Quality Assessment for Stabilization of Black Cotton Soil by Using Lime

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Abstract-This experimental study have been carried out to find the effect of different percentages of lime as reinforcement with black cotton soil sample. A cycle of experiments such as Liquid limit test, Plastic Limit Test, Unconfined compressive Strength California bearing ratio test (CBR) test is carried out on black cotton soil sample with different percentages of lime. From this lime-soil, bearing strength of soil sample was found to be increase, in all the mixes the strength increases gradually. Lime stabilization can be used successfully for projects to improve very poor subgrade soils, increase the soil support value and eliminate wasting bad soils.

Keywords – Stabilization, Lime, Soil, Plasticity characteristic, unconfined compressive Strength, C.B.R. test

I. INTRODUCTION

The term soil stabilization means the improvement of the stability or bearing power of the soil by the use of controlled compaction, proportioning or the addition of suitable admixtures or stabilizers. Soil stabilization deals with physical, physicochemical and chemical methods to make the stabilized soil serve its purpose as pavement materials.

Chemical stabilization is one of the oldest methods of stabilization of problematic soil. In general, all lime treated fine-grained soils exhibit decreased plasticity, improved workability and reduced volume change characteristics. However, not all soils exhibit improved strength characteristics. It should be emphasized that the properties of soil-lime mixtures are dependent on many variables. But Soil type, lime type, lime percentage and curing conditions (time, temperature, and moisture) are the most. The basic objectives of study of black cotton soil are as following:

1) Improvement of bearing capacity of Black Cotton Soil on addition of lime.
2) Variation of Strength of soil at different water content.
3) Effect of lime on CBR value of the soil.

In order to achieve the above objective, the black cotton soil has been arbitrarily mixed with lime. So the suitability of lime is considered to enhance the properties of black cotton soil.

II. LITERATURE REVIEW

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In the past, soil stabilization was done by utilizing the binding properties of clay soils, cement-based products, and/or utilizing the "rammed earth" technique and lime. However, recent technology has increased the number of traditional additives used for soil stabilization purposes. Such non-traditional stabilizers include: Polymers Based Products (e.g. cross-linking water-based styrene acrylic polymers that significantly improves the load-bearing capacity and tensile strength of treated soils), Copolymer Based Products, fiber reinforcement, calcium chloride, and Sodium Chloride.

Traditionally and widely accepted types of soil stabilization techniques use products such as bitumen emulsions which can be used as a binding agents for producing a road base. However, bitumen is not

environmentally friendly and becomes brittle when it dries out. Portland cement has been used as an alternative to soil stabilization. However, this can often be expensive and is not a very good "green" alternative. Cement Fly Ash, Lime Fly Ash (separately, or with Cement or Lime), Asphalt, Bitumen, Tar, Cement Kiln Dust (CKD), Tree resin and Ionic stabilizers are all commonly used stabilizing agents. When using such products issues such as safety, health and the environment must be considered.

Lime and Soil Stabilization-Soil stabilization occurs when lime is added to a reactive soil to generate long-term strength gain through a pozzolanic reaction. This reaction produces stable calcium silicate hydrates and calcium aluminates hydrates as the calcium from the lime reacts with the aluminates and silicates solublized from the clay. The full-term pozzolanic reaction can continue for a very long period of time, even decades -- as long as enough lime is present and the pH remain high (above 10). As a result, lime treatment can produce high and long-lasting strength gains. The key to pozzolanic reactivity and stabilization is a reactive soil, a good mix design protocol, and reliable construction practices. Following are the benefits of Lime Stabilization

1) Drying- On mixing, there is immediate exothermic hydration reaction. It reduces water content with further reduced by aeration of soil. Water – fall percentage varies by 2 to 3 % of added lime.
2) Flocculation- Mixing affects the ultrasonic field between clay particles which changes to Granular structure.
3) Reduction in Plasticity Index (PI) - It switches from being plastic to stiff and grainy.
4) Improvement in bearing capacity - After two hours of mixing, CBR of a treated soil is between 4 and 10 times higher than that of an untreated soil. The reaction greatly relieves on site transportation difficulties.

