

Stabilization of Black Cotton Soil Using Fly Ash and Coconut Coir

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Abstract

Black cotton soil is fertile and very good for agriculture, but it is not so good for civil engineering works. Major source of power generation in India is the thermal power plants producing more than 150 million tons of fly ash annually as a by-product, due to combustion of the pulverized coal posing not only disposal problems but also serious health and environmental problems. To control these problems, the most commonly used method is addition of fly ash as a stabilizing agent usually used in combination with soil. In this study, fly ashes were used to investigate the effect of fly ash on the various potential of BC soil. Based on the favorable results, it was concluded that the fly ash could be successfully use as an effective additive in stabilization of problematic soils.

Keywords: *Fly-Ash, Coconut Coir, Liquid Limit, Plastic Limit, Free Swell, Shrinkage Limit, OMC, MDD, Nu-Soaked CBR, Soil Stabilization Expansive Soil*

I. INTRODUCTION

In India about 51.8 million hectares of the land area are covered with expansive soils (black cotton soil). The black cotton soils are very hard when dry, but lose its strength completely when in wet

condition. Expansive soils are a worldwide problem that poses several challenges for civil Engineers. Various methods are adapted to improve the engineering characteristics of expansive soils. The problematic soils are either removed and

replaced by good and better quality material or treated using additive. The stabilization of the problematic soils is very important for many of the geotechnical engineering applications such as pavement structures, roadways, building foundations, channel and reservoir linings, irrigation systems, water lines, and sewer lines to avoid damage due to settle of soft soil or to the swelling action of expansive soil. Generally, the stabilization concept can be dated 5000 years ago.

Treated earth roads were used in ancient Mesopotamia and Egypt, and that the Greek and Roman used soil-lime mixtures. The first experiments on soil stabilization were achieved in the USA with sand/clay mixtures around 1906. In the 20th century, especially in the thirties, the soil stabilization relevant to road construction was applied in Europe. The pavement soil qualities will be improved by thoroughly mixing

On combustion of pulverized coal, annually produces some millions tons of fly ash as a waste byproduct by thermal power stations and the disposal of this waste byproduct has become an important global concern. The coconut coir is an important commercial product obtained from husk of coconut. The main

advantages of using these two by products in improving the strength of sub grade are they are locally available and are very cheap. With the change in water content the black cotton soil experiences excessive variation in volume. Due to the shrinkage and swelling, the pavements constructed on the black cotton sub grade results in extensive cracks and large settlements.

In the present study experimental investigations like unconfined compression strength (U.C.S) and California bearing ratio (C.B.R) were carried out on the black cotton soil using different percentages of fly ash with 04% to 20% and Coconut Coir at 0.1% to 05% and find out the variation of strength of the sub grade.

Coal burning electric utilities annually produce million tons of fly ash as a waste by product and the environmentally acceptable disposal of this material has become an increasing concern. Efforts have always been made by the researchers to make pertinent use of fly ash in road constructions in the localities which exists in the vicinity of thermal power stations.

One of the most promising approaches in this area is use of fly ash as a replacement to the conventional weak earth material

and fiber as reinforcement will solve two problems with one effort i.e. elimination of solid waste problem on one hand and provision of a needed construction material on other. Also, this will help in achieving sustainable development of natural resources.

Fly ash is a lightweight material, as compared to commonly used filling material (local soils), therefore, causes lesser settlements. It is especially attractive for embankment construction over weak sub grade such as alluvial clay or silt where excessive weight could cause failure. Use of fly ash in road works results in reduction in construction cost by about 10 to 20 percent. Typically cost of borrow soil varies from about Rs.100 to 200 per cubic meter. Fly ash is available free of

cost at the power plant and hence only transportation cost, laying and rolling cost are there in case of fly ash. Hence, when fly ash is used as a fill material, the economy achieved is directly related to transportation cost of fly ash. **See Table: 1**

2. OBJECTIVES

- 1) To study the combined effects of fly ash and coconut coir on properties of black cotton soil
- 2) To find the optimum percentage of ash and coir combined as stabilizing agents
- 3) To find the increase in geotechnical properties after addition of ash and coir

Table 1 Properties and classification of black cotton soil (Expensive Soil)

Specific gravity	2.403
Maximum dry density(mg/cm ³)	1.506
Optimum moisture content (%)	15
Liquid limit (%)	42.907
Plastic limit (%)	44.950
Shrinkage limit	12.88
Free swell index	0.30
CBR	2.009&1.708

3. METHODOLOGY

In the present study, sieve analysis, plastic limit, liquid limit, shrinkage limit, optimum moisture content, maximum dry density, swell index test, specific gravity – tests were conducted on Black cotton soil (expensive soil) first by mixing with varying percentage of fly ash and coconut coir to stabilize the soil. Among these varying percentages of the black cotton soil get maximum bearing capacity and strength are known.

Table -2 Combination of materials and the tests:

Materials combination	Tests conducted for all combination
Black cotton soil + fly ash + coconut coir	Liquid limit, plastic limit, shrinkage limit, optimum moisture content, maximum dry density, swell index test, specific gravity.

4. RESULTS

In the present study, sieve analysis, plastic limit, liquid limit, shrinkage limit, optimum moisture content, maximum dry density, swell index test, specific gravity – tests were conducted on Black cotton soil (Expensive Soil). Black cotton soil

partially replaced with the fly ash and coconut coir with different proportions respectively. These test results are analyzed for most favorable combination of different ingredients for optimum strength of bearing capacity of soil. The test is carried on Black Cotton Soil base for various percentages. Fly ash is 04% to 20% and coconut coir is 01% to 05%.

For better understanding of the experiments the results are presented in the graphical form and where possible in tabular forms. After test result we saw adding the ingredients in black cotton soil. The soil is very less swelling and cracking -and also increases the bearing capacity of soil and shear strength.

5. GRAPHS

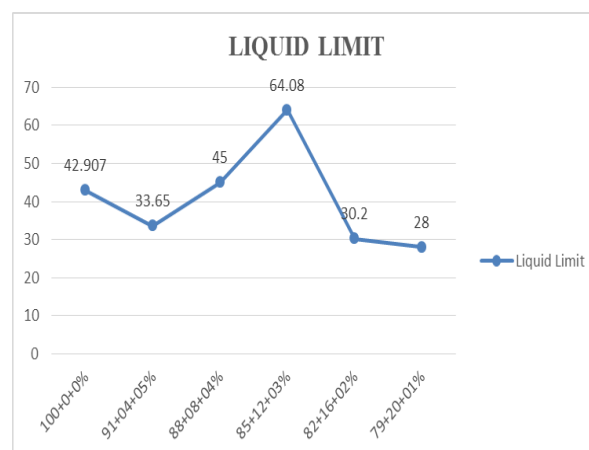


Figure 1 Liquid Limit Test

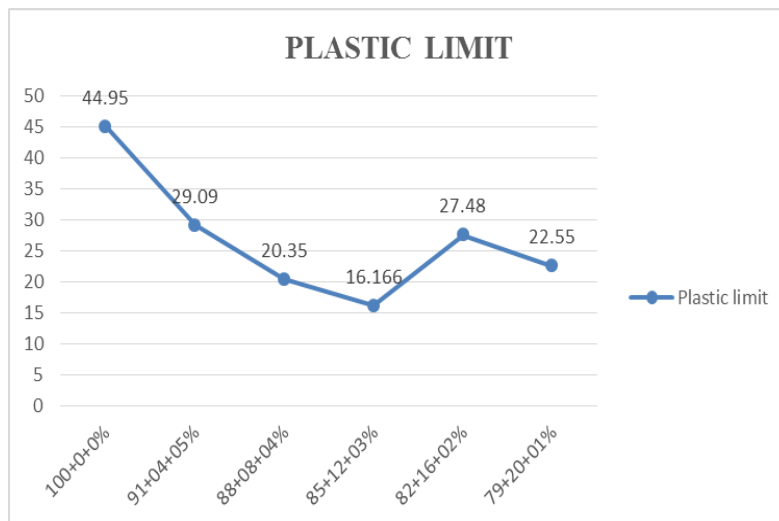


Figure 2 Plastic Limit Test

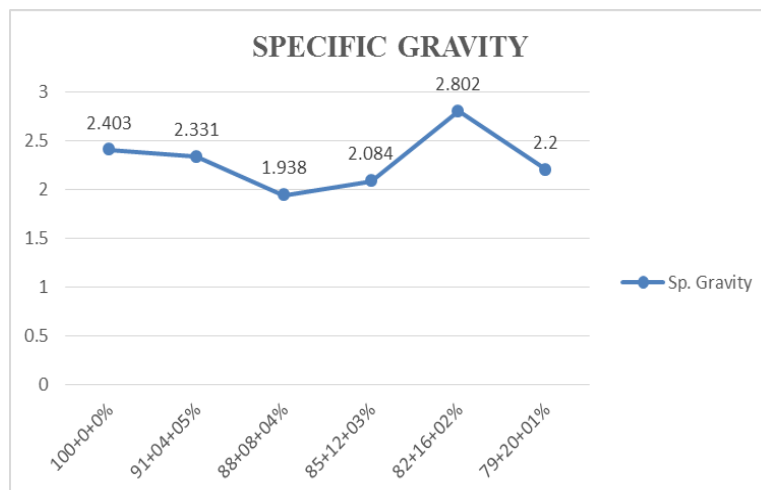


Figure 3 Specific Gravity Test

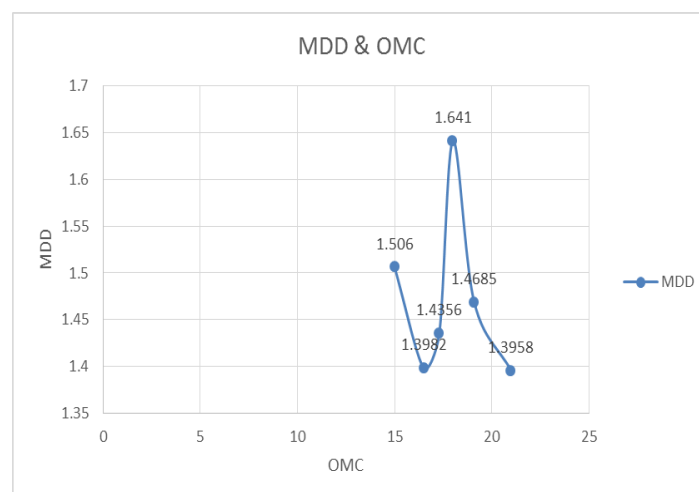


Figure 4 MDD & OMC Test

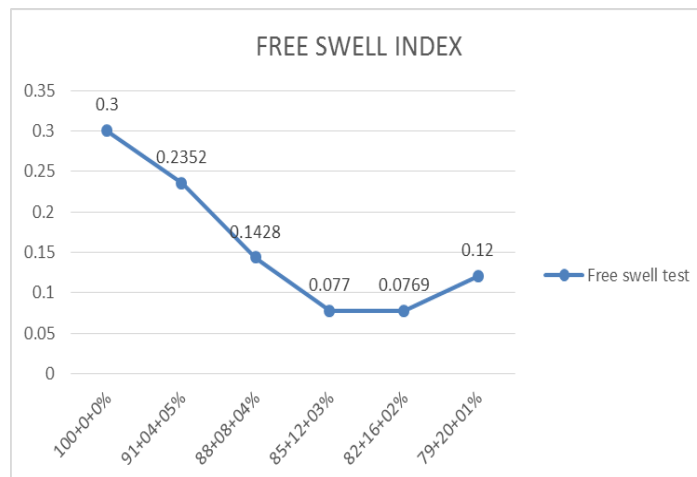


Figure 5 free swell index

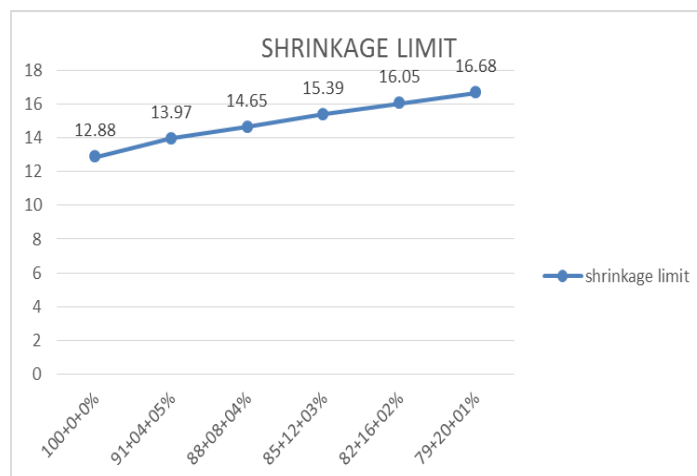


Figure 6 Shrinkage Limit

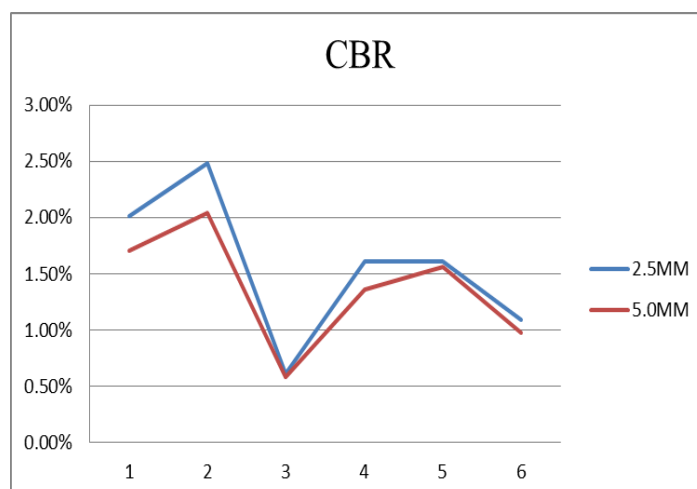


Figure 7 CBR Test

CONCLUSION

In the present research work, black cotton soil of Maharashtra, which is highly compressible in nature is mixed with the varying percentages of fly ash and coconut coir. Black cotton soil partially replaced with the fly ash and coconut coir with different proportions respectively. There test results are analyzed for most favorable combination of different ingredients for optimum strength of bearing capacity of soil. The test is carried on Black Cotton Soil base for various percentages. Fly ash is 04% to 20% and coconut coir is 01% to 05%.

This set of combinations shows that individual they are weak to produce good result but use in proportion increases the soil properties more than there individual performance.

7. FUTURE SCOPE

The research on reinforced soils demonstrated that this material might be a practical and cost effective technique for reinforcement of sub grade soils in flexible pavements In comparison with systematically reinforced soils Principle of soil stabilization is the process with admixtures is covered. As the work of this project we use the black cotton soil for the purpose of road construction.

It is required when soil available for construction is not suitable for the intended purpose. In the broad sense, stabilization includes compaction, pre-consolidation, drainage and many other such processes. Stabilization is the process of blending and mixing materials with a soil to improve certain properties of the soil and because of that the soil is comes in earthen dam construction.

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