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A STUDY ON SUBGRADE CHARACTERISTICS OF BLACK COTTON SOIL TREATED WITH LIME AND PHOSPHOGYPSUM

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ABSTRACT: Expansive soils are problematic soils for Civil Engineers. Black cotton soils have the properties of low strength and high compressibility, due to these properties black cotton soils are problematic soils. To achieve desired properties of soil for construction purpose these black cotton soil must be treated. To improve the properties of black cotton soils so many treatments are there. Stabilization using some industrial waste is the one method for improving the properties of black cotton soil. By stabilizing the soil make it suitable for subgrade construction. In this thesis the discussion on the combined effect of Lime and Phosphogypsum on compaction characteristics, Atterberg Limits, Unconfined Compressive Strength (UCS) for original soil, California Bearing Ratio (CBR) and Triaxial Compression Test of a black cotton soil with percentage varying of Lime and Phosphogypsum. The soil specimens were tested for triaxial compression test and CBR tests were carried out after 4 days curing period. From the results, it was found that black cotton soil treated with Lime and Phosphogypsum in the percentages of (4:4) has better strength characteristics. So, these Lime and Phosphogypsum can be used for stabilization of black cotton soils for pavement subgrade

Key Words: Black cotton soil, Lime, phosphogypsum, CBR Value, Triaxial compression test

1.INTRODUCTION

Black cotton soils posture significant issues to structural designing structures, for example, streets built on them as far as differential settlements, poor quality and high compressibility. A few states in India, for example, Rajasthan, Madhya Pradesh, Gujarat, Andhra Pradesh, Karnataka also, Tamilnadu have incomprehensible store of far reaching soils. These extensive soils are colloidal soils containing two micron earth part fluctuating half to 70% comprising of noteworthy parcel of Montmorillonite and Illite minerals. Among all, Black cotton soil is a very broad as it shows high swelling, shrinkage, compressibility and poor quality in contact with water, particularly amid blustery season prompting splits in overlying street asphalts. In the course of recent decades, huge research has been performed to create treatment strategies to balance out delicate and extensive soils. Taking into account the component of soil change, adjustment strategies can separate into physical, mechanical, and compound adjustment (Mitchell and katti, 1981). Among these mechanical and substance adjustment strategies are much of the time utilized since they give quick, productive, repeatable and solid changes to soil properties (Haussmann, 1990). In spite of the fact that these strategies are viable, still there is a requirement for use of squanders as settling materials which conservative as well as fathoms the transfer issue of squanders. Along these lines, the present study has been completed.

Phosphogypsum can likewise be perceived as a potential soil settling or stabilizing operator. An extensive amount of mechanical by-product material, for example, Phosphogypsum is being created prompting transfer, natural and wellbeing issues. Numerous studies are accessible on the stabilization of black cotton soils utilizing lime alone and exceptionally constrained studies utilizing Phosphogypsum as a part of the writing. In this manner, the introduce work did to think about the impact of lime and Phosphogypsum on designing properties, for example, compaction, unconfined compressive quality, consistency limits and the California bearing ratio and triaxial compression test of BC soil.

1.1. Objectives of Work

The principle points of the work reported in this postulation are as per the following:-

1. To study the impact of lime and Phosphogypsum blend or mixing on the geotechnical qualities of BC Soil.
2. To research the mineralogical and morphological changes operating at a BC soil due to adjustment utilizing lime and Phosphogypsum combined mixture.

2. LITERATURE REVIEW

Sujeet Kumar et al., (2014) watched that dry unit weight, optimum water content , liquid limit, plastic limit,% swell, of soil mix with Bentonite + 8% lime on expansion of 8 % PG expanded and free swell record diminished. Also, watched diminish in UCS past 8% expansion of PG where CV has no impact on expansion of PG. Additionally CBR, the modulus of the subgrade response and secant modulus expanded for the Bentonite balanced out with lime and PG which helps in decrease in earthwork, required thickness of subgrade Bentonite. Conduct of the Bentonite-lime-PG combined will help the development of pavements on expansive soils.

Sleiman M. Al-Zaidyeen and Arabi N. S. Al-Qadi (2015) directed tests to understand the impact of PG as a waste material in soil adjustment of pavement layers which demonstrated that the potential quality of the clay soil expanded with the expansion in the PG up to 20% from CBR test. What's more, ideal % of PG to be added to silty or clayey rock and sand soil is favoured as 21.4%. Additionally presumed that in asphalt development by utilization of PG as a stabilizer could lessen the depth of asphalt layer.