III. MATERIALS AND METHODOLOGY

A Materials- Before taking recourse of lime stabilization, it is desirable to examine the suitability of soil for this treatment. This is done taking samples of the soil at appropriate locations. Distributed samples are normally adequate for this purpose. The normal practice followed in the field is to take three samples in a stretch of one kilometer along the alignment of the road if the same type of soil is found throughout. In case of soil type changes earlier, at least one sample is taken from each new stretch of soil. Also, when soil type changes with depth within a borrow pit, at least one sample should be collected from each strata.

Figure-1 Typical cracks in BC soil in dried state

B Casting of Specimens Details

Soil Sample-Black soil specimens from the Navasari, V.M.V. Road, Amravati district of Maharashtra were taken to study the effects of addition of lime on the properties of the soil

Suitability of Soil- A soil must have a fraction passing 425 micron sieve not less than 15% and its PI should be at least 10%. It is desirable that the percent retained on 425 micron sieve should be well graded with uniformity coefficient not less than 5. Organic matter in the selected soil for lime stabilization should not be more than 2.0% and sulphate content should not exceed 0.2 %.

Lime- Lime in the form of quicklime (calcium oxide – CaO), hydrated lime (calcium hydroxide – Ca[OH]2), or lime slurry can be used to treat soils.

Suitability of Lime-Lime for lime–soil stabilization work shall be calcite dry lime, commercial available, slacked at site or pre-slacked lime delivered at site in suitable packing. Use of dolomite lime is not considered suitable.

C Mix Proportion Basically we used the 4 types of percentage for stabilized the soil and also knowing the percent gives the maximum strength to the soil. The following percentage used to stabilized the soil,

1) 4% lime by the weight of soil,
2) 6% lime by the weight of soil,
3) 8% lime by the weight of soil, and

4) 10% lime by the weight of soil.

D Testing Procedure-For testing the strength of stabilized soil, the CBR test is widely used in case of gravelly soil. This test is done at three days curing without lime and seven days moist curing. Guiding strength criteria are as follows:

CBR Test- Minimum CBR value for the lime- stabilized sub- base should be 15 % for low trafficked rural roads, 20 % for cumulative traffic up to 2 million standard axles (MSA) and 30 % for traffic exceeding 2 MSA. The CBR test should carry out on samples compacted to the density specified and moulded at optimum moisture content (OMC).

IV. OBSERVATIONS

Table 1- Properties of Black Cotton soil

Soil type	Liquid limit	Plastic limit	Plasticity index	Shrinkage limit	% passing 425 micron sieve
B.C soil	66%	19%	47%	14.6%	24%

Table 2- Effect of treated lime on Plasticity characteristic of Black Cotton soil

Plasticity characteristics	Virgin soil	Liquid limit			
		4%	**6%**	**8%**	**10%**
Liquid Limit	66%	53.50%	46.00%	36.00%	35.40%
Plastic Limit	19%	27.30%	33.20%	30.70%	32.40%
Plasticity Index	47%	26.20%	17.50%	05.60%	02,60%

Table 3- Unconfined compressive Strength (U.C.S.) on lime treated Black Cotton soil

U.C.S. (kg/cm2) - 7 days curing comprising of 3 days moist curing + 4 days immersion in water.

	Lime			
Soil sample	4%	6%	8%	10%
Disintegrates	6.05	15.22	16.63	19.69
Immersed in water	7.23	18.49	20.32	21.31

Table 4- CBR values of treated lime on Plasticity characteristic of Black Cotton soil

