

# Stabilization of Black Cotton Soil for Pavement Using Fly Ash and Lime

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**Abstract** - The term soil stabilization means improvement of the stability or bearing power of the soil by the use of controlled proportioning, compaction and the addition of suitable admixture or stabilizers. Soil stabilization deals with physical, physio-chemical and chemical methods to ensure that the stabilized soil services its intended purpose as pavement component material. In this paper we deal the stabilization of soil with the help of fly ash and lime. These admixtures are mixed in different proportions with the soil sample and tests are performed for the results.

**Index Terms** - Soil stabilization, Fly ash, Lime, Black cotton soil, Pavement.

## I. INTRODUCTION

The basic principles of soil stabilization include evaluating the properties of given soil and assessing the deficient property due to which the soil is considered weak. It also decides the appropriate method of supplementing the deficient property by the economical and effective methods of stabilization. Due to lack of availability of suitable soil for the construction purposes, the soil available is stabilized by different methods such as mechanical and chemical stabilization. In this study we made an attempt to improve the different properties of bc soil such as bearing capacity, cbr ratio, atterberg limits by carrying laboratory investigations with the mixing of fly ash and lime in different proportions. The test performed in this study are carried out in a proportion of mix of soil with 25% fly ash and some proportions of lime.

## II. OBJECTIVES

To determine the optimum content of fly ash and lime by conducting liquid limit test, plastic limit test and plasticity index.

- To determine the optimum moisture content and maximum dry density by conducting the proctor compaction test.
- To determine the CBR value of BC soil mixed with different percentages of lime and fly ash.

## III. ENGINEERING PROPERTIES OF SOIL

1. **Permeability:** It is defined as the property of the soil which allows the passage or seepage of water through its interconnecting voids.
2. **Plasticity:** It is defined as the property of soil which allows it to deform rapidly without any volume change and without elastic rebound.
3. **Compaction:** It is a artificial process by which soil particles are rearranged and packed together into a closer state of contact by mechanical means to increase its dry density and decrease its porosity.
4. **Compressibility:** The property of the soil to reduce in volume under pressure is called compressibility.
5. **Shear Resistance:** It is the resistance to deformation by continuous shear displacement of soil particles.

## IV. EXPERIMENTAL INVESTIGATIONS:

1. **Grain size distribution:** The sample of soil is taken and oven dried. A set of sieve of sizes 4.75mm, 2.36mm, 1mm, 600 $\mu$ , 425 $\mu$ , 300 $\mu$ , 212 $\mu$ , 150 $\mu$ , 75 $\mu$  is taken. The sample is sieved through this set and the results are obtained.
2. **Determination of specific gravity of soil:** With the help of instrument known as pycnometer the test is performed and the results are obtained.
3. **Determination of specific gravity of fly ash:** Pycnometer ; which is used to perform test for specific gravity is used and the results are calculated.
4. **Determination of liquid limit of soil:** Moisture content of the soil which is expressed by the percentage of weight of oven dried soil in between plastic and liquid states of consistency.

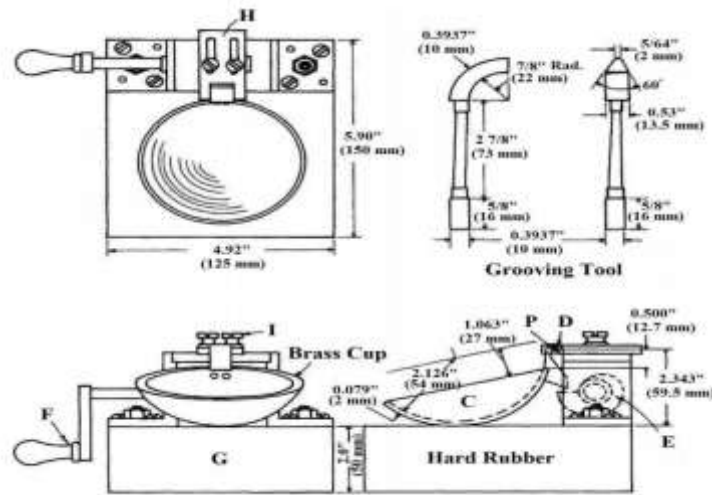


Fig. Liquid limit test

- Determination of plastic limit of soil:** Moisture content of the soil which is expressed by the percentage of weight of oven dried soil in between plastic and semi solid states of consistency.