3. MATERIALS AND METHODOLOGY

3.1. Materials

Black cotton soil (BC Soil) was collected from site near the "KRISHNAPURAM RAILWAY STATION" surroundings in KADAPA. The soil was collected at a depth of 1.0m below the ground level. The standard proctor compaction test results shows optimum moisture content (OMC) is 24.5% and maximum dry density (MDD) is 1.32g/cc.

The lime used in the present project was purchased from the local market in KADAPA. A general term for burned limestone also known as quicklime, hydrated lime and un slaked lime or slaked lime.

Phospogypsum used in this study was collected from N.J.P. Plasters pvt.ltd which is located in Hyderabad.

3.2. Methodology

In this study the properties of black cotton soil such that index and engineering properties were analysed. From the index and engineering properties the soil was found to be having very low strength and expansive in nature. Soil stabilization with lime and Phospogypsum was chosen in order to improve the properties of soils.

The process of improvement in properties of black cotton soil split into two stages.

Stage1:

- The first stage dealt with finding the optimum content calcium carbide residue (lime) from the tests of:
  - Atterberg's Limits
  - Standard Proctor Compaction Test
  - Unconfined Compressive Strength Test
  - Triaxial Compression Test
  - California Baring Ratio Test
- These tests involved in addition of different percentages of lime (2%, 4%, 6%, 8%) to the expansive soil.
- The lime was thoroughly mixed with soil by hand until homogeneity was reached.
- To prevent loss of moisture content of mixture, stored in a large plastic bag.
- Atterberg's limits tests carried out with addition of varying percentages of lime (2%, 4%, 6% and 8%).
- Standard proctor compaction tests carried out with addition of varying percentages of lime (2%, 4%, 6% and 8%).
- The unconfined compressive strength and California baring ratio test was conducted for original Black Cotton soil only.
- The Triaxial Compression test and California baring ratio tests were conducted with lime percentages of (2%, 4%, 6% and 8%).
- California bearing ratio tests were carried out with 4 days soaking.
- The second stage of this study dealt with the obtaining Triaxial compression test values and California bearing ration by fixing 4% lime and % varying of Phospogypsum (2%, 4%, 6% and 8%).
- The UCS tests carried for only soil.
- The CBR tests were carried out with soaked period of 4 days.

4. RESULTS

4.1 EXPERIMENTAL INVESTIGATION ON SOIL SAMPLE:

Table 4.1: Properties of the black cotton soil

S.NO	PROPERTIES	VALUES OF BC SOIL
1	Specific gravity	2.36
2	Grain size analysis	

	Sand % Silt %&Clay %	19 81
3	Atterberg limits Liquid limit Plastic limit Plasticity index	 54 19 35
4	IS classification of soil	CH
5	Compaction parameters Optimum moisture content (%) Maximum dry density (g/cc)	 24.5 1.32
6	Unconfined compressive strength (kg/cm²)	0.98
7	CBR Value	2.05

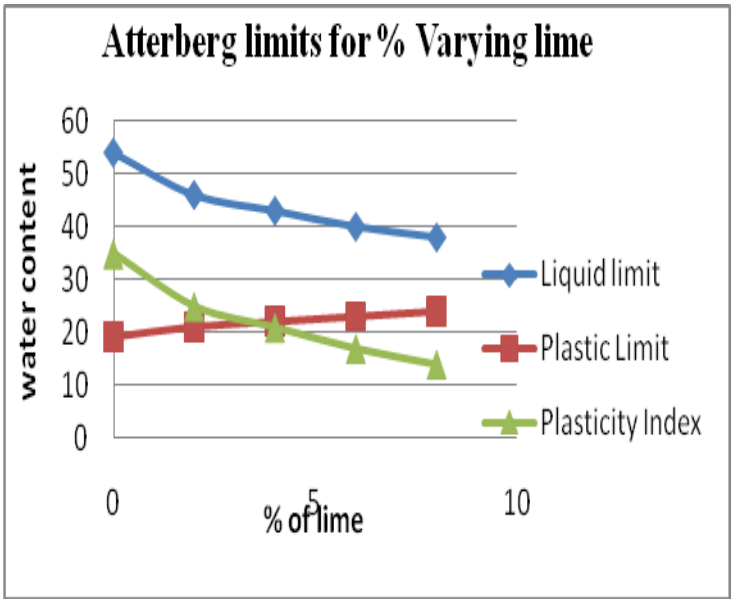

Fig 4.1: Atterberg Limits For Various Percentages of Lime

Table 4.3: Variation of Liquid Limit, Plastic Limit & Plasticity Index with adding of 4% of Lime + Varying percentages of PG