Sample	Virgin	4%	6%	8%	10%
CBR	03.30	28.70	62.80	41.60	27.40

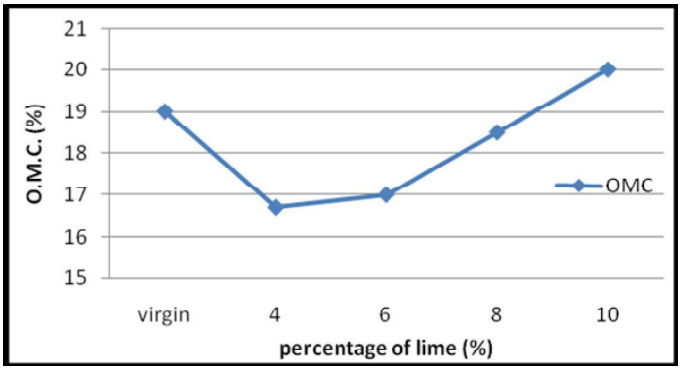

Figure-2 Graph showing the effect of treated lime on O.M.C. of Black Cotton soil

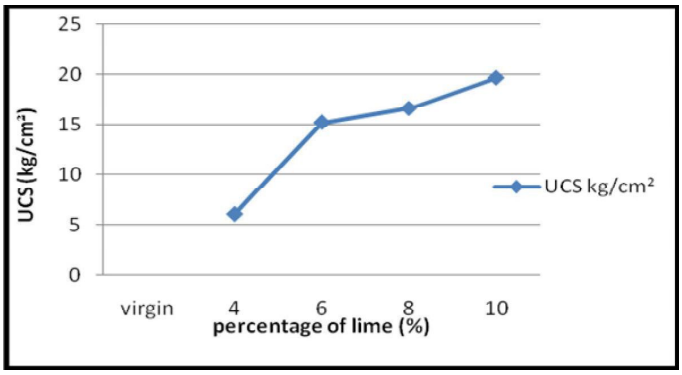

Figure -3 Graph showing the effect of treated lime on U.C.S. of Black Cotton soil

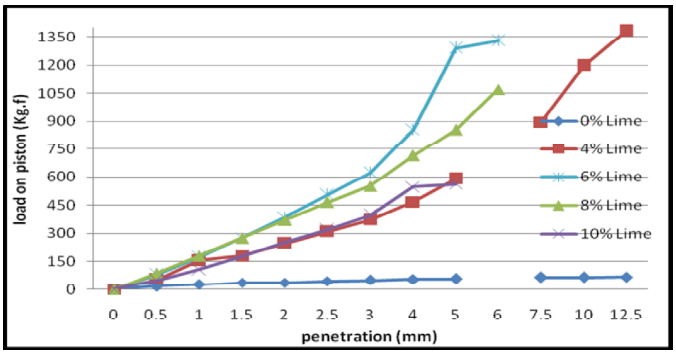

Figure -4 Graph showing Comparisons of CBR Test for all percentages of Lime with Black Cotton Soil

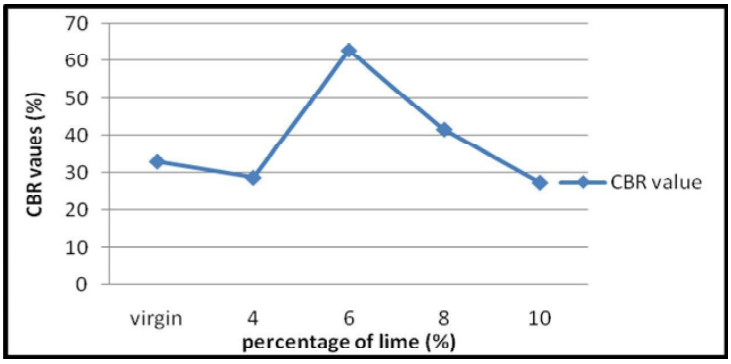

Figure -3 Graph showing the effect of treated lime on C.B.R. values (Black Cotton soil

IV.CONCLUSION

It has been observed that an addition of 6% lime to black cotton soil cuts down it's plasticity, shrinkage & swelling characteristics considerably. The compressive strength rises to about 15.22 kg/cm2 under wet condition. The CBR values rises from 3.3% of virgin soil to about 62.8%. The treated black cotton soil can be safely used as a sub-grade, sub-base or base material, thereby cutting down considerably the thickness of the upper crust of a road which is of an expansive material like hard stone.

It has been noted that the strength developed in soil lime mixture is not only due to flocculation action of lime alone, but also due to certain pozzolanic action with black cotton soil which gives it a high strength.

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