Stabilization of Black Cotton Soil by using Cashew nut shell ash and Lime

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Abstract: There is a need to stabilize expansive soil such as black cotton soil in order to mitigate the inherent deleterious property of swelling and shrinking. For effective utilization of soil as subgrade it has to be stabilized and more importantly at a relatively cheap cost. In this project an attempt is made to stabilize the soil with locally available material. For this investigation 5, 10, 15, 20 and 25% of Cashew nut shell ash was added to the Black cotton soil while keeping the Lime percentage at 5% for all mix ratios. Experimental tests conducted in this research includes: Atterberg’s limits, Specific Gravity, Standard Proctor Compaction, Unconfined Compressive Strength, California Bearing Ratio (CBR). Tests were carried out to determine the optimum percentage of Cashew nut shell ash and Lime. Results obtained after the test shows that there is marginal improvement in the CBR and UCS value. Results of Compaction, Unconfined Compressive Strength, California Bearing Ratio (CBR) tests indicate that combination of 20% Cashew nut shell ash + 5% Lime is better for stabilizing the Black cotton soil.

KEYWORDS: black cotton soil, CBR, OMC.

I. INTRODUCTION

Every Civil engineering structure such as buildings, bridges, roads or railway track will in general have super structure and foundation. The civil engineers are the forerunners of all developmental activities, that the environment is consciously given due to consideration while embarking on development activities, which are essential to meet the aspiration of people, especially in developing countries, like India. In developing countries, limited finances are available for planning and development of construction network. The conventional hard quality stones construction materials in regards to strength and durability. But the sources of these materials are depleting fast which has increased the leads in transporting material from source to site. Moreover, in India, many state governments have imposed ban in earth cutting and quarrying to preserve the ecosystem. So, the proper utilization of low grade material should be made useful, which not only bring about significant saving in construction work.

Expansive clay is a major source of problem involved in structural distress. Swelling of these soils causes problems and damages the structure. Expansive soils are the problematic soil. Black cotton soil is produced geologically by the disintegration of volcanic rock and is very rich loamy earth of great fertility and unusually power of retaining moisture. Black cotton soil is also called Montmorillonite. They may be dry or hard and wet or soft. Black cotton soil also called swelling soil create problem for lightly loaded structures, and changing volumetrically along with seasonal moisture variation. Which results in excessive settlement and differential movement in superstructures causing damage to foundation system and architectural features of building. In various practical cases the structure loses its strength and need to improve its bearing capacity and minimize its expansion by addition of some additives. The actual problem with black cotton soil is, it develops number of cracks on drying, it flows like a liquid when moisture content is higher and they develop a high compressive strength when moisture content is low. They cause exceedingly slippery making travel by vehicle and construction difficulty when wet. Their rich granular structure makes them resistant to wind and water.

II. OBJECTIVES

- To study various physical and chemical properties of black cotton soil.
- To find the optimum moisture content and maximum dry density by addition of cashew nut shell ash and lime to black cotton soil.
- To learn the influence of additives on strength characteristics in terms of CBR for Black cotton soil.
- To determine strength parameters of soil combined with different percentage of additives by performing unconfined compression test.
III. MATERIALS

Properties of black cotton soil

Chemical composition of black cotton soil - Black cotton soil is composed of various clay mineral properties like montmorillonite, illite and kaolinite also chemicals like iron oxide and calcium carbonate and in addition organic matter like humus, Montmorillonite plays a main role in black cotton soil. This mineral causes swelling and shrinkage of black cotton soil. Engineering properties of black cotton soil - Black cotton soils are very problematic to engineers especially in India due to wide temperature change and distinct dry and wet seasons, causing variation in moisture content of soil. These problems may be low bearing capacity, high compressibility, swelling and swell pressure, shrinkage

Properties of lime

Lime is nothing but a calcium oxide (CaO). Lime is a substance obtained from burning of lime stone chalk, alkali waste, shells, bones etc. It may be in oxide form or hydrated form, normally a hydrated lime is known as lime.

Properties of cashew nut shell ash:
We have heard lot of research works on improvement of soil strength by using fly ash, lime, egg shell or some pozzolanic materials. And in recent research work it was found that cashew nut shell ash being pozzolanic in nature used as a additive to improve the soil characteristics. The oxide compositions in CNSA are Silica, Al2O3, Fe2O3, MgO, CaO.

