

# “Assessment of Use of Lime in Expansive Soil Subgrade for Sangli – Kolhapur Highway”

Mr. Gunjagi D.A.<sup>1</sup>, Mr. Kore S. B.<sup>2</sup>, Mr. Lole A. A.<sup>3</sup>, Mr. Kadam S. R.<sup>4</sup>

Assistant Professor, Department of Civil Engineering, Sanjay Ghodawat Group of Institutions,  
Sangli-Kolhapur Highway, Kolhapur, India

## ABSTRACT

Black cotton soil is one of the major soil deposits of India. They exhibit high swelling and shrinking when exposed to changes in moisture content and hence have been found to be most troublesome from engineering considerations. Stabilization occurs when lime is added to black cotton soil and a pozzolanic reaction takes place. The hydrated lime reacts with the clay particles and permanently transforms them into a strong cementitious matrix. Black cotton soil showing low to medium swelling potential from collage campos Maharashtra was used for determining the basic properties of the soil. Changes in various soil properties such as Liquid limit, Plastic Limit, Maximum Dry Density, Optimum Moisture Content, Differential Free Swell, Swelling Pressure and California Bearing Ratio were studied

## INTRODUCTION

The seasonal moisture variations in expansive soil deposits around and beneath the structures lead to their subsequent upward and downward movements resulting into damages of varying degrees. Civil engineering structures such as highways, canals, and embankments occupy vast areas of land as they often stretch over several kilometers.

Among various methods for the solutions to the problems posed by expansive soils, especially for large area coverage, the stabilization of such soils would be a natural choice. Stabilization of expansive soils using lime is widely adopted by practicing engineers the world over. The pozzolanic property of fly ash makes it a potentially useful material especially in the civil engineering industry. Thus, there is a growing awareness among civil engineers to explore the possibility of beneficial utilization of this industrial waste material, which is available almost free of cost in India.

Urbanization and growth in the economy of cities of India have led to the steep increase in the building construction activities and has necessitated the implementation of infrastructure projects such as highways, railways, air strips, water tanks, reclamation etc. As we know the development of the Nation is depends upon their infrastructure and road

constructions. Proper highway networks contribute to give the boost to the Economic development of country. Wide range of soil types available as highway construction materials. Roads running in black cotton soils are known for bad condition and unpredictable behavior for which the nature of the soil contributes to some extent.

The properties of the black cotton soils may be altered in many ways viz. mechanical, thermal, chemical and other means.

## CHARACTERISTICS OF BLACK COTTON SOIL

Black Cotton soils are inorganic clays of medium to high compressibility and form a major soil group in India. Black Cotton soil has a high percentage of clay, which is predominantly montmorillonite in structure and black or blackish grey in color. Because of its high swelling and shrinkage characteristics, the Black Cotton soil has been a challenge to geotechnical and highway engineers. The soil is very hard when dry, but loses its strength completely when in wet condition (Balasubramaniam, et. al, 1989). The wetting and drying process causes vertical movement in the soil mass which leads to failure of a pavement, in the form of settlement, heavy depression, cracking and unevenness. It also forms clods which cannot be easily pulverized as treatment for its use in road construction (Holtz & Gibbs, 1956). This poses serious problems as regards to subsequent performance of the road. Moreover, the softened sub grade has a tendency to heave into the upper layers of the pavement, especially when the sub-base consists of stone soling with lot of voids. Gradual intrusion of wet Black Cotton soil invariably leads to failure of the road. However, since this soil is available easily at low cost, it is frequently used for construction purposes (Bell, 1988). Some of the factors which influence the behaviour of these expansive soils are initial moisture content, initial dry density, amount and type of clay, Atterberg limits of the soil, and swell potential.

