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COMBINED EFFECT OF LIME AND STONE DUST ADMIXTURES ON SOIL PROPERTIES

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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. Lime and stone dust in varying percentages are used as admixtures in the present study to stabilize the black cotton soil. Changes in various soil properties such as Liquid limit, Plasticity Index, Optimum Moisture Content, Maximum Dry Density and California Bearing Ratio were studied. The test results indicate that with increase in the percentage of lime and stone dust the liquid limit, plasticity index & optimum moisture content (OMC) decreases and correspondingly the Maximum Dry Density (MDD) & California bearing ratio (CBR) continues to increase. It can also be concluded that the combination of lime and stone dust as stabilizers is more effective in improving the properties of soil.*

Key Words - *Lime, Stone Dust, Pozzