Stabilization of Expansive Soil by using Wheat Husk Ash and Granulated Blast Furnace Slag

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Abstract— Expansive soil shows major volumetric changes due to change when comes in contact with moisture content. This causes major damage to property constructed on it. These expansive soils contain minerals such as montmorillonite that are capable of absorbing water. When they absorb water volume of the soil increases. There are different methods to improve the strength of the soil mechanically compacting, dewatering and earth reinforcement have been found to improve the strength of the soils, and other methods like stabilization using admixtures are more advantageous. The different admixtures available are wheat husk ash, lime, cement, blast furnace slag etc. This study focused on the use of the industrial waste material GBS and wheat husk ash. GBS is obtained from blast furnace slag, a by-product from the manufacture of iron. By adding granulated blast furnace slag and wheat husk ash reducing water content and increasing dry density and also improves the strength. The results are more effective for optimum percentage (9%) of granulated blast furnace slag and wheat husk ash.

Key words: Density, Expansive soil, GBS, Strength, WHA

I. INTRODUCTION

A. General

Expansive soils, well-known as Black Cotton Soils in India, occupy about one-fifth of land area of the country. Black Cotton Soils are residual deposits formed from basalt or trap rocks. Expansive soil contain significant amount of montmorillonite material. These soils are very hard in dry state but lose their load carrying capacity when once they are comes in contact with water. They have high shrinkage and swelling characteristics. In general, these expansive soils are very much keen to changes in environment. The environment includes the stress system, the chemistry of pore water in the system, the seasonal variations in ground water table with consequent changes in natural moisture content and temperature variations. These swelling and shrinkage properties have made the soil unsuitable for civil engineering purposes either as foundation or embankment material.

The compaction is a mechanical process in which the densification is achieved through the expulsion of air voids at almost constant water content of the soil mass. However, densification through consolidation is primarily attributed to the gradual expulsion of pore water from the voids of the soil mass undergoing consolidation and to the increase in the effective stress on the soil mass. Stabilizing agents such as fly ash, quarry dust and rice husk ash are used for the stabilization of expansive soils. In the same way granulated blast furnace slag (GBS) one of the materials used as stabilizing agent which is generated from the steel plant. Waste management issue in Steel plant has become increasingly important. Utilization of industrial and agricultural waste products in the industry has been the focus of research for economical, environmental, and technical reasons. GBS is a ore waste product of the steel plant. This waste-product is already causing serious environmental pollution which calls for urgent ways of handling the waste.

Hence, an attempt has been made in this investigation for the effective utilization of GBS to improve the physical and engineering properties of Expansive soil with wheat husk ash.

B. Scope of the Present Study

1) To study the index and compaction properties of Expansive soil with the addition of various percentages of GBS to arrive the optimum percentage and also intended to compare the change in geotechnical properties of natural soils.
2) To study the index and compaction properties of Expansive soil with the addition of various percentages of wheat husk ash to arrive the optimum percentage and also intended to compare the change in geotechnical properties of natural soils.
3) To study the strength behavior of Expansive soil at various percentages of GBS and wheat husk ash with curing to examine maximum percentage addition of GBS and wheat husk ash to expansive soil independently, to arrive the optimum results.
4) To study the strength behavior of Expansive soil treated with optimum percentage of GBS and optimum percentage of wheat husk ash at various curing periods.
5) To develop the rational approaches for the use of GBS and wheat husk ash for geotechnical purposes. Hence, enhancing the rate of utilizing the GBS more effectively for construction purpose and to reduce the disposal problem and minimize the environmental hazards.

II. MATERIAL AND METHODOLOGY

A. Materials

For the present study, Expansive soil, GBS and wheat husk ash have been used. Their physical properties have been determined.

B. Methods

1) Specific gravity by pycnometer method
2) Grain size distribution
3) Liquid limit by casagrande method
4) Plastic limit
5) Standard proctor test(Compaction)
6) Unconfined compressive strength.

C. Index Properties

The Specific Gravity (Gs) of the soil samples was determined as per IS: 2720 (part 3/Sec1) – 1980, Methods of test for soils: Determination of Specific Gravity, fine grained soils. The clay and silt sized fractions of the soil specimen was determined as per IS: 2720 (part 4) - 1985, Methods of test for soils: Grain size analysis. Atterberg’s limits of the soil specimen was determined as per IS: 2720 (part 5) – 1985, Methods of test for soils: Determination of liquid and plastic limit.

D. Engineering Properties

The standard proctor compaction characteristics of the soil specimen was determined as per the IS: 2720 (part 7) – 1980, Methods of test for soils: Determination of water content-dry density using light compaction.

