techniques.

The subsequent sections will delve into the properties of these ash materials, analyze the available studies, and provide insights into their performance as soil stabilizers. Through this comprehensive examination, we can evaluate the feasibility and effectiveness of utilizing agricultural waste products for sustainable infrastructure development.

Rice husk ash

Rice husk ash is a by-product obtained from the burning of rice husks, which are the outer protective layers of rice grains. It is an abundant and widely available agricultural waste material that has gained attention for its potential applications in various fields, including soil stabilization. Understanding the properties and benefits of rice husk ash is crucial for evaluating its suitability as a soil stabilizer.

One of the key components of rice husk ash is silica. Silica is known to enhance soil properties such as compaction, strength, and resistance to moisture. The high silica content in rice husk ash can significantly improve the stability and load-bearing capacity of subgrade soils. Silica also has the ability to reduce the plasticity and swelling potential of expansive soils, making it an effective solution for mitigating volume changes caused by moisture variations.

Rice husk ash also contains other beneficial elements such as potassium, calcium, and magnesium. These elements contribute to the overall nutrient content of the soil, promoting healthy vegetation growth and improving the fertility of the treated soil. Additionally, rice husk ash has been found to exhibit pozzolanic properties, meaning it can react with

calcium hydroxide to form cementitious compounds. This pozzolanic activity further enhances the strength and durability of the stabilized soil.

The utilization of rice husk ash as a soil stabilizer offers numerous advantages. Firstly, it is a sustainable solution that repurposes agricultural waste material, reducing the environmental impact associated with waste disposal. Secondly, rice husk ash is cost-effective and readily available in rice-producing regions, making it an economical option for soil stabilization projects. Furthermore, the use of rice husk ash can contribute to the reduction of greenhouse gas emissions, as it replaces the need for energy-intensive traditional stabilizers.

However, it is important to consider certain factors when using rice husk ash as a soil stabilizer. The quality and composition of rice husk ash may vary depending on the burning process and rice variety. Therefore, careful quality control and characterization are necessary to ensure consistent performance. Additionally, the long-term performance and durability of rice husk ash in different environmental conditions should be further studied to determine its suitability for various geotechnical applications.

Rice husk ash exhibits significant potential as a soil stabilizer due to its high silica content, nutrient composition, and pozzolanic activity. Its ability to enhance soil properties, promote vegetation growth, and contribute to waste management makes it an attractive option for sustainable soil stabilization. Further research and testing are needed to optimize its application, evaluate its long-term performance, and develop guidelines for its implementation. Utilizing rice husk ash can not only improve subgrade soil stability but also contribute to sustainable agricultural practices and environmental conservation.

LITERATURE REVIEW

Yadav, A. K (2017) The stabilization of alluvial soil for subgrade is an essential aspect in civil engineering projects to improve the engineering properties and overall performance of the soil. In this study, the potential of utilizing rice husk ash (RHA), sugarcane bagasse ash (SBA), and cow dung as stabilizing agents for alluvial soil subgrade was investigated.The experimental program consisted of laboratory tests conducted on alluvial soil samples mixed with varying proportions of RHA, SBA, and cow dung. The properties of the stabilized soil, including compaction characteristics, California Bearing Ratio (CBR), and unconfined compressive strength (UCS), were evaluated. The effects of different proportions of the stabilizing agents on the soil's engineering properties were analyzed and compared. The results demonstrated that the addition of RHA, SBA, and cow dung significantly improved the compaction characteristics and strength of the alluvial soil. The

optimum proportion of stabilizing agents was determined based on the highest CBR and UCS values obtained. The stabilization mechanism was attributed to the pozzolanic reaction of RHA and SBA, which enhanced the soil's strength and reduced its compressibility. Cow dung, on the other hand, acted as an organic binder and contributed to the overall stability of the soil.

Fadmoro, O. F et al (2022) Soil stabilization techniques play a crucial role in civil engineering projects to improve the engineering properties of subgrade soils. This study focuses on assessing the environmental and economic impact of using a mixture of cow dung and husk ashes for subgrade soil stabilization. Laboratory experiments were conducted on soil samples mixed with varying proportions of cow dung and husk ashes. The properties of the stabilized soil, including compaction characteristics, strength parameters, and environmental impact, were evaluated. The economic feasibility of the stabilization technique was also analyzed by considering the cost of the stabilizing agents and their availability. The results showed that the addition of the cow dung and husk ash mixture effectively enhanced the compaction characteristics and strength of the subgrade soil. The stabilization mechanism involved the pozzolanic reaction of husk ash, which improved the soil's strength, and the organic binding properties of cow dung, which increased its stability. Additionally, the mixture exhibited a positive environmental impact by utilizing agricultural waste materials and reducing the demand for conventional stabilizers.

