PERFORMANCE ANALYSIS OF BLACK COTTON SOIL TREATED WITH GRANITE DUST AND LIME

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ABSTRACT

Generally black cotton soils are not good for road construction or for the construction of foundation. These soils are expansive clays which have high potential for shrinkage or swelling when there is a chance of change in moisture content. A laboratory study was undertaken to evaluate the effect of granite dust and lime as a soil stabilizer. Soil sample containing granite dust (0, 10, 20, 30%) and lime (3, 4, 5, 6%) by weight of soil were prepared and compaction characteristics, variation in free swell index, variation in plasticity index and California bearing ratio test were conducted accordingly by IS code of practice.

These tests are repeated on sample of soil mixed with different percentage of granite dust and lime in order to examine modifications in geo-technical properties of soil. The conclusions from the test results explains that the Compaction parameters, CBR and DFS values of the soil are improved greatly with the addition of the granite dust and lime. The conclusion that was drawn from the experimental work is that the expansive clay like black cotton soil can be stabilized by the combination of granite dust and lime to control its swell nature and to increase the bearing stability.

Key words: Atterberg’s Limits, Black Cotton Soil, California Bearing Ratio, Compaction Characteristics, Granite Dust, Lime, Unconfined Compression Strength.

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1. **INTRODUCTION**

A dark, rich alluvial soil found in the Deccan region of India, produced by the disintegration of black lava and which are well suitable for cotton cultivation. These soils are termed as Black cotton soils and these soils are expansive soils which can be found in many parts of India. These soils have high potential for shrinkage or swelling because of a mineral called montmorillonite. Due to this mineral these soils have the tendency of swell and shrink excessively when there is a change in moisture content. The mineral that is more dominant in most black cotton soils is Montmorillonite. In general, these soils have average clay content being 50% and ranging from 40-50%. Black cotton soils are residual deposits from trap or basalt rocks. India has large tracks of black cotton soils covering area of 8million square kilometres. Untreated black cotton soils are not suitable to foundations, buildings, roads, canal lining etc. resulting in severe damage due to swelling and shrinkage.

Black cotton soil stabilization with additives before its application is inevitable. Generally, clay is good pozzolana containing siliceous and aluminous materials which can form cementitious compounds on treatment with lime. Lime stabilization increases strength, reduces the volume change and swelling capacity of black cotton soils. This study presents properties of expansive soils treated with 3%, 4%, 5%, and 6% of lime.

Granite belongs to igneous rock family, is a very hard, crystalline. The composition of granite consists of quartz and feldspar with small amounts of mica, amphiboles, and other minerals. The Granite dust is a byproduct of cutting industries, about 3000 metric ton of granite dust/slurry is produced per day. All the waste produced from granite industry are disposed in dumping yards, nearly occupying 25% area of granite industry. This leads to environmental pollution and occupation of vast area of land especially after the slurry dries up. This laboratory study is to find the effect of 10%, 20%, and 30% of granite dust on the properties of soil mixed with 3%, 4%, 5% and 6% of lime.

2. **LITERATURE REVIEW**

**Sridharan et al. (2006)** presented the Shear strength studies on soil-quarry dust mixtures. They studied that increase in dry density on addition of quarry dust with attendant decrease in the optimum moisture content (OMC). Increase in shear strength was observed for the soils and the mixture of soil-quarry dust combinations were seen when compacted in case of dry side of optimum.

**Ali M.S et al. (2012)** presented the effect of stone dust and fly ash on characteristics of expansive soil. They have given that there is a marked improvement in the properties of expansive soils when stone dust and fly ash is mixed in equal ratios. There is a change even in the selling behaviour of expansive clay

**P. Indiramma et al. (2014)** presented that the effect of quarry dust and fly ash on properties of expansive soil. They concluded that as the percentages of admixtures that is fly ash alone/quarry dust alone/combination increases, there significant improvement in the properties of expansive clay.

**Corka et al. (2001)** presented the effect of Fly ash on the expansive soil. The outcomes of his research are that the plasticity index, activity and swelling potential of the samples decreased with increasing percentage stabilizer and curing time and the optimum content of fly ash in decreasing the swell potential was 20%. Also explained that both these high calcium and low calcium class C fly ashes can be recommended as the effective stabilizing agents for improving the expansive soils.
Performance Analysis of Black Cotton Soil Treated with Granite Dust and Lime

Dr. T. FelixKala (2013) present experimental investigation indicates that the strength properties of the concrete could enhance the effect of utilization of granite powder obtained from the crusher units in place of river sand in concrete. Generally, the behaviour of granite dust with admixtures in concrete gives the higher properties like concrete made by river sand.

Shailendranadh et al. (2013) presented that the properties of black cotton soil get effectively modified by varying the proportions of lime such as liquid limit, maximum dry density and optimum moisture content.