## LIME STABILIZATION:

Lime in the form of quicklime (calcium oxide – CaO), hydrated lime (calcium hydroxide – Ca[OH]<sub>2</sub>), or lime slurry can be used to treat soils. Quicklime is manufactured by chemically transforming calcium carbonate (limestone – CaCO<sub>3</sub>) into calcium oxide. Hydrated lime is created when quicklime chemically reacts with water. It is hydrated lime that reacts with clay particles and permanently transforms them into a strong cementitious matrix. Most lime used for soil treatment is “high calcium” lime, which contains no more than 5 percent magnesium oxide or hydroxide. On some occasions, however, “dolomitic” lime is used. Dolomite lime contains 35 to 46 percent magnesium oxide or hydroxide. Dolomite lime can perform well in soil stabilization

The use of lime for stabilizing plastic montmorillonitic clays has been increasing in favor during the last few decades because it lowers volume change characteristics. Generally the amount of lime required to stabilize expansive soils ranges from 2 to 10% by weight. The addition of lime to clay soil provides an abundance of calcium ions (Ca<sup>2+</sup>) and magnesium ions (Mg<sup>2+</sup>). These ions tend to displace other common cations such as sodium (Na<sup>+</sup>) and potassium (K<sup>+</sup>), in a process known as cation exchange. Replacement of sodium and potassium ions with calcium significantly reduces the plasticity index of the clay.

## OBJECTIVE OF PROPOSED WORK:

In present experimental program the performance of Black Cotton Soil with Lime for the improvement in strength. The experimental program is planned to study the following objectives.

1. To study physical properties of Black Cotton Soil with varying percentage of lime from 0 to 10 %.
2. To study the behavior of strength gain in BC soil using process of lime stabilization. Finding out optimize proportion of lime to achieve maximum strength.

## CALIFORNIA BEARING RATIO TEST (IS: 2720 (PART 16) 1979 )

California Bearing Ratio (CBR) test was developed by the California Division of Highway as a method of classifying and evaluating soil-sub grade and base course materials for flexible pavements. CBR test, an empirical test, has been used to determine the material properties for pavement design. Empirical tests measure the strength of the material and are not

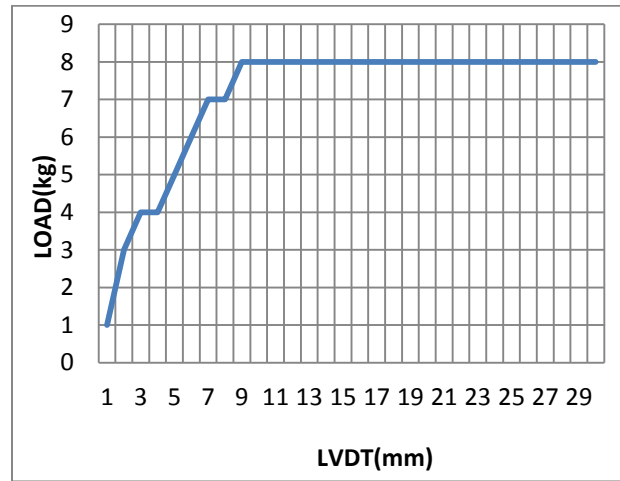
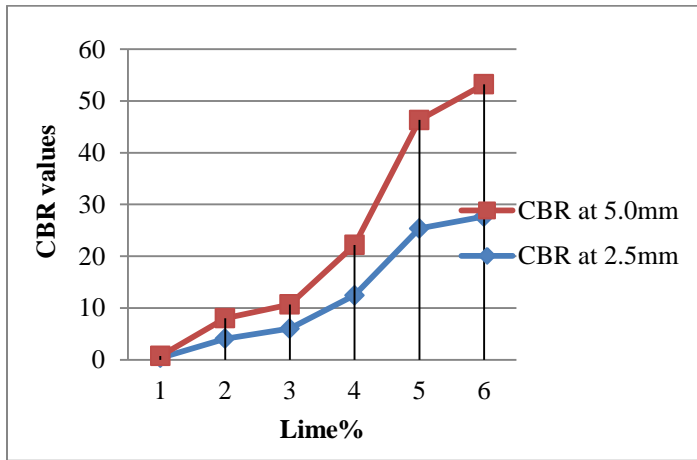
a true representation of the resilient modulus. It is a penetration test wherein a standard piston, having an area of 50 mm diameter, is used to penetrate the soil at a standard rate of 1.25 mm/minute. The pressure up to a penetration of 12.5 mm and it's ratio to the bearing value of a standard crushed rock is termed as the CBR.