Ayodele, F. O.(2022) The stabilization of tropical soils is crucial in civil engineering projects to improve their engineering properties and mitigate challenges associated with their poor performance. This study investigates the potential of using calcium carbide residue (CCR) and rice husk ash (RHA) as stabilizing agents for tropical soil. Laboratory tests were conducted on tropical soil samples mixed with varying proportions of CCR and RHA. The properties of the stabilized soil, including compaction characteristics, California Bearing Ratio (CBR), and unconfined compressive strength (UCS), were evaluated. The effects of different proportions of CCR and RHA on the soil's engineering properties were analyzed and compared. The results indicated that the addition of CCR and RHA significantly improved the compaction characteristics and strength of the tropical soil. Optimum proportions of the stabilizing agents were determined based on achieving the highest CBR and UCS values. The stabilization mechanism was attributed to the pozzolanic reaction of RHA, which contributed to the soil's strength enhancement, and the cementitious properties of CCR, which improved its compressive strength.

Okonkwo, U. (2018). The compressibility of lateritic soil poses significant challenges in sub-grade soil applications. This study investigates the potential of utilizing palm kernel husk ash (PKHA) as a strengthening agent for lateritic soil to improve its compressibility characteristics. Laboratory tests were conducted on lateritic soil samples mixed with varying proportions of PKHA. The properties of the stabilized soil, including compaction characteristics, Atterberg limits, and consolidation behavior, were evaluated. The effects of different proportions of PKHA on the soil's compressibility were analyzed and compared. The results demonstrated that the addition of PKHA effectively reduced the compressibility of lateritic soil. Optimum proportions of PKHA were determined based on achieving the desired reduction in compressibility. The stabilization mechanism was attributed to the pozzolanic reaction of PKHA, which contributed to the soil's strength enhancement and reduced its plasticity.the study concluded that PKHA can successfully strengthen lateritic soil and improve its compressibility characteristics for sub-grade soil applications. The use of PKHA offers an environmentally friendly and cost-effective approach to soil stabilization, as it utilizes a waste product from the palm kernel industry.

Nyagah, A. M. (2022). Pozzolanic materials play a significant role in enhancing the properties of construction materials, particularly for gravel roads. This study investigates the pozzolanic potential of fresh cow dung and cow dung ash for improving the performance of gravel roads.Laboratory experiments were conducted to evaluate the pozzolanic properties of fresh cow dung and cow dung ash. The chemical composition, fineness, and reactivity of the materials were analyzed. The effectiveness of fresh cow dung and cow dung ash in enhancing the mechanical properties of gravel road materials, such as strength and durability, was also evaluated.Cow dung ash, obtained by burning cow dung at a controlled temperature, demonstrated increased fineness and enhanced pozzolanic activity. The addition of fresh cow dung and cow dung ash to gravel road materials significantly improved their compressive strength, abrasion resistance, and durability. Their utilization as supplementary cementitious materials can enhance the performance and longevity of gravel road surfaces. Furthermore, the use of cow dung and its ash as a construction material contributes to sustainable waste management by recycling an organic waste product.

Hidalgo, F et al (2020) Laboratory experiments were conducted on clayey soil samples mixed with varying proportions of RHA and SCBA. The properties of the stabilized soil, including compaction characteristics, California Bearing Ratio (CBR), and unconfined compressive strength (UCS), were evaluated. The effects of different proportions of RHA

and SCBA on the soil's engineering properties were analyzed and compared. The results demonstrated that the addition of RHA and SCBA significantly improved the compaction characteristics and strength of the clayey soil. Optimum proportions of RHA and SCBA were determined based on achieving the highest CBR and UCS values. The stabilization mechanism was attributed to the pozzolanic reaction of RHA and SCBA, which increased the soil's strength and reduced its compressibility. The study concluded that the combination of RHA and SCBA showed promising results in stabilizing clayey soil for subgrade applications. The use of these agricultural waste materials as stabilizing agents offers an environmentally friendly and cost-effective approach to soil stabilization. RHA and SCBA are abundantly available and can be easily obtained from rice husk and sugarcane bagasse, respectively.

