

Comparative Study on Properties of Soil replaced with Agrowaste Stabilized using Metakaolin and Cement as Additives

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Abstract—Soil stabilization is a technique of refining properties of soil by combining with other materials. It is the course of enhancing the shear strength parameters of soil and thereby increasing the bearing capacity of soil. Soil stabilization is used to lessen permeability and compressibility of the soil mass in earth structures. In common soil stabilization changes physical, chemical and mechanical properties to meet the engineering principle. Soil stabilization can be achieved by in-situ stabilization or ex-situ stabilization methodology. In the present case, an investigation is done to increase the strength properties of cohesive soil using a rice husk ash which is an agro waste and the mixture is treated with metakaolin and cement as an additive and is tested for various strength parameters.

Index Terms— Cohesive soil, Rice husk ash, Metakaolin and Cement.

I. INTRODUCTION

Soil stabilization is a technique of improving soil properties by blending and mixing with other materials. It is the process of improving the shear strength properties of soil and accordingly increasing its bearing capacity. Increment in the bearing capacity is required when the soil available for construction is not suitable to carry structural load. Stabilization reduces the permeability and compressibility of the soil mass in earth structures which increases its shear strength and decrease the settlement of structures. Soil stabilization includes the use of stabilizing agents (binder materials) in weak soils to improve its geotechnical properties such as compressibility, strength, permeability and durability.

Stabilization of Soil is a process of changing the soil properties using any physical, chemical, mechanical, biological, or consolidated technique to meet a designing reason. Improvements comprises of enhancement in soil bearing capabilities, tensile strength, and complete performance of in-situ sub soils, sands, and waste materials in order to improve quality of road pavements. The commonly used renewable technologies for stabilization are: enzymes, surfactants, polymers, tree resins, ionic stabilizers, fiber reinforcement, calcium chloride, calcite and more. These new stabilizing techniques create hydrophobic surfaces and prevent road failure from water penetration or heavy frosts by inhibiting the ingress of water into the treated layer. Additional stabilization practices include usage of on-site materials including sub-soils, sands, mining & natural stone industry waste to provide stable, dust free local roads for complete dust control and soil stabilization.

In present investigation an agro waste namely Rice husk ash with Metakaolin and Cement is selected to analyze the effects on index and engineering characteristics of cohesive soil. In order to utilize the rice husk ash for the

improvement of cohesive soil a thorough investigation has been formulated and index, compaction, shear strength and CBR tests have been conducted with increasing percentage of agro waste and a varying percentage of metakaolin and cement.

The objective of the present work is to explore the possibility of using Rice husk ash with metakaolin and cement in construction programme. To study the effect of Rice husk ash with metakaolin and cement on the density and OMC of cohesive soil. To study the effect of Rice husk ashes with metakaolin and cement on consistency limits and shear strength parameters of cohesive soil. To study the changes in CBR of cohesive soil by addition of Rice husk ash with metakaolin.

II. LITERATURE REVIEW

[1] Aamir Farooq et al conducted experiments on soil stabilization using geo-jute as stabilizer and he found that with the increase in fiber content the dry density of soil decreases whereas the shear strength of soil increases with increase in Jute fiber content and also by enhancing the jute fiber content percentage the maximum dry density of the soil is decreased and Optimum moisture content is increased.

[3] Muthupriya et al Conducted experiment on soil Stabilization using Industrial Waste Material as a stabilizer like clay, lime, industrial waste sand and found that there is an improvement in the properties of soil such as OMC and MDD for the soil treated with industrial waste.

III. METHODOLOGY

A suitable cohesive soil is replaced with 10%, 15% & 20% of Rice husk ash as a replacement for soil and mixed with 5%-15% metakaolin and 4% - 8% cement separately as additives & tested for its basic properties & strength properties.

Materials

A. Soil

Soil is a combination of organic matter, minerals, gases, liquids, and organisms that together support life. Soil samples are collected from Bannur (Mysore district) and are tested for their geotechnical properties and strength.

B. Rice Husk Ash

Rice husk ash (RHA) is a by-product from the burning of rice husk. Rice husk presence is extremely widespread in East and South-East Asia because of mass rice production in this area. The rich land and tropical climate make for perfect conditions to cultivate rice and is taken advantage by these Asian countries. The refined rice husk ash can be used as a substitute or admixture in cement production. Rice husk ash is collected from Mysuru and is tested for their geotechnical properties and strength.

C. Metakaolin

Metakaolin is the anhydrous form of the clay mineral kaolinite. Minerals which are rich in kaolinite is called China clay or kaolin, which is traditionally used in the manufacturing of porcelain. Particle size of metakaolin is very small than cement particles, but not as fine as silica fume. Metakaolin is collected from Bangalore and is tested for their geotechnical properties and strength.

D. Cement

Cement is a binder substance used in construction that sets, hardens, and adheres to other materials to bind them together. Soil-cement is a simple but highly-compacted mixture made up of soil, cement, and water. The cement mixed with soil, strengthens the properties of the it and giving the final material its durable qualities.

