



# AN INVESTIGATION ON STRENGTHENING PROPERTIES OF BLACK COTTON SOIL STABILIZED WITH FLY ASH AND GEO REINFORCEMENT

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## Abstract

Bricks like-wise have been viewed as one of the durable and most grounded constructing material utilized all through history. Customary building pieces are made of a blend of mud, which is subjected to different procedures, diverse as indicated by the idea of the material, in the wake of being legitimately arranged the earth is structure in molds to the coveted shape, at that point dried and consumed. The giving reasonable lodging is a test far and wide, particularly in creating nations. The obstacles to taking care of the lodging issue are shortage of land and high cost of building materials. Furthermore,, such materials must be abundantly accessible and inexhaustible in nature. Neighborhood soil has dependably been the most broadly utilized material for earthen development. The primary target of this examination had been centered on the change of the compressive quality of the dark cotton soil hinders with various substance of lime by fortifying the geo-network. The rectangular (200mm × 100mm × 100mm) pieces are set up with soil treated with 5%, 10% and 15% lime with the geo-network support at the center profundity of the obstructs, the compressive quality of the blocks is acquired by

*research facility pressure test contraption the outcomes got are contrasted and unreinforced tests.*

**Keywords:** Black Cotton Soil, Lime, Geo-lattice, Compressive strength, Rectangular blocks.

## 1.0 introduction:

Soil has been used as a construction material from time immortal. Being poor in mechanical properties, it has been putting challenges to civil engineers to improve its properties depending upon the requirement which varies from site to site. The roads laid on BC soil bases develop undulations at the road surface due to loss of strength of the sub grade through softening during monsoon. Soaked laboratory CBR values of Black Cotton soils are generally found in the range of 2 to 4%. Due to very low CBR values on sub grade BC soil, excessive pavement thickness is required for designing for flexible pavement. Research & Development (R&D) efforts have been made for a long time to improve the strength characteristics of BC soil with new technologies During last 25 years, much work has been done on strength deformation

behavior of fly ash and fiber reinforced soil and it has been established beyond doubt that addition of fiber and fly ash in soil improves the overall engineering performance of soil

### Soil Stabilization:

Soil is one of nature's most abundant construction materials. Almost all construction is built with or upon soil. When unsuitable construction conditions are encountered, a contractor has four options:

- (1) Find a new construction site
- (2) Redesign the structure so it can be constructed on the poor soil
- (3) Remove the poor soil and replace it with good soil
- (4) Improve the engineering properties of the site soils

In general, Options 1 and 2 tend to be impractical today, while in the past, Option 3 has been the most commonly used method. However, due to improvement in technology coupled with increased transportation costs, Option 4 is being used more often today and is expected to dramatically increase in the future. Improving an on-site (in situ) soil's engineering properties is referred to as either soil modification or soil stabilization. The term modification implies a minor change in the properties of a soil, while stabilization means that the engineering properties of the soil have been changed enough to allow field construction to take place. Nearly every road construction project will utilize one or both of these stabilization techniques.

The most common form of mechanical soil stabilization is compaction of the soil,

### Chemical Soil Stabilization:-

One method of improving the engineering properties of soil is by adding chemicals or other materials to improve the existing soil. Additives can be mechanical, meaning that upon addition to the parent soil their own load-bearing properties bolster the engineering characteristics of the parent soil. Additives can also be chemical, meaning that the additive reacts with or changes the chemical properties of the soil, thereby upgrading its engineering properties. Placing the wrong kind or wrong amount of additive – or, improperly incorporating the additive into the soil – can have devastating results on the success of the project. So, in order to properly implement this technique, an engineer must have:

- A clear idea of the desired result
- An understanding of the type(s) of soil and their characteristics on site
- An understanding of the use of the additive(s), how they react with the soil type and other additives, and how they interact with the surrounding environment.



**Fig 1: Addition of chemical to the soil****LITERATURE REVIEW:**

**Pallavi1, Pradeep Tiwari2, Dr P D Poorey(2016)** In this experimental study was conducted on locally available soil stabilized with Jute fiber. In this study the soil samples were prepared at its MDD corresponding to its OMC in the CBR mould with and without reinforcement. The percentage of Jute fiber by dry weight of soil was carried as 0.25%, 0.5%, 0.75% and 1%. In the present investigation the lengths of fiber was carried as 30 mm, 60 mm and 90 mm and two various diameters, 1 mm and 2 mm were considered for each fiber length. Tests result shows that CBR value of soil increases with the increase in fiber content. It was also observed that increasing the length and diameter of fiber further increases the CBR value of reinforced soil and this increase is substantial at fiber content of 1 % for 90 mm fiber length having diameter 2 mm. Thus there is significant increase in CBR value of soil reinforced with Jute fiber and increase in CBR value will substantially reduce the thickness of pavement subgrade.