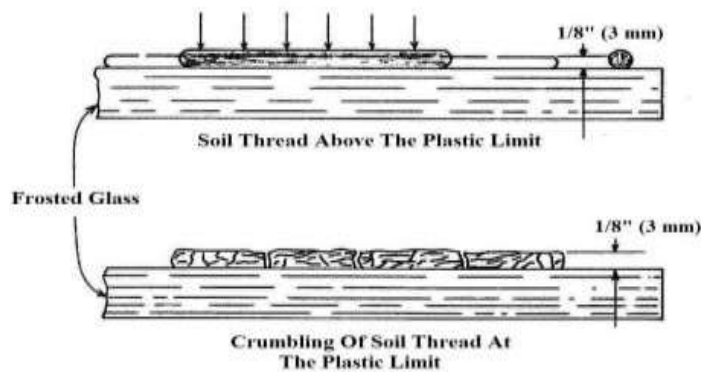


Fig. plastic limit test

- Plasticity index :** Plasticity index of soil is the difference between its moisture content of liquid limit and plastic limit.

$$\text{Plasticity Index} = \text{Liquid Limit} - \text{Plastic Limit}$$

$$PI = LL - PL$$

- CBR test:** California bearing ratio is the ratio of force per unit area required to penetrate in to a soil mass with a circular plunger of 50mm diameter at the rate of 1.25mm/min. The test is performed with the mix of soil with 25% fly ash and different proportions of lime.

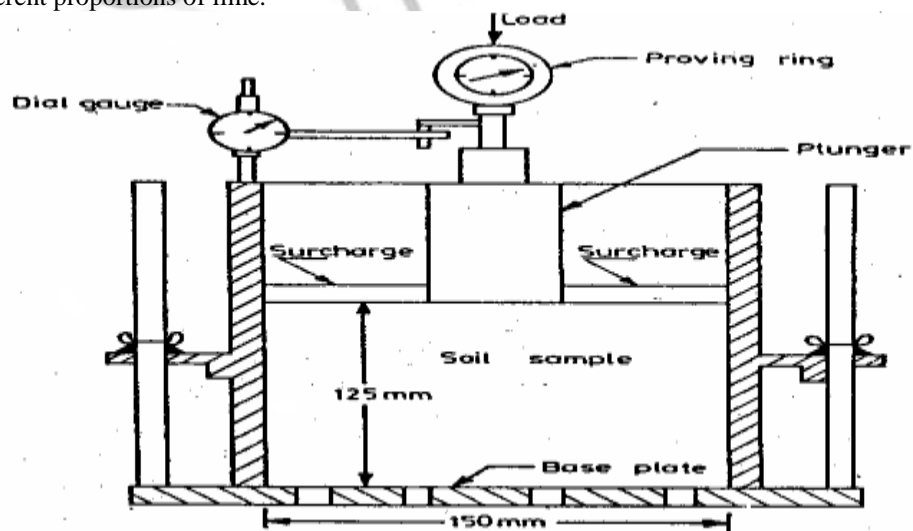


Fig. CBR test

V. RESULTS:

- Grain size:

Percentage of gravel = 1.576%  
 Percentage of sand = 10.766%  
 Percentage of silt and clay = 87.6%.