Need of the study

The study on the subgrade soil stability using cow dung ash and rice husk ash is a significant endeavor in the field of geotechnical engineering. Subgrade soil stability is a critical factor in the design and construction of transportation infrastructure, such as roads, highways, and railways. The ability of the subgrade soil to bear the load from traffic and other external forces is crucial for the durability and performance of these structures. Traditionally, stabilizing subgrade soil has relied on the use of cement, lime, or other chemical additives. However, these methods often pose environmental concerns and are expensive. Therefore, exploring alternative and sustainable materials for soil stabilization has become a priority in recent years. Cow dung ash and rice husk ash are two such materials that have gained attention due to their abundant availability and potential as eco-friendly alternatives. Cow dung ash and rice husk ash are waste products from agricultural activities, and their utilization in soil stabilization can provide a dual benefit of waste management and enhanced subgrade soil performance. These materials contain a high percentage of silica, which is known to improve soil properties, such as compaction, strength, and resistance to moisture. Additionally, the organic content in cow dung ash can contribute to improved soil fertility, which is advantageous for vegetation growth in roadside areas.

The need for this study arises from the desire to evaluate the feasibility and effectiveness of using cow dung ash and rice husk ash as soil stabilizers. Understanding their potential benefits and limitations will allow engineers and researchers to make informed decisions regarding their implementation in real-world projects. By conducting laboratory tests and

field trials, the study aims to determine the optimum dosage of these ashes, their impact on soil properties, and the resulting improvement in subgrade soil stability.

Cow Dung Ash

Cow dung ash is a by-product derived from the burning of cow dung, a readily available organic waste material. This ash contains various minerals and elements that have potential benefits in soil stabilization applications. Understanding the properties and characteristics of cow dung ash is essential to evaluate its suitability as a soil stabilizer.

One of the key components of cow dung ash is silica. Silica is known to enhance soil properties such as compaction, strength, and resistance to moisture. Its presence in cow dung ash can contribute to improving the stability and load-bearing capacity of subgrade soils. Additionally, silica has a positive effect on reducing the plasticity and swelling potential of expansive soils, which are prone to volume changes with changes in moisture content.

Cow dung ash also contains organic matter, which can provide additional advantages in soil stabilization. The organic content acts as a natural binder, promoting cohesion and improving the soil's overall strength. Furthermore, organic matter contributes to the soil's fertility and nutrient content, creating a favorable environment for vegetation growth in roadside areas.

The use of cow dung ash as a soil stabilizer offers several benefits. Firstly, it is an eco-friendly solution that utilizes an agricultural waste product, reducing environmental concerns associated with traditional stabilizers. Secondly, cow dung ash is cost-effective and readily available in many agricultural regions, making it a sustainable and affordable option for soil stabilization projects. Moreover, the use of cow dung ash aligns with the

principles of circular economy by repurposing waste materials and promoting resource efficiency.

However, there are some considerations to be mindful of when using cow dung ash as a soil stabilizer. The variability in composition and properties of cow dung ash can affect its effectiveness. Therefore, careful characterization and quality control are necessary to ensure consistent performance. Additionally, the long-term durability and performance of cow dung ash in different environmental conditions should be further investigated to determine its suitability for various geotechnical applications.

CONCLUSION

In conclusion, the study on subgrade soil stability using cow dung ash and rice husk ash is an important research endeavor that addresses the need for sustainable and environmentally friendly soil stabilization techniques. The findings of this study have the potential to bring significant benefits to the field of geotechnical engineering and the construction industry as a whole.

By evaluating the feasibility and effectiveness of using cow dung ash and rice husk ash as soil stabilizers, the study aims to provide valuable insights into their impact on subgrade soil properties. The utilization of these waste materials not only offers a sustainable solution but also contributes to waste management strategies by repurposing agricultural by-products.

The study's laboratory tests and field trials will help determine the optimal dosage of cow dung ash and rice husk ash, as well as their influence on soil compaction, strength, and resistance to moisture. These parameters are crucial for assessing the overall stability and performance of subgrade soils in transportation infrastructure projects. The implementation of cow dung ash and rice husk ash as soil stabilizers would reduce reliance on traditional materials with higher environmental impacts, promoting sustainable practices in geotechnical engineering. Additionally, the study's findings could contribute to the development of guidelines and specifications for incorporating these ashes in future construction projects.

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