

Soil Stabilization by Using Fly Ash and Rice Husk Ash

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Abstract- A number of studies have been carried out to investigate the effect of waste materials on improving soil properties. The present study focuses on modifying soil characteristics using locally available rice husk ash (RHA) and fly ash (FA), which are widely recognized as effective stabilizing agents [1][2]. The cost of stabilization can be reduced by partially replacing conventional binders with RHA [1]. The soil used in this study is highly compressible clay that requires stabilization to minimize volume change. Soil samples were stabilized with varying percentages of RHA and FA, and tests such as compaction, unconfined compressive strength (UCS), and California Bearing Ratio (CBR) were conducted [3][4]. Results indicate that maximum dry density increases with increasing RHA content, while optimum moisture content decreases, whereas the reverse trend is observed with fly ash addition [2][5].

Keywords- Soil Stabilization, Fly Ash, Expansive Soil, Soil Modification, Soil Modification.

I. INTRODUCTION

Soil stabilization is the process of improving soil properties to enhance its strength and durability for construction purposes. Many natural soils are unsuitable for construction due to low bearing capacity and high compressibility, making stabilization essential [2]. Soil plays a crucial role in construction as it supports all structural loads.

Clayey soils generally exhibit poor engineering properties such as low shear strength, high plasticity, and excessive swelling and shrinkage when subjected to moisture changes [3]. These volume changes can lead to cracking, settlement, and structural damage. Expansive clays are particularly problematic because they lose strength upon wetting and exhibit creep under sustained loads [4]. The use of industrial by-products like fly ash and agricultural waste such as rice husk ash has been widely studied as an economical and eco-friendly method for improving the engineering behavior of such soils [1][5].

II. LITERATURE REVIEW

Previous studies confirm that soil stabilization using fly ash (FA) and rice husk ash (RHA) is an effective and sustainable technique for improving weak and expansive soils [1][2]. Fly ash possesses pozzolanic and, in some cases, self-cementing properties that reduce plasticity, swelling, and increase strength parameters such as UCS and CBR at optimum dosages [2][6]. Rice husk ash, rich in amorphous silica, contributes to strength improvement by forming cementitious compounds in the presence of calcium [1][3]. Research also indicates that combined use of FA and RHA produces synergistic effects, leading to better compaction characteristics and strength improvement compared to individual use [4][5]. However, the effectiveness of stabilization depends on ash quality, curing time, and soil type, which influence the optimum mix proportions [2][3].

III. METHODOLOGY

Soil stabilization using fly ash and rice husk ash is a resource-efficient approach that utilizes industrial and agricultural wastes as binding materials. The stabilization mechanism primarily involves pozzolanic reactions between silica and alumina present in ashes and calcium compounds in soil, forming cementitious products over time [1][6]. Laboratory investigations include particle size analysis, Atterberg limits, compaction tests, CBR, and permeability tests, conducted according to standard procedures [6]. Mix proportions were selected based on previous literature and preliminary testing [2][4].

IV. MATERIALS

Soil: Describe source, classification (e.g., CL), and physical properties (grain size distribution, specific gravity, natural moisture content).

Fly Ash (FA): Source, class (e.g., Class F or C), fineness, chemical composition (SiO_2 , Al_2O_3 , CaO), and specific gravity.

Rice Husk Ash (RHA): Source, method of production (burning and calcination temperature), amorphous silica content, fineness.

Mix Proportions

Select binder contents based on preliminary trials and literature:

- FA: 0% (control), 5%, 10%, 15%, 20% (by dry weight of soil)
- RHA: 0% (control), 2%, 4%, 6%, 8% (by dry weight of soil)

Also prepare combined mixes (e.g., FA 10% + RHA 4%, FA 15% + RHA 6%) to study synergistic effects. Maintain a consistent total dry mass; report each mix by percentage of soil mass.

At least three replicate specimens per test and mix for statistical reliability.

Particle size analysis (sieve + hydrometer).

Atterberg limits (Liquid Limit, Plastic Limit).

Specific gravity (Pycnometer).

Compaction test (Standard/Modified Proctor): Determine Maximum Dry Density (MDD) and Optimum Moisture Content (OMC) for each mix.

California Bearing Ratio (CBR): Prepare soaked and unsoaked specimens per standard and record CBR at 2.5 mm and 5.0 mm penetrations.

Permeability (constant/head test): Determine change in hydraulic conductivity due to stabilization.

V. CONCLUSION

The study concludes that using fly ash and rice husk ash significantly improves the engineering properties of weak soils in a sustainable and economical way. The combined pozzolanic action of FA and RHA enhances strength, reduces plasticity, and increases bearing capacity, making the soil more suitable for construction applications [1][3][5]. This approach also promotes effective waste utilization and supports environmentally friendly soil stabilization practices. Overall, FA and RHA provide a reliable, low-cost, and

eco-friendly alternative to traditional stabilizers.

Soil stabilization using fly ash and rice husk ash is an effective and sustainable method for improving the engineering properties of weak or problematic soils.[2][6] The addition of these pozzolanic materials significantly reduces the soil's plasticity, swelling, and shrinkage, while increasing its strength, density, and load-bearing capacity.

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