Composition	Liquid Limit	Plastic Limit	Plasticity Index
BC + 4% Lime + 2% PG	39	22	17
BC + 4% Lime + 4% PG	37	23	14
BC + 4% Lime + 6% PG	36	24	12
BC + 4% Lime + 8% PG	35	25	10

4.2 ATTERBERG LIMITS

Table 4.2: Variation of Liquid Limit, Plastic Limit & Plasticity Index with adding of Lime in Percentage

Composition	Liquid Limit	Plastic Limit	Plasticity Index
BC + 0% Lime	54	19	35
BC + 2% Lime	46	21	25
BC + 4% Lime	43	22	21
BC + 6% Lime	40	23	17
BC + 8% Lime	38	24	14

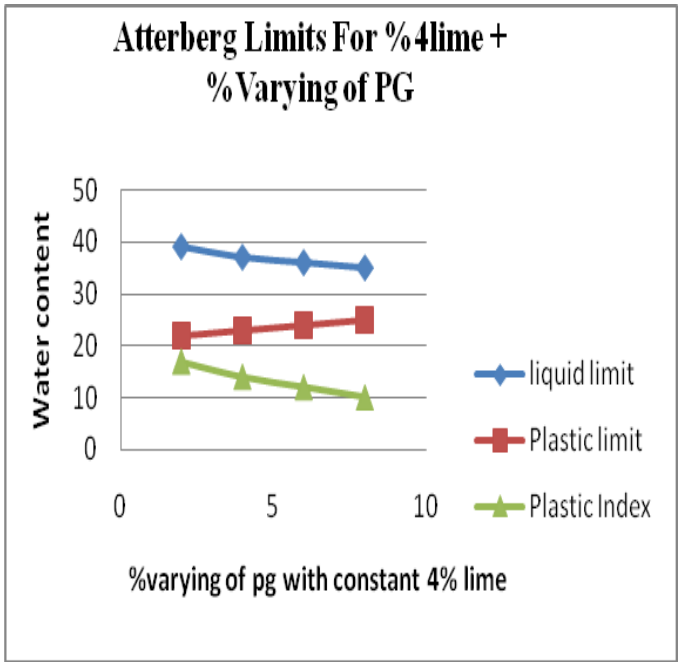

Fig 4.2: Atterberg Limits For 4% Lime +Varying Percentage of PG

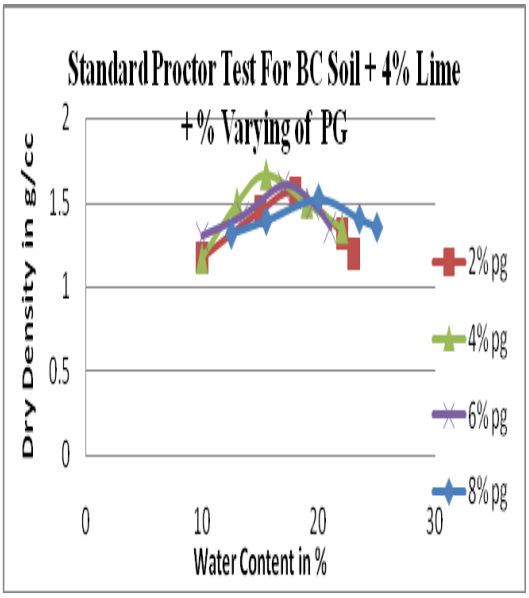

Fig 4.4: Compaction Curves for Black Cotton Soil + 4% Lime + % Varying of PG

4.3 STANDARD PROCTOR TEST

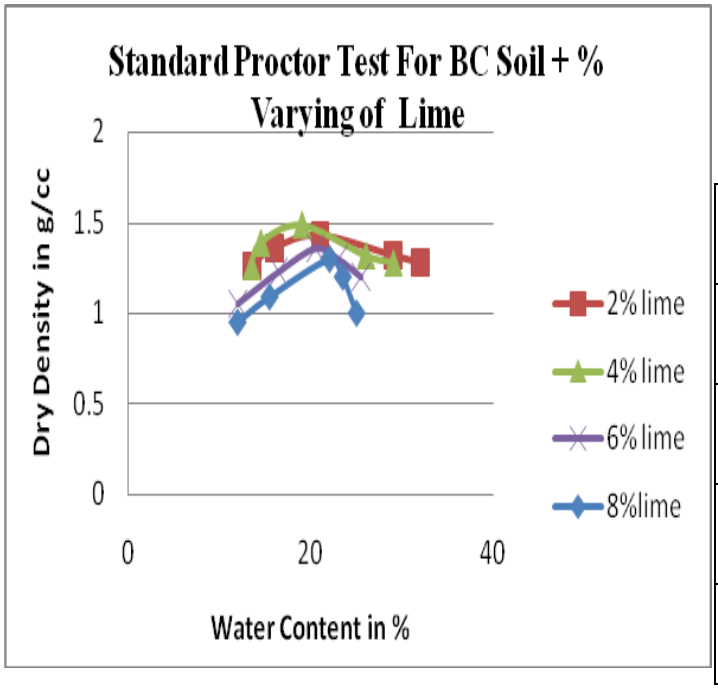

Fig 4.3: Compaction Curves for Black Cotton Soil + % Varying of Lime

4.4 CALIFORNIA BEARING RATIO TEST (CBR TEST)

Table 4.4: Variation of CBR Soaked & Unsoaked Values for BC Soil + 4% Lime + % Varying of PG

Composition	Unsoaked CBR Value	Soaked CBR Value
BC Soil + 4% Lime + %2 PG	4.61	3.24
BC Soil + 4% Lime + % 4 PG	5.89	4.1
BC Soil + 4% Lime + % 6 PG	5.46	3.41
BC Soil + 4% Lime + % 8 PG	4.27	2.82

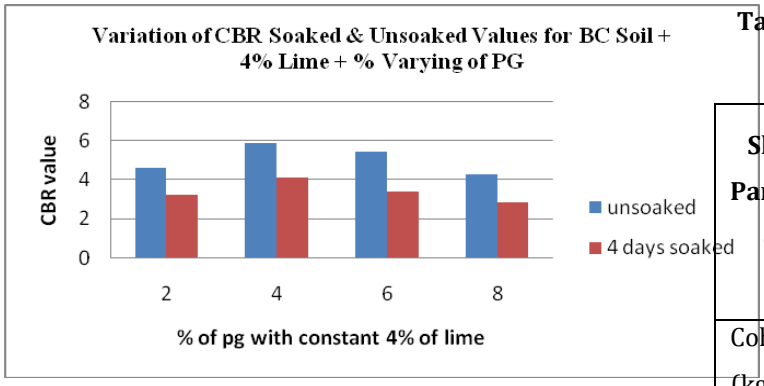

Fig 4.5: Variation of CBR Soaked & Unsoaked Values for BC Soil + 4% Lime + % Varying of PG

4.5 TRIAXIAL COMPRESSION TEST

Table 4.5: Shear Parameters of BC Soil Stabilized with Lime

Shear Parameters	BC Soil+2 % Lime	BC Soil+4 % Lime	BC Soil+6 % Lime	BC Soil+8 % Lime