S. Bhuvaneswari et al. (2014) studied the behaviour of expansive treated with lime. They concluded that as there is improvement in the properties of expansive soil as there is increasing the percentage of lime. They also stated that as the lime content increases beyond optimum lime content there significant decrease in the strength of expansive clay.

Pankaj R. Modak et al. (2012) studied the strength character of black cotton soil by adding lime and fly ash. They concluded that, by adding of lime and fly ash the strength of soil that is California bearing ratio increase to great extent.

Dilip Shrivastava et al. (2014) conducted a series of laboratory test on black cotton soil by adding lime and rice husk ash. This study concluded that the Rice Husk Ash has a potential to improve the characteristics of black cotton soil such as OMC, MDD, CBR and UCC.

3. EXPERIMENTAL INVESTIGATIONS

Table 1 Engineering Properties of Natural Soil

<table>
<thead>
<tr>
<th>Colour of Soil</th>
<th>Black</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Gravity</td>
<td>2.64</td>
</tr>
<tr>
<td>Grain size analysis</td>
<td></td>
</tr>
<tr>
<td>a) Sand</td>
<td>12%</td>
</tr>
<tr>
<td>b) Silt</td>
<td>29%</td>
</tr>
<tr>
<td>c) Clay</td>
<td>59%</td>
</tr>
<tr>
<td>IS Classification</td>
<td>CH</td>
</tr>
<tr>
<td>Liquid Limit</td>
<td>74%</td>
</tr>
<tr>
<td>Plastic Limit</td>
<td>30%</td>
</tr>
<tr>
<td>Plasticity Index</td>
<td>44%</td>
</tr>
<tr>
<td>CBR</td>
<td></td>
</tr>
<tr>
<td>a) Un-soaked</td>
<td>2.32%</td>
</tr>
<tr>
<td>b) Soaked</td>
<td>0.84%</td>
</tr>
<tr>
<td>Optimum Moisture Content</td>
<td>27.45%</td>
</tr>
<tr>
<td>Maximum Dry Density</td>
<td>1.58g/cc</td>
</tr>
<tr>
<td>Cohesion</td>
<td>56kPa</td>
</tr>
<tr>
<td>Angle of Internal Friction</td>
<td>2o</td>
</tr>
<tr>
<td>Degree of Free Swell Index</td>
<td>100%</td>
</tr>
</tbody>
</table>
Table 2: Engineering Properties of Natural Soil

In this study, Granite Dust is collected from Srimani Granites and Marbles, Kakinada.

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour</td>
<td>Mostly light Colour</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>2.71</td>
</tr>
</tbody>
</table>

From Hydrometer analysis:
- Coefficient of Uniformity: 7.81
- Coefficient of curvature: 1.91

4. RESULTS AND DISCUSSIONS

MDD and OMC of Virgin Soil

![Figure 1: Optimum Moisture Content and Maximum Dry Density of Virgin soil](image)

Figure 1: Optimum Moisture Content and Maximum Dry Density of Virgin soil
Performance Analysis of Black Cotton Soil Treated with Granite Dust and Lime

Free Swell Index Variation

![Free Swell Index Variation](image)

**Figure 2** Effect of Granite dust on Differential free swells

Variation in Plasticity Index

![Variation in Plasticity Index](image)

**Figure 3** Effect of Granite dust on Atterberg’s Limits

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MDD for 3%, 4%, 5%, and 6% Lime

Figure 4 Effect of Granite dust on Maximum Dry Density

Variation of Cohesion with Curing Period
Performance Analysis of Black Cotton Soil Treated with Granite Dust and Lime

**Figure 5** Effect of Granite dust on Cohesion

Variation of angle of internal friction with 10%, 20%, 30% GD
**Figure 6** Effect of Granite dust on Angle of Internal Friction

Variation in CBR with 10%, 20%, 30% Granite Dust
5. CONCLUSIONS
The following conclusions were drawn on the basis of the experimental work conducted on soil samples containing granite dust and lime which are mixed in different proportions to stabilize the black cotton soil.

1. By blending the BC soil with lime and Granite dust, considerable increase in plastic limit, plasticity index, maximum dry density and decrease in optimum moisture content, liquid limit, and degree of free swell.

2. The addition of granite dust to the lime stabilized BC soil improved the soaked CBR considerably. The addition of lime and granite dust to the black cotton soil increases the CBR from 0.84% to 8.51%.

3. The addition of lime and granite dust improves the CBR in increasing rate up to 5% lime and 20% granite dust. After that the CBR value increases in decreasing rate.

4. The cohesion of soil increases as the lime content increases up to 5% lime and 20% granite dust; beyond these the cohesion value increases in decreasing rate.

5. As the curing period increases the cohesion value increases up to 7 days of curing. Beyond that the cohesion value decreases in rate.

6. The experimental results were obtained from this work explains that the expansive soil like black cotton soil can be stabilized by the mixture of lime and granite dust which reduces its swelling nature and increase the stability.

![Figure 7 Effect of Granite dust on California Bearing Ratio](image-url)
REFERENCES