**S.W.Thakare, Priti Chauhan(2016)** Studied soil reinforcement with jute geotextile layers. The Jute Geotextile layers are arranged within the soil sample in different combination such as 1 layer, 2 layers, 3 layers, 4 layers etc. and laboratory CBR values were determined in both soaked and unsoaked conditions corresponding to each combination of reinforcing layer. Further, these test results were compared with that of unreinforced soil. It was

observed that inclusion of Jute Geotextile layer increases the CBR value of soil and this increase is maximum corresponding to 4 layers of Jute Geotextile layers. Hence there is a significant increase in CBR value of soil due to inclusion of Jute Geotextile layers as reinforcement.

**SujitKawade MahendraMapari (2014)** In this study disposal of an industrial waste like fly ash formed from burning of coals in thermal power stations requires a large land area. The decreasing availability of good construction site has led to the increased use of low lying areas filled up with industrial wastes whose bearing capacity is low. In-situ treatment of such industrial waste fills; in order to improve their bearing capacity with reinforcements is a good replacement to other conventional methods of stabilization. In comparison with systematically reinforced soil, randomly distributed discrete fibre reinforced soil mimics soil stabilization by admixture and exhibits some advantages.

**3.0 METHODOLOGY:**

This paper presents laboratory tests to evaluate the effect of addition of fly ash on the geotechnical behavior of the expansive soil in terms of grain size distribution, Waterberg limits, specific gravity, compaction characteristics, free swell, swell potential, swelling pressure, axial shrinkage percent, and unconfined compressive strength as per IS code.

**Test techniques and sample preparation:**

The individual morphology and particle chemistry were studied by SEM and XRD

analysis. The index and geo-engineering properties of fly ash-clay mixture have been evaluated in this work. The granulometry was studied for the different mixes by hydrometer analysis. Specimens for swelling pressure were prepared using standard proctor compaction effort of 592.8 kJ/m<sup>3</sup> with optimum water content and maximum dry weight. With a diameter of 100mm and height 25mm. Specimens for the unconfined compressive strength test of 50mm diameter and 100mm height were prepared under the optimum water content and dry density corresponding to 95% of maximum dry unit weight of soil.

**Table 1: Chemical composition of fly ash**

Constituents	percentage
MgO	0.57
Al <sub>2</sub> O <sub>3</sub>	24.12
SiO <sub>2</sub>	52.55
K <sub>2</sub> O	0.965
P <sub>2</sub> O <sub>5</sub>	0.72

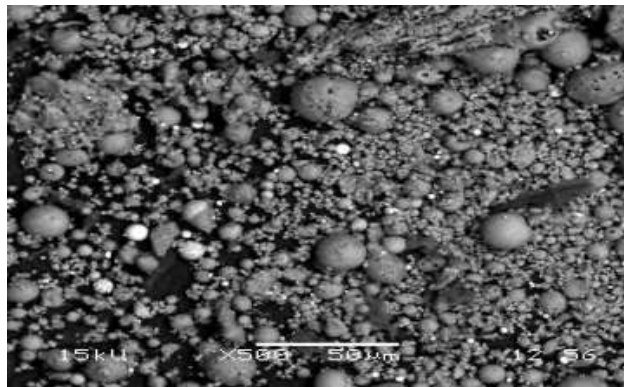


Figure : Particle arrangement (SEM) at 500M: Fly ash

### Black Cotton Soil

The soil used in this project is a Black Cotton Soil collected from Kolhewadigaon

in Pune, Maharashtra State in India. Kolhewadi is located at Latitude 18° 26' 24.29" N and Longitude 73° 47' 10.84" E.

The black cotton soil was collected by method of disturbed sampling after removing the top soil at 150mm depth and transported in sacks to the laboratory. Little amount of the sample was sealed in polythene bag for determining its natural moisture content. The soil was air dried and sieved with IS sieve 4.75mm as required for laboratory test.

**Lime** :In this project various percentage of lime (i.e. 5%, 10%, and 15%) is used as admixture.

### Geo-grid:

Geo-grid used in this project is Biaxial Geo-grid shown in figure I and the physical properties of geo-grid are given in table I. The geo-grid reinforcement of size 180mm×90mm is placed at the middle of the rectangular block i.e. at height of 50mm from bottom. Its price ranges between Rs 80/- to Rs 200/- per sq.m. It is not till being manufactured in India.