In most cases, CBR decreases as the penetration increases. The ratio at 2.5 mm penetration is used as the CBR. In some case, the ratio at 5 mm may be greater than that at 2.5 mm. If this occurs, the ratio at 5 mm should be used. The CBR is a measure of resistance of a material to penetration of standard plunger under controlled density and moisture conditions. The test procedure should be strictly adhered if high degree of reproducibility is desired. The CBR test may be conducted in re-molded or undisturbed specimen in the laboratory. The test is simple and has been extensively investigated for field correlations of flexible pavement thickness requirement.

$$CBR = \frac{\text{load carries by specimen}}{\text{load carries by saturated specimen}} \times 100$$

## CBR Value v/s percentage of lime

Lime %	CBR at 2.5mm	CBR at 5.0mm
0%	0.36	0.38
2%	4.07	3.97
4%	6.03	4.65
6%	12.44	9.74
8%	25.39	20.95
10%	27.65	25.59



### Sample California Bearing Ratio for M00

Δ	P	Δ	P	Δ	P
0.5	1	5.5	8	10.5	8
1	3	6	8	11	8
1.5	4	6.5	8	11.5	8
2	4	7	8	12	8
2.5	5	7.5	8	12.5	8
3	6	8	8	13	8
3.5	7	8.5	8	13.5	8
4	7	9	8	14	8
4.5	8	9.5	8	14.5	8
5	8	10	8	15	8

### CONCLUSION

From the literature it appears that a number of stabilizers are available like lime, cement, lime and cement combinations etc. Through this experimentation it is concluded that the lime is good stabilizing compound. The main engineering properties of the black cotton soil can be improved by using lime. The following conclusions can be derived from the present investigation:

- Lime is beneficial in combination with OMC in improving properties of soil. With the increase in the percentage of lime, strength tends to increase and reaches a certain maximum value and thereafter it starts decreasing.
- Utilization of lime in this manner has the advantage of reusing an industrial waste by-product without adversely affecting the environment or potential land use.
- The results show a considerable decrease in the liquid limit. Decrease in Liquid limit means there is decrease in permeability & increase in dry strength of black cotton soil.
- With the increase in lime content, the maximum dry density of soil-lime mixes decreases and optimum moisture content increases. The fall in density is more significant at lower percentages of lime.
- The CBR value of the soil increases with the addition of lime
- The optimum value of lime content in soil mixtures may be taken as 10%.

### REFERENCES

- Prof. N. R. Patil, Prof. Mrs. D. R. Kulkarni & Prof. S. D. Talegaonkar, ***“Economical Pavement Design by Stabilizing Effect of Fly Ash and Lime”***Paripex - Indian Journal Of Research. Volume : 2 | Issue : 3 March 2013
- Gyanen. Takhelmayum, Savitha.A.L, Krishna Gudi, ***“Laboratory Study on Soil Stabilization Using Fly ash Mixtures”***International Journal of Engineering Science and Innovative Technology (IJESIT) Volume 2, Issue 1, January 2013
- Udayashankar D.Hakari, S.C.Puranik, ***“Stabilization of Black Cotton Soils Using Fly Ash”***Global Journal of researches in engineering Civil And Structural engineering Volume 12 Issue 2 Version 1.0 February 2012.
- Saeid. Amiralian, Amin. Chegenizadeh, and Hamid. Nikraz, ***“A Review on The Lime and Fly ash Application in Soil Stabilization”***International Journal of Biological, Ecological and Environmental Sciences (IJBEES) Vol. 1, No. 3, 2012 ISSN 2277 – 4394
- Rajesh Kumar Tripathi&LaxmikantYadu, ***“Comparison of Fly Ash and Rice Husk Ash Stabilized Black Cotton Soil”***, International Journal of Earth Sciences and Engineering ISSN 0974-5904, Volume 04, No 06 SPL, October 2011
- P. P. Dahale, ***“Disposal of solid waste for black cotton soil Stabilization”***, (Ijaest) International Journal Of Advanced Engineering Sciences And Technologies Vol No. 8, Issue No. 1, 113 – 120. 2011