A Study on the Effect of Rice Husk Ash & Lime on the Properties of Soft Clay

Umadevi. S1, Hashifa Hassan2

1 M.Tech Student, GS-12-009, Geo-Mechanics and Structures, Saint Gits College of Engineering, Pathamuttam, Kottayam, India
2 Assistant Professor, Department of Civil Engineering, Saint Gits College of Engineering, Kottayam, Kerala, India

Abstract—Since Kuttanad soil is a soft clayey soil it requires an efficient method to improve its load bearing capacity. In this study, rice husk ash (RHA) and lime are mixed with the soil to improve its load bearing capacity. Laboratory tests like California Bearing Ratio (CBR) tests are conducted to find out the optimum percentage of Rice husk ash and lime. The unconfined compression tests were conducted with the optimum percentage of these additives showed an improvement in the shear parameters. The studies showed that 15 % RHA and 6% lime gave the optimum CBR Values. X-ray Diffraction studies conducted on both stabilized and unstabilized clay showed the presence of a new mineral Albite in the stabilized clay structure. Finite element analysis in plaxis software conducted on both stabilized and unstabilized sample showed that the settlement of the foundation has been reduced remarkably on the stabilized clay.

Keywords—Albite, CBR, Lime, Proctor compaction test, Rice husk Ash.

I. INTRODUCTION

Since the property of the soil does not reach the required specification for the construction of pavements it requires an efficient and economical method to improve the soil properties. Several methods of soil improvements have been developed and in this study rice husk ash and lime were used for the stabilization of soil. Rice husk ash is the waste product of rice mills. This paper presents results of the study of using RHA and lime on the geotechnical properties of soil. CBR and unconfined compression test have been conducted to arrive at the results. CBR Tests results show that soil can be successfully used for pavement design by effective stabilization. The chemical examination has also been done before and after. stabilization of the soil to find out the changes in the mineral component after stabilization.

II. THE STUDY

In this study undisturbed sample of soil was taken from a depth of 1m below the ground level from the Nedumudy area in the Alappuzha District, Kerala.

Properties of the soil were determined as per Indian Standards, i.e. Specific gravity, grain size distribution, Atterberg limits, maximum dry density, optimum moisture content, shear parameters (c, Ø), CBR of the soil were determined in the lab. The hydrometer analysis results showed that the clay is having a silty content of 67%. The Atterberg results show that the liquid limit of the Kuttanad clay is 171%, plastic limit is 60% and shrinkage limit is 35%. The soil was classified as CH or MH. ‘CBR’ value was found to be 2.48 and the Shear parameters are: Cohesion, c = 5kN/m², Angle of internal friction, Ø = 3°.

The shear parameters indicate that the soil is soft clay and the soil requires stabilization for effective utilization.

III. RESULTS AND DISCUSSION

After determining the soil properties stabilizing additives are added to determine their optimum values. Initially RHA is added in different percentages and its optimum value is found out. To the mix of RHA and clay lime is added in different percentages and its optimum value is also found out.

A. Stabilization with RHA

RHA is added to the soil sample in varying proportions. The Proctor compaction test was conducted by adding 5%, 10%, 15%, 20%, and 25% RHA into this soft clay. Maximum dry density and optimum moisture content were determined for each percentage of RHA. The soaked CBR values are determined for various mixes of Kuttanad clay and rice husk ash by mixing the sample thoroughly at the optimum moisture content obtained from the proctor compaction test. The optimum value of RHA is found out from the CBR value which increase with the increase in RHA up to the optimum value and then decreases. The optimum CBR value is thus found out and the corresponding value of RHA for the maximum CBR is taken as the optimum percentage of RHA. Variation of CBR with % variation in RHA is presented.
Table I Variation Of CBR With RHA

