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An Experimental Study on Stabilization of Black Cotton Soil by Using Quarry Dust and Lime Mixture

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Abstract: ***With the increasing of population and the reduction of available land, more and more construction of buildings and other civil engineering structures have to be carried out on weak or soft soil. Owing to such soil of poor shear strength and high swelling & shrinkage, a great diversity of ground improvement techniques such as soil stabilization and reinforcement are employed to improve mechanical behaviour of soil, thereby enhancing the reliability of construction. The correct stabilization of foundation soils constitutes an increasingly important issue in the present civil engineering world. Concerns over the environment have taken significant proportions, and there is the awareness today that efforts must be made to diminish the environmental damage caused by the development of infrastructures. Therefore, it has become urgent not only to find building procedures, which will allow this objective to be achieved, but also to accelerate their implementation. This study is carried out with an intention to evaluate the effects of Quarry dust and lime on the geotechnical properties of the locally available expansive soil from Davanagere city. Tests which are to be carried out on the sample of soil dealt with specific gravity, compaction, California bearing ratio, unconfined compressive strength and shear strength. These tests are to be conducted at both non-stabilized and stabilized states by adding 2%, 4%, 6%, 8% and 10% of lime in addition with 5%, 10%, 15%, 20% and 25% of quarry dust. The results show the effect of quarry dust and lime on geotechnical properties of the soil samples strength. Also it may be estimated that this is an efficient way of reducing costs, without losing the strength gains and water sensibility***

Keywords: **Stabilization, lime, quarry dust, expansive soil**, **CBR, Unconfined.**

I. Introduction

Expansive soils are soils or soft bedrock that increases in volume or expand as they get wet and shrink as they dry out. In India this Expansive soil is called "Black Cotton Soil". Colour of this Soil is reddish brown to black and this helps for cultivation of cotton, so is called black cotton swelling soil covers about 30% of the land area in India. They are also commonly known as bentonite, expansive, or Black Cotton soil. In India Black Cotton soil also known as regurs and are found in extensive regions of Deccan Trap. They have variable thickness and are underlain by sticky material locally known as "Kali Mitti". In terms of geotechnical Engineering, Black Cotton soil is one which when associated with as engineering structure and in presence of water will show a tendency to swell or shrink causing the structure to experience moments which are largely unrelated to the direct effect of loading by the structure.

The correct stabilization of foundation soils constitutes an increasingly important issue in the present civil engineering world. Concerns over the environment have taken significant proportions, and there is the awareness today that efforts must be made to diminish the environmental damage caused by the development of infrastructures. Therefore, it has become urgent not only to find building procedures, which will allow this objective to be achieved, but also to accelerate their implementation.

Soil stabilization is a way of achieving the proposed goals, which is at the same time inexpensive and easy to apply in practically on any type of soil. Also Black cotton soil is one of the major soil deposits of India.

II. Material and Methodology

Black Cotton Soil: Black Cotton soil which is expansive in nature was collected from Harihara, Davanagere District, and Karnataka State. The top surface of the soil was cleared with all the organic wastes and other waste materials. The top soil was excavated up to a depth of 1.5 feet and then the soil was collected.

Lime: Lime is a white caustic alkaline substance consisting of calcium oxide, which is obtained by heating limestone and which combines with water with the production of much heat. This was procured from the local market.

Quarry Dust: Quarry dust is the By-Product containing minerals and trace elements, obtained from the crushing operation of stones, usually processed by natural or mechanical means. It was obtained in a locally available quarry. The Specific Gravity of Quarry dust was 2.53

Methodology

Following laboratory tests have been carried out as per IS: 2720. The tests were carried out both on natural soil and stabilized soil with Lime and Quarry dust.

1. Differential Free Swell index – IS 2720 Part-XI, 1972.
2. Grain size analysis – IS 2720 Part 4, 1985
3. Specific gravity - IS 2720 Part-3, 1980
4. Liquid limit - IS 2720 Part-5, 1985
5. Proctor Compaction – IS 2720 Part-8, 1983
6. CBR test – IS 2720 Part-16, 1987
7. Unconfined compression – IS 2720 Part-10, 1991
8. Direct Shear test - IS: 2720 Part-13, 1986

Sampling of Soil

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The laboratory studies were carried out on the samples of Soil, Soil + Lime + Quarry dust, for different percentage of Lime and Quarry dust as shown in the below proportion by weight of the soil. Soil Particulars

Soil Particulars	Percentage of lime and quarry dust added
Natural Soil	0%
Soil sample-1	Natural soil+2% of lime+5% quarry dust
Soil sample-2	Natural soil+4% of lime+10% quarry dust
Soil sample-3	Natural soil+6% of lime+15% quarry dust
Soil sample-4	Natural soil+8% of lime+20% quarry dust
Soil sample-5	Natural soil+10% of lime+25% quarry dust

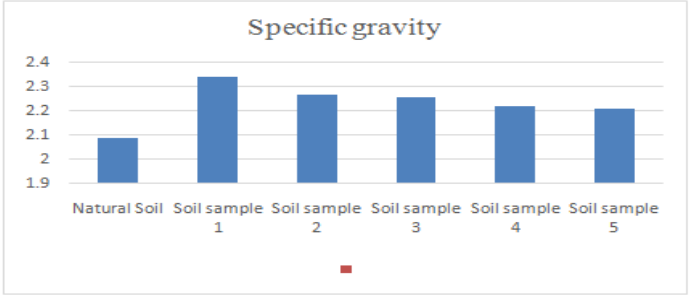
III. Results and Tables

Following tables and graphs gives the overall results of Specific gravity, Liquit limit, Maximum dry density, Optimum moisture content, CBR, Unconfined compressive strength.