Unconfined compressive strength were carried out as perIS: 2720 (part 10) – 1991, Methods of test for soils: Determination of Unconfined compressive strength.

III. FIGURES AND TABLES

Black cotton soil: In this project the soil was collected from Rudnoor which is 20 km away from Bhalki taluka. These were obtained and tested to evaluate their basic characteristics, compaction and direct shear test. The soil samples thus obtained are oven dried, pulverized and subjected to different laboratory tests.

<table>
<thead>
<tr>
<th>Properties</th>
<th>Expansive soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour</td>
<td>Black</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>2.65</td>
</tr>
<tr>
<td>GRAIN SIZE DISTRIBUTION</td>
<td>Well graded</td>
</tr>
<tr>
<td>ATTERBERG’S LIMIT</td>
<td></td>
</tr>
<tr>
<td>Liquid Limit (%)</td>
<td>65.5</td>
</tr>
<tr>
<td>Plastic Limit (%)</td>
<td>33.20</td>
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<tr>
<td>Plasticity Index (%)</td>
<td>32.30</td>
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<tr>
<td>Shrinkage Limit (%)</td>
<td>10.45</td>
</tr>
<tr>
<td>Unified Classification</td>
<td>CH</td>
</tr>
<tr>
<td>COMPACTION CHARACTERISTICS</td>
<td></td>
</tr>
<tr>
<td>Maximum Dry Density (kN/m³)</td>
<td>14.92</td>
</tr>
<tr>
<td>Optimum Moisture Content (%)</td>
<td>22</td>
</tr>
<tr>
<td>Unconfined Compressive Strength (kn/m2)</td>
<td>219.18</td>
</tr>
</tbody>
</table>

Table1: Properties of black cotton Soil

The above graph shows, as the particle size increase the percentage finer also increases. From graph the values of D₁₀, D₅₀,D₆₀ are calculated and then the uniformity coefficient and curvature coefficient calculated. From above results the soil is the medium graded soil.

A. Compaction

The above graph shows, as the water content increases the dry density increases upto a limit afterwards decreases. The optimum moisture content and the maximum dry density is calculated from graph.

Fig. 2.1.1: From the above graph for different %of wheat husk ash shows that optimum moisture content is obtained on 9% of WHA as 18%.

Fig. 2.1.2: from the above graph for different % of wheat husk ash shows that Maximum dry density obtained is 9% i.e 15.6 KN/m³.
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Fig. 2.2.1: from the above graph GBS for different % shows that optimum moisture content is 20%

Fig. 2.2.2: from the above graph GBS for different % shows that maximum dry density is 15.24 kN/m³.

Fig. 2.3: from the above graph OMC is 20% and MDD is 16.21 kN/m³.

B. Unconfined Compressive Strength

Fig. 3: from the above graph the value obtained for the UCS for expansive soil without stabilizer is 219.18 kN/m².

Fig. 3.1: Graph stress against no of days for different % of WHA

Fig. 3.2: Graph stress against no of days for different % of GBS

Fig. 3.3: from the above graph the unconfined compressive strength increases with increasing days.

IV. CONCLUSION

A. Conclusion

1) Addition of different % of WHA the water content decrease up to a limit afterwards again it increases. This is more effective for addition of 9% (optimum) WHA.

2) Addition of different % of WHA the dry density increases up to a limit afterwards again it decreases. This is more effective for addition of 9% (optimum) WHA.
3) Addition of different % of GBS the water content decrease up to a limit afterwards again it increases. This is more effective for addition of 9% (optimum) GBS.

4) Addition of different % of GBS the dry density increases up to a limit afterwards again it decreases. This is more effective for addition of 9% (optimum) GBS.

5) The stress against different days for varying % WHA. For varying % of WHA, as number of day’s increases stress also increases. This is more effective for 7 days.

6) The stress against different days for varying % GBS. For varying % of GBS, as number of day’s increases stress also increases. This is more effective for 7 days.

7) The stress against strain for optimum (9%) of WHA and GBS for different days as strain increases stress also increases up to a limit, afterwards it decreases. This is more effective for 7 days.

B. Scope for Future Work

1) The study is continued for different regions of soil.
2) The study is continued for different type of soil.

REFERENCES


[3] Celik and Nalbantoglu (2013) had studied the effects of ground granulated blast furnace slag on IP, linear shrinkage (LS), and SP of lime stabilized sulphate-bearing expansive soil.


[6] Osinubi et al. (2012) had studied the effect of compaction delay on strength characteristics of black cotton soil stabilized with blast furnace slag and cement.


[8] Rajan et al (1982) in Karnataka engineering research station, Krishnarajasagara. It was felt that rice-husk ash behaves as pozzolanic material in the presence of lime.