IV. METHODOLOGY
The laboratory tests carried out on black cotton soil combined with CNSA and lime are Atterberg’s limit test, compaction test, California bearing ratio test and unconfined compression test.
- Later stabilization process was carried out on black cotton soil with lime and cashew nut shell ash. Mixing the black cotton soil with different percentage of cashew nut shell ash (5%, 10%, 15%, 20%, 25%) and keeping lime constant i.e 5% and determination of optimal content of cashew nut shell ash is found.
- To find strength characteristics of black cotton soil mixed with additives by conducting compaction, CBR and UCS tests.
- The test results of all mixtures are compared and optimum mix is identified.

V. EXPERIMENTAL INVESTIGATION
a) Grain size analysis:
b) Specific gravity
c) Atterberg’s limit
d) Liquid limit
e) Shrinkage limit
f) Plastic limit
VI. RESULTS AND DISCUSSION

<table>
<thead>
<tr>
<th>Sl.no</th>
<th>Property</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Liquid limit (%)</td>
<td>46</td>
</tr>
<tr>
<td>2</td>
<td>Plastic limit (%)</td>
<td>22.7</td>
</tr>
<tr>
<td>3</td>
<td>Shrinkage limit (%)</td>
<td>8.6</td>
</tr>
<tr>
<td>4</td>
<td>Specific gravity</td>
<td>2.186</td>
</tr>
<tr>
<td>5</td>
<td>(q_u \text{ (KN/m}^2)</td>
<td>72.39</td>
</tr>
<tr>
<td>6</td>
<td>C (KN/m²)</td>
<td>36.19</td>
</tr>
<tr>
<td>7</td>
<td>OMC (%)</td>
<td>12</td>
</tr>
<tr>
<td>8</td>
<td>MDD (KN/m³)</td>
<td>18.83</td>
</tr>
</tbody>
</table>

Table-1 Geotechnical properties of black cotton soil

<table>
<thead>
<tr>
<th>Mix Proportions</th>
<th>MDD (KN/m³)</th>
<th>OMC (%)</th>
<th>UCS (q_u) (KN/m²)</th>
<th>CBR Un-soaked (%)</th>
<th>CBR Soaked (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCS</td>
<td>18.83</td>
<td></td>
<td>72.39</td>
<td>2.92</td>
<td>2.59</td>
</tr>
<tr>
<td>BC + 5% lime</td>
<td>17.77</td>
<td>14</td>
<td>93.78</td>
<td>3.24</td>
<td>3.08</td>
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<tr>
<td>BC + 5% lime + 5% CNSA</td>
<td>16.56</td>
<td>14</td>
<td>99.27</td>
<td>4.86</td>
<td>4.21</td>
</tr>
<tr>
<td>BC + 5% lime + 10% CNSA</td>
<td>17.06</td>
<td>16</td>
<td>114.97</td>
<td>5.506</td>
<td>4.86</td>
</tr>
<tr>
<td>BC + 5% lime + 15% CNSA</td>
<td>17.55</td>
<td>16</td>
<td>144.5</td>
<td>6.80</td>
<td>6.16</td>
</tr>
<tr>
<td>BC + 5% lime + 20% CNSA</td>
<td>15.59</td>
<td>18</td>
<td>134.29</td>
<td>5.02</td>
<td>4.21</td>
</tr>
</tbody>
</table>

Table-2 Results of mix proportion of CNSA and lime with soil

![Dry density graph](image-url)
VI. CONCLUSIONS
The utilization of cashew nut shell ash improves the characteristics of black cotton soil. Cashew nut shell ash can be used as partial replacement in black cotton soil up to certain limits. Below shows various properties improved in black cotton soil.

1. Black cotton soil have high degree of expansion and possess high swelling potential and require stabilization for their better performance.
2. The introduction of lime and cashew nut shell ash in the natural soil will cause a decrease in MDD and increasing in OMC in the composite mixture.
3. As the percentage of cashew nut shell ash increases, the OMC increases from 12 to 18 percent MDD reduces from 18.83 to 15.59 KN/m³.
4. UCS value increases from 72.39 to 144.5 KN/m², Further addition of cashew nut shell ash UCS values decreases.
5. CBR value increases from 2.92% to 6.8% for un soaked and 2.59% to 6.16% for soaked condition. Further addition of cashew nut shell ash CBR values decreases.
6. The effective replacement of cashew nut shell ash found to be 20%. The mixture recommended from the research work is black cotton soil + 5% lime + 20% CNSA, which is economical.
7. This method of soil stabilization will be more economical as the cashew nut shell ash is naturally available at free of cost. Hence overall cost of the road construction becomes very less.
REFERENCES


[5] Prakash Chavan and Dr. M. S. Nagakumar, “study of soil stabilization by using bagasse ash”, The international journal of scientific research engineering and technology. ISSN 2278-0882, August 2014