Table 1: Overall results of Experiments.

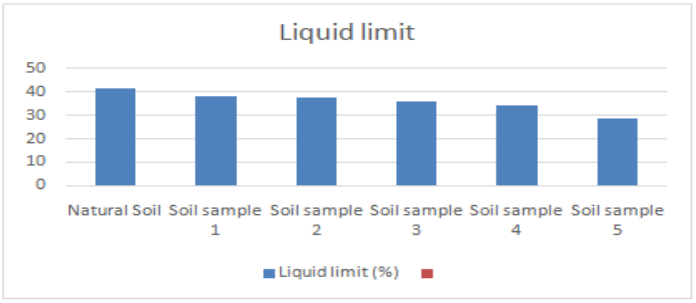
Description	Natural Soil	Soil sample 1	Soil sample 2	Soil sample 3	Soil sample 4	Soil sample 5
Specific gravity	2.04	2.34	2.27	2.27	2.22	2.21
Liquid limit (%)	41.5	38.20	37.75	36.20	34.10	28.84
Maximum Dry Density (g/cc)	2.05	1.60	1.63	1.65	1.63	1.64
Optimum moisture content (%)	20.65	24.74	24.31	24.04	24.18	23.78
CBR (%)	2	4	7	9	12	11
Unconfined Compressive Strength (Kg/cm^2)	5.69	11.46	9.17	12.19	18.22	7.67

Following Graph 1 shows the variation of specific gravity for soil with reference mix of lime and quarry dust.



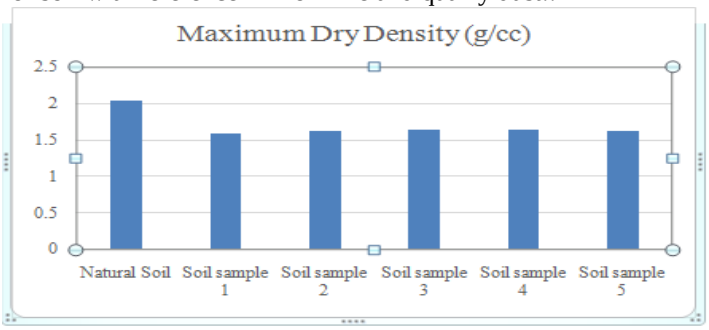
Graph 1: Variation of specific gravity

Following Graph 2 shows the variation of liquid limit for soil with reference mix of lime and quarry dust..



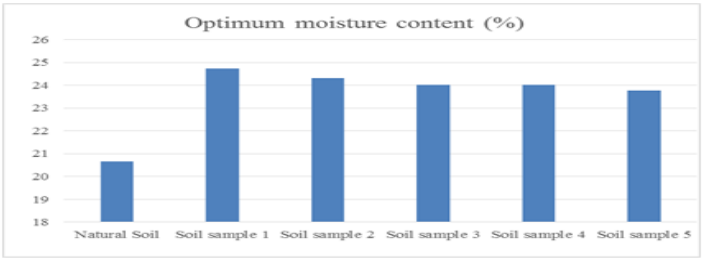
Graph 2: Variation of liquid limit

Following Graph 3 shows the variation of maximum dry density for soil with reference mix of lime and quarry dust..



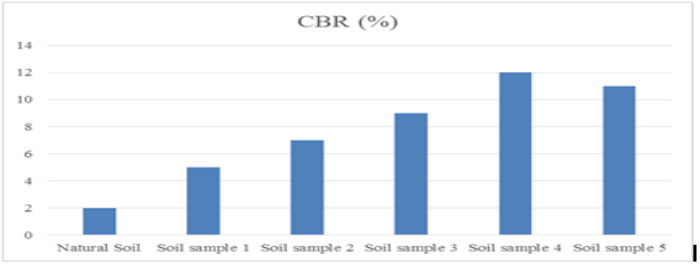
Graph 3: Variation of maximum dry density

Following Graph 4 shows the variation of optimum moisture content for soil with reference mix of lime and quarry dust..



Graph 4: Variation of optimum moisture content

Following Graph 5 shows the variation of CBR value for soil with reference mix of lime and quarry dust..



Graph 5: Variation of CBR value

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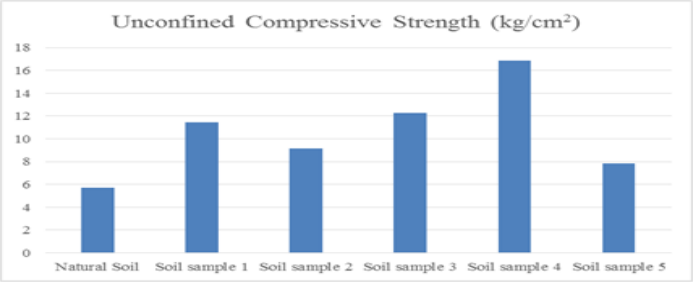
Following Graph 6 shows the variation of unconfined compressive strength for soil with reference mix of lime and quarry dust..



Graph 6: Variation of unconfined compressive strength

IV. Conclusion

Black cotton soils when blended with quarry dust and lime are very promising to improve the geotechnical properties. This will provide solution for the use of locally available black cotton soil.

(1) Specific gravity of BC soil decreased with the addition of quarry dust and lime, this reduction of specific gravity value may be due to the reduction of plasticity character of BC soil.

(2) Maximum dry density (MDD) is observed at soil sample 3 for addition of quarry dust and lime. Further addition of it, MDD value decreased.

(3) The strength of black cotton soil increasing with the addition up to soil sample 4 and further decreased.

(4) From the test it is concluded that the strength characteristics of BC soil are optimum at Soil sample 4 (8% lime + 20% quarry dust).

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