TABLE I. TEST CONDUCTED ON MATERIALS

Soil	Rice husk ash	Metakaolin	Cement
• Specific gravity • Consistency Limits • Dry density & OMC • Tri Axial Test • CBR	• Specific gravity	• Specific gravity	• Specific gravity

TABLE II. TESTS CONDUCTED ON SOIL & STABILISED SOIL

Index Properties	Engineering properties
➤ Consistency Limits	➤ Dry density & OMC ➤ Tri Axial Test ➤ CBR

TABLE III. SPECIFIC GRAVITY OF MATERIALS

Material	Specific gravity
Soil	2.55
Rice husk ash	3.0
Metakaolin	2.25
Cement	3.1

TABLE IV. INDEX & ENGINEERING PROPERTIES OF SOIL

Tests conducted	Results
Specific gravity	2.55
Liquid limit	42%
Plastic limit	12.5%
Shrinkage limit	8.85%
Proctor test (OMC)	14.2%
Proctor test (Max dry density)	1800 g/cc
Cohesion (C)	5.09 kg/cm ²
Angle of friction (ϕ)	20%
CBR for 2.5 mm	5.3%
CBR for 5.0 mm	4.9%

IV. RESULTS AND DISCUSSIONS

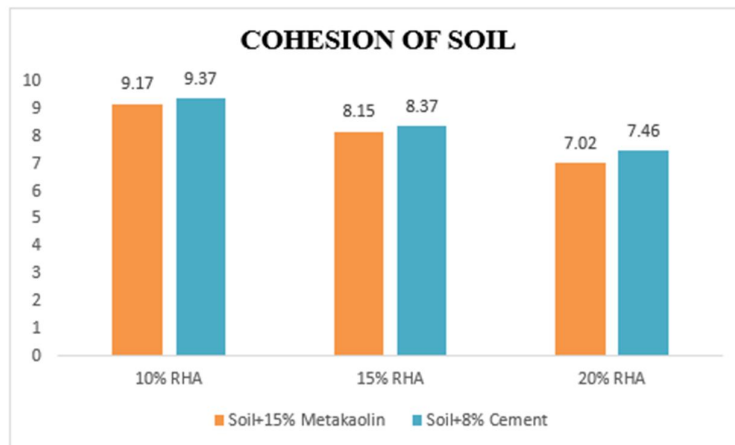


Fig 1. Cohesion value of stabilized soil

The above graph shows the variation of Cohesion value of soil with varying percentages of Rice Husk ash from 10% - 20% stabilized using 15% Metakaolin and 8% Cement. Test results shows Soil replaced with 10% Rice husk ash and treated with 15% Metakaolin increases the shear strength by 80.15% and reduces the internal friction angle by 40% when compared with soil alone and Soil replaced with 10% Rice husk ash and treated with 8% Cement increases the shear strength by 84.10% and reduces the internal friction angle by 20% when compared with soil alone.

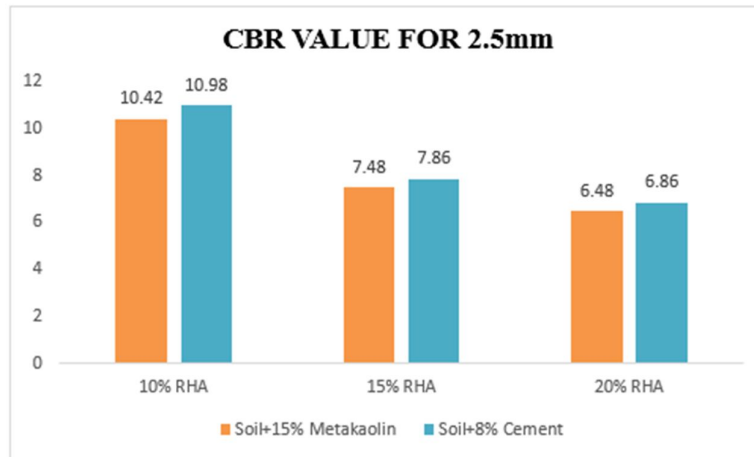


Fig 2. CBR value of stabilized soil for 2.5mm

The above graph shows the variation of Cohesion value of soil with varying percentages of Rice Husk ash from 10% - 20% stabilized using 15% Metakaolin and 8% Cement. California bearing ratio of the soil replaced with 10% rice husk ash and mixed with 15% metakaolin increases by 99.23% and soil mixed with 8% cement increases by 110% when compared with soil alone.

V. CONCLUSIONS

1. From the above experimental data, Rice husk ash can be used as a replacement for soil up to a limit of 10% - 15%.
2. Usage of Metakaolin and Cement as additives improves the engineering properties of the cohesive soil. Metakaolin being limited to 10%-15% and Cement usage being limited to 8%.
3. The hydration reaction between the cement powder and moisture in soil increases the strength of the soil (Cement content being limited to 8%).
4. Increase in CBR value due to the addition of Metakaolin and Cement, helps in reducing the thickness of the subgrade course.

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