## 2. Specific gravity of soil:

Sl. No	Particulars	Wt. in gm
01	Mass of pycnometer ( $M_1$ ) gm	652
02	Mass of pycnometer + soil ( $M_2$ )gm	908
03	Mass of pycnometer + soil + water ( $M_3$ )gm	1630
04	Mass of pycnometer + water ( $M_4$ )gm	1470
05	Specific gravity G	2.67

## 3. Specific gravity of fly ash:

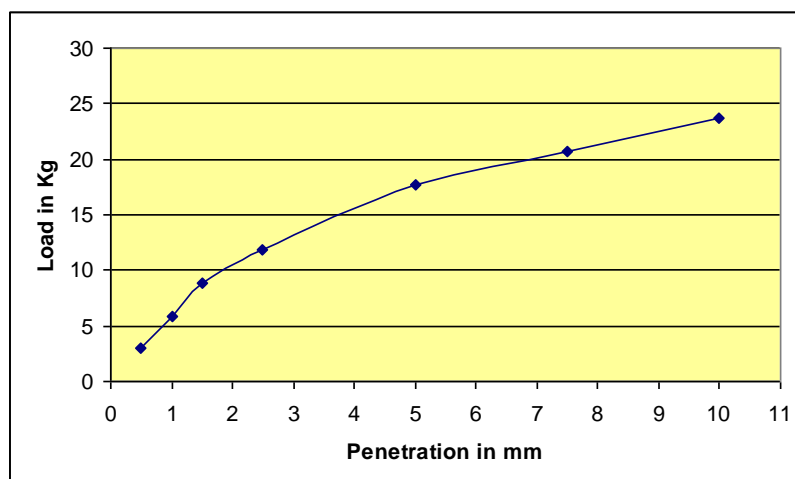
Sl. No	Particulars	Wt in gm
01	Mass of pycnometer ( $M_1$ ) gm	26
02	Mass of pycnometer + flyash ( $M_2$ )gm	38
03	Mass of pycnometer + flyash+ kerosene ( $M_3$ )gm	76
04	Mass of pycnometer + kerosene ( $M_4$ )gm	68
05	Specific gravity G	0.807
06	Specific gravity of flyash	2.42

## 4. Liquid limit, Plastic limit, Plasticity index of soil:

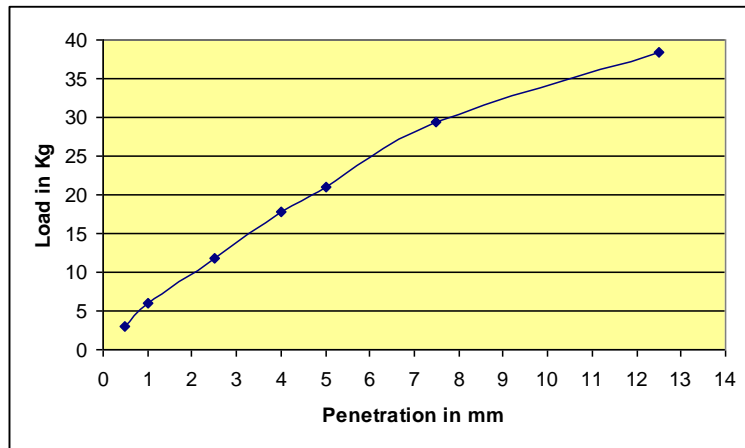
Sample	Liquid limit	Plastic limit	Plasticity index
Plain soil	77.5	40.86	36.64
Soil + 25% flyash	67.5	48.92	18.58
Soil + 25% + 2% (flyash + lime)	66	46.63	19.37
Soil + 25% + 3% (flyash + lime)	62.28	48.54	13.74
Soil + 25% + 4% (flyash + lime)	60	49.07	10.93

## 5. CBR test:

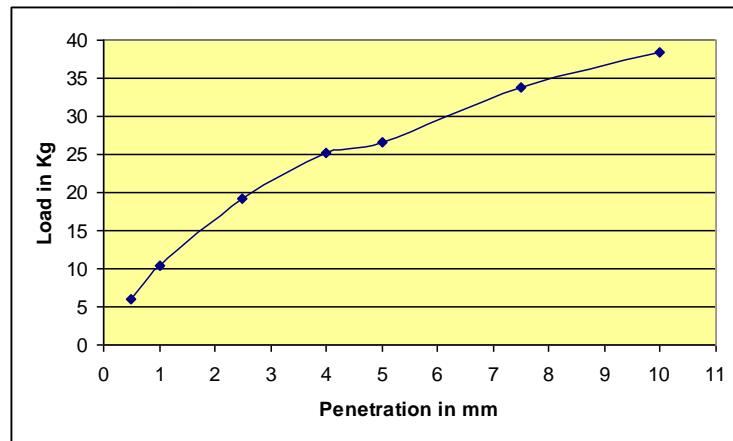
Particulars	CBR value
Plain soil	0.86
Soil + 25% flyash	1.02
Soil + 25% flyash + 2 % lime	1.405
Soil + 25 % flyash + 3 % lime	1.75
Soil + 25 % flyash + 4 % lime	1.93