Cohesion (kg/cm²)	0.085	0.1	0.09	0.075
Angle of internal friction	2°20’	1°80’	2°10’	2°70’
Shear strength (kg/cm²)	0.111	0.12	0.105	0.097

Table 4.6: Shear Parameters of BC Soil Stabilized with Lime and PG

Shear Parameters	BC Soil+4% Lime+% 2PG	BC Soil+4% Lime+% 4PG	BC Soil+4% Lime+% 6PG	BC Soil+4% Lime+% 8PG
Cohesion (kg/cm²)	0.13	0.15	0.125	0.12
Angle of internal friction	1°50’	1°	2°15’	3°40’
Shear strength (kg/cm²)	0.156	0.164	0.156	0.152

5. CONCLUSIONS

The following conclusions are derived based on the laboratory tests carried out in this thesis.

- Triaxial compression strength and California bearing ratio values of lime stabilized black cotton soil improved with increasing percentages of lime up to 4% after that the values were decreased.
- The cohesion value of black cotton soil increased 54% after stabilized with lime.
- The CBR value of black cotton soil increased 116.5% after stabilized with lime.
- The cohesion value of black cotton soil increased 110% after stabilized with lime and phosphogypsum.
- The CBR value of black cotton soil increased 188% after stabilized with lime and phosphogypsum.
- From the results, it was found that black cotton soil treated with Lime and Phosphogypsum in the percentages of (4%lime& 4% Phosphogypsum) has better strength characteristics.

- So, these Lime and Phosphogypsum can be used for stabilization of black cotton soils for pavement subgrade.

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