**TABLE I GEOTECHNICAL PROPERTIES OF THE UNTREATED BLACK COTTON SOIL**

Specific gravity	2.37
Liquid limit	66.1%
Plastic Limit	36.74%
Plasticity Index	29.36%
Unified Soil Classification System (USCS)	CH
Maximum Dry Density (MDD)	1.2726 kg/m <sup>3</sup>
Optimum Moisture Content (OMC)	34.6%



Natural Moisture Content	17.399%
Color	Dark black

Atterberg Limits:

Liquid limit = 66.1% Plastic limit = 36.74%  
 Plasticity index = 29.36% Plasticity of black cotton soil was found 29.36%. So according to unified soil classification system (USCS) clay is classified as inorganic clays of high compressibility (CH)

**Material Used:**

The different materials used in the present investigation are described as follows: 1. Soil:- Soil is an accumulation or deposit of earth material, derived naturally from the disintegration of rocks or decay of vegetation that can be excavated readily with power equipment in the field or disintegrated by gentle mechanical means in the laboratory. The supporting soil beneath pavement and its special under courses is called sub grade. Undisturbed soil beneath the pavement is called natural sub grade. Compacted sub grade is the soil compacted by controlled movement of heavy compactors. The desirable properties of sub grade soil as a highway material are

- Stability • Incompressibility
- Permanency of strength
- Minimum changes in volume and stability under adverse conditions of weather and ground water
- Good drainage, and

• Ease of compaction The soil used in this investigation is an expansive clay, one type of most problematic soil for sub grade constructions is used in this research work which is locally available Black Cotton Soil collected .

**4.0 RESULTS:**

In the present study, Specific Gravity Test, Consistency Indices (Liquid Limit (LL), Plastic Limit (PL), and Plasticity Index (PI)), Modified Proctor's Test, and California Bearing Ratio (CBR) Tests were conducted on the Black Cotton Soil (Highly Clayey Soil) first by mixing with varying percentage of fly ash to stabilize the soil and then the varying percent of fly ash at which the maximum CBR is gained is selected for the next step of the experiment. The optimum percentage of fly ash at which maximum CBR is achieved is then selected and gets reinforced with varying percentage of synthetic Nylon fiber. Among these varying percentages of the reinforcement the optimum quantity of fiber required to get maximum strength is known. After that the depth of reinforcement is varied on premix fly ash and Black cotton soil mix and the changes in engineering properties are determined. For better understanding of the experiment the results are presented in the graphical form and where possible in tabular forms.

Table Combined results for Clayey Soil (B.C. Soil) and B.C. Soil with varying Percentages of fly ash

Properties	B.C. Soil	10% fly ash+ B.C. Soil	20% Fly ash+ B.C. Soil	30% fly ash+ B.C. Soil	40% fly ash+ B.C. Soil
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Specific Gravity 2	2.55	2.48	2.42	2.33	2.22
MDD (gm/cc)	1.57	1.83	1.90	1.86	1.85
O.M.C. (%)	18.20	16.70	17.38	17.52	17.93
Liquid Limit(%)	71.20	54.30	49.40	48.50	48.50
Plastic Limit(%) 3	30.50	28.20	28.20	28.20	22.50
Plasticity Index (%)	40.70	26.30	23.40	24.80	23.50
CBR % Soaked 1	1.71	4.50	4.95	3.55	3.38

It is cleared that with the gradual addition of fly ash in soil the properties of the soil is regularly changing and the change is high up to 20 percent addition of fly ash and after that the change is not so remarkable and starts reducing. The change in Plasticity index of value is regularly noted with the fly ash addition and PI value reduced up to 21.90 % at 40 percent fly ash mix. The maximum value of CBR achieved with varying percentages of fly ash is at 20 percent addition of fly ash is 4.95, which is 2.89 times more than the initial CBR of the Black Cotton Soil. That percentage of 20 % fly ash is taken for the next step of the experiment at which these samples undergoes tests with varying concentration of nylon fiber at different aspect ratio.

#### CONCLUSION:

The results of tests conducted on rectangular BC soil blocks (200mm×100mm×100mm), reinforced and unreinforced with geo-grid are presented in chapter 4. Based on the results, following conclusions were drawn. With increase in addition of lime content the compressive strength of BC soil blocks

increases. The soil is classified under CH. Liquid limit and Plastic limit values are 66.1 % and 36.74% respectively suggest that the soil is highly compressible. Thus, from the results obtained, the soil falls below the standard recommended for most geotechnical work. Lime and geo-grid is used as reinforcement for improving the geotechnical characteristics of black cotton soils. Lime significantly improves strength characteristics of black cotton soil under study and the effect of lime vary depending upon the quantity of lime that is mixed with the black cotton soil sample. The compressive strength of these soils increases upon the addition of lime. The trend of improvement in the compressive strength is observed to be more pronounced with the curing of the soil and lime mix.

#### References:

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