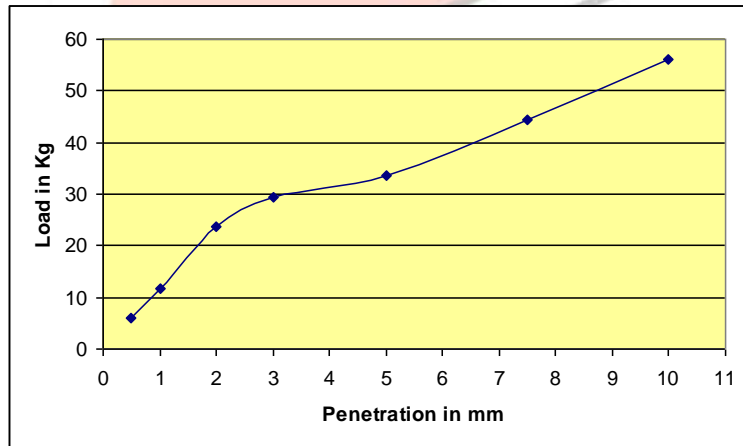
**Fig. CBR test for plain soil**



**Fig. CBR test for plain soil + 25% flyash**



**Fig. CBR test for plain soil +25% flyash + 2% lime**



**Fig. CBR test for plain soil +25% flyash + 3% lime**

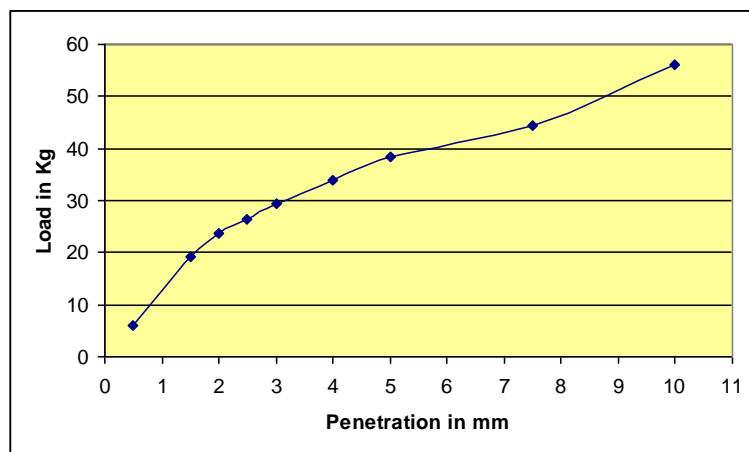


Fig. CBR test for plain soil +25% flyash + 4% lime

## VI. CONCLUSION

- Liquid limit, plastic limit and plasticity index for plain soil are 77.5%, 40.8% and 36.7% respectively with addition of 25% fly ash of BC soil. The above values are 67.5%, 48.92% and 18.56% respectively. This clearly indicates that the addition of fly ash reduces the plasticity characteristics of BC soil and makes the soil non plastic.
- It reveals that by addition of 25% fly ash with 2% of lime the liquid limit and plasticity index reduced by 14.83% and 47.22% respectively whereas increase in plastic limit by 14.28%.
- By addition of 25% fly ash with 3% lime the liquid limit and plasticity index reduced by 19.63% and 62.56% where as increase in plastic limit by 18.97%.
- By addition of 25% of fly ash with 4% lime the liquid limit and plasticity index reduced by 22.58% and 70.21% where as increase in plastic limit by 20.26%.
- There is increase in CBR value with normal 4 days soaking is 55.44% more than the plain soil

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