Stabilization of Black Cotton Soil Using Blast Furnace Slag: - A review

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ABSTRACT

Soil stabilization may be defined as the alteration of the properties of an existing soil to meet specified engineering requirements. The main properties that may require to be altered by stabilization are strength, volume stability, durability and permeability. In India, the black cotton soil covers an area of about 0.8 million sq. km. which is about 20% of the total land area. It is considered as problematic soil due to detrimental volume changes with variation in moisture content. When it comes in contact with water it shows immense swelling whereas it shrinks with the decrease in water content and develops cracks on drying. Now-a-days the utilization of waste products with soil has gained attention due to the shortage of suitable soil and increasing problems of industrial waste management.

Key Word: Blast furnace slag, Back cotton soil, CBR, UCS, stabilization.

1. INTRODUCTION

In developing country like India due to the remarkable development in road infrastructure, Soil stabilization has become the major issue in construction activity. Stabilization is an unavoidable for the purpose of highway and runway construction, stabilization denotes improvement in both strength and durability which are related to performance. Stabilization is a method of processing available materials for the production of low-cost road design and construction, the emphasis is definitely placed upon the effective utilization of waste by products like blast furnace slag BFS, with a view to decreasing the construction cost.

The pavement directly rests on the artificially prepared soil sub grade and thus derives considerable strength from it. The adequate design and construction of embankments is therefore the key to the successful performance of the pavement. Soil stabilization may be defined as the alteration of the properties of an existing soil to meet specified engineering requirements. Soil stabilization is broadly utilized as a part of road development to enhance sub-bases and
sub-grades for rail, road and landing strip development, as landfill and waterway linings, for development of soil underneath establishment piece.

2. MATERIALS USED

2.1 Black Cotton Soil:
Infrastructure projects such as highways, railways, water reservoirs, reclamation etc require earth materials in very large quantity. In urban areas, burrow earth is not easily available which has to be hauled from a long distance. Very often, large areas are covered with highly plastic and expansive soil, which is not suitable for any construction activity. The present investigation aims at improving the geo-technical properties of Natural black cotton soil. The soil was excavated from a depth of 2.0 m from the natural ground level. The soil is dark grey to black in color with high clay content. The obtained soil was air dried and pulverized manually and soil passing through 425 μ IS sieved is used. This soil has a property of high moisture retentively and develops cracks in summer. This soil predominantly consists of expansive montmorillonite as the principal clay mineral. Sieve analysis, hydrometer analysis, and Atterberg’s limits is performed to classify the soil the index properties, Compaction characteristics and unconfined compressive strength test were carried out for both fine and coarse soil mixtures.

2.2 Blast Furnace Slag:
Ten million tons of blast furnace slag is produced in India annually as a by-product of Iron and Steel Industry. Blast furnace slag is composed of silicates and alumino silicates of lime and other bases. It is a latent hydraulic product which can be activated with anyone- lime, alkalies or Portland cement. GGBS which is obtained by quenching molten iron slag from a blast furnace has been used and it is then dried and ground into a fine powder.

3. METHODOLOGY

3.1 Compaction:- Compaction test is carried out by using Mini compaction test apparatus. In accordance with IS 2720 (part7)-1980. It has been published in the Geotechnical Testing Journal, (2004) (vol 28, no 3). The mould is having an internal diameter of 3.8 cms and external diameter of 4.61 cms. The mould has a detachable base plate and a removable collar of 3.5 cms height. The weight of the hammer is 25N. Number of blows is 36 per layer. The soil is compacted for 3 layers. About 250 grams soil is used for each trial. The soil is mixed with consistent quantity of water and is transferred on to the mould of diameter 3.8 cms and height of 10 cms in three layers, each layer is compacted by 36 blows. The remaining procedure is same as that of Light Compaction test as per IS 2720 (part 7) – 1980.

3.2 Soaked CBR:- California Bearing Ratio (CBR) test will performed on the soil sample as per the Bureau of Indian Standard (BIS)
specifications [23], in soaked condition. Then water corresponding to the optimum moisture content will added and compacted to its MDD. After compaction, a surcharge weight of 5 kg, sufficient to produce an intensity of load equal to the weight of base material and pavement will placed as per IS specifications during soaking and penetration. A metal penetration plunger of diameter 50 mm is used to penetrate the samples at a rate of 1.25 mm/min. The samples will soaked for 4 days and three CBR tests will conducted on each specimen and the average of the three will reported. The CBR tests will also conducted on GGBS-stabilized soil with and without lime after moist curing for 24 days and soaking them for 4 days.

3.3 Unconfined Compressive Strength:- Unconfined compressive strength (UCS) will performed on the soil sample as per BIS specifications [24]. Test specimens will prepared in a static compaction mould of length 76.2 mm and diameter 38.1 mm to MDD by adding moisture content corresponding to its OMC. The compacted samples will cured in desiccators at 100% humidity. Unconfined compressive strength tests will conduct for the BFS-stabilized expansive soil mixes by varying the BFS content from after curing them for one day and 28 days in desiccators at 100% humidity.

4. LITERATURE REVIEW

4.1 Gyanen Takhelmayum “The increase of the maximum dry unit weight with the increase of the percentage of Coarse GGBS is mainly due to the higher specific gravity of the GGBS compared with expansive soil and the immediate formation of cemented products by hydration which reduces the density of soil. It can also be observed that the optimum moisture content was decreased with further increase in GGBS content.”

4.2 K.V. Manjunath “In this study the black cotton soil was stabilized with lime and varying percentage of blast furnace slag, the soil engineering and index properties is enhance. Optimum moisture content decreased and maximum dry density increased due to the replacement of the Blast furnace slag when compared with native soil.”

4.3 Sreerama Rao “It is also observed that GGBS is exposed to water a Si-Al-O rich layer forms on the GGBS particle surfaces. This layer may absorb H+ from water, resulting in an increase in OH- concentration and then the pH of the solution also increases to values close to the pH of a saturated lime solution [27]. At these high values of pH, Si-0 and Al-O bonds are broken and then semi-crystalline C-A-S-H, crystalline calcium aluminate hydrate and C-A-S-H (Calcium aluminosilicate hydrate) are formed.
5. CONCLUSION

Soil stabilization using slag is found to be an effective means for enhancing the engineering performance of Black Cotton soil. Following are the observations while using ground granulated blast furnace slag as a stabilizer in black cotton soil -

1. The primary benefits of using these additives for soil stabilization are
   a. Cost Savings: because slag is typically cheaper than cement and lime; and
   b. Availability: because slag sources are easily available across the country from nearby steel plants.

2. Waste management one of the industrial waste can be done economically.

3. Use of slag as an admixture for improving engineering properties of the soils is an economical solution to use the locally available poor soil

4. Blast furnace slag was found to be very effective especially in California bearing ratio and unconfined compressive strength tests.

6. FUTURE SCOPE

- Use of slag as an admixture for improving engineering properties of the soils is an economical solution to use the locally available poor soil.
- With percentage increases of BFS specific gravity goes on increasing, thus making the soil denser.
- With the increases of BFS percentage, percentage finer goes on decreases, which strengthens the soil.
- With the increases of BFS percentage liquid limit, plastic limit and plasticity index decreases which makes the soil less plastic and hence plasticity index reduces. With the increases of BFS percentage compressive strength increases that means arrangement of soil particles are very closely, which reduces the voids.
- C B R value increases with increases in percentage of BFS that show the densification of soil takes place and more suitable for pavement thickness.

REFRENCE