<table>
<thead>
<tr>
<th>Mix Proportion</th>
<th>Water Content</th>
<th>Soaked CBR</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% soil</td>
<td>32</td>
<td>2.48</td>
</tr>
<tr>
<td>90% + 10% RHA</td>
<td>40</td>
<td>7.46</td>
</tr>
<tr>
<td>85% + 15% RHA</td>
<td>25.5</td>
<td>12.94</td>
</tr>
<tr>
<td>80% + 20% RHA</td>
<td>45</td>
<td>9.45</td>
</tr>
<tr>
<td>75% + 25% RHA</td>
<td>46</td>
<td>6.965</td>
</tr>
</tbody>
</table>

Unconfined compression test was also conducted on various samples of varying percentages of RHA and 15% RHA gave the maximum value. The value of cohesion obtained is as under, \( c = 6 \text{kN/m}^2 \) for 15% RHA. The atterberg limit test results showed a decrease in the plasticity index.

B. Stabilization with lime

The proctor compaction test was done on soil samples mixed thoroughly with optimum percentage of RHA and varying percentage of 2%, 4%, 6% and 8% lime. The optimum percentage of lime is found out from the maximum CBR value.

Table II Variation Of CBR With LIME

<table>
<thead>
<tr>
<th>Mix proportion</th>
<th>Water content (%)</th>
<th>Soaked CBR</th>
</tr>
</thead>
<tbody>
<tr>
<td>2% lime</td>
<td>53.67</td>
<td>7.46</td>
</tr>
<tr>
<td>4% lime</td>
<td>42.8</td>
<td>20.89</td>
</tr>
<tr>
<td>6% lime</td>
<td>39</td>
<td>25.8</td>
</tr>
<tr>
<td>8% lime</td>
<td>54</td>
<td>20.89</td>
</tr>
<tr>
<td>10% lime</td>
<td>48</td>
<td>18.1</td>
</tr>
</tbody>
</table>

The CBR test results show that 6% lime is the optimum value. Unconfined compression test was also conducted on various samples of varying percentages of lime and 6% lime gave the maximum CBR value. The value of cohesion obtained is as under, \( c = 8 \text{kN/m}^2 \) and \( \phi = 9^\circ \) for 6% RHA. The atterberg limit test results showed a further decrease in the plasticity index.

C. Chemical Analysis of the samples using XRD

The chemical analysis of the sample was done using X Ray Diffraction method before and after stabilization. The results showed the identification of the minerals in the stabilized clay as shown in the figure III. A new mineral Albite has been identified in the stabilized soil. It can be thus stated that the stabilized clay improved its strength characteristics due to the cementitious properties of this new mineral Albite.
D. Finite element Analysis

Plaxis is a finite element package that has been developed specifically for the analysis of deformation and stability in geotechnical engineering projects. The simple graphical input procedures enable a quick generation of complex finite element models and the enhanced output facilities provide a detailed presentation of computational results. The calculation itself is fully automated and based on robust numerical procedures. The general procedures are for the creation of geometry model, the generation of finite element mesh, the execution of finite element calculation and the evaluation of output results.

A model of the soil formation is prepared by giving the soil properties in the unstabilized and stabilized condition and load is applied on the foundation by means of a plate. The figure III and IV shows the deformation under the mesh in both the cases.

Before stabilization

After stabilization

IV. CONCLUSIONS

It is noticed that the liquid limit of the clay has been decreased by 50% on addition of 15% rice husk ash and it has been further decreased by 6% when 6% lime is added.

It is observed that the plastic limit of the clay has been improved by 3.33% on addition of 15% rice husk ash and it has been further improved by 3% when 6% lime is added.

It is observed that the plasticity index of the clay has been decreased by 60% on addition of 15% rice husk ash and it has been further decreased by 10% when 6% lime is added.

It is observed that the CBR value of the clay was found to be 2.48% and after stabilization with 15% rice husk ash it improved to 12.14% and on addition of 6% lime it improved to 25.8%.

The chemical analyses of the sample was done using X Ray Diffraction method for the sample of clay before and after stabilization and the results showing the identification of minerals in the stabilized clay are illustrated. A new mineral Albite has been identified in the stabilized clay.

The analysis is done in the plaxis software and it is found that the displacement under the foundation is reduced to a very large extent after stabilization.

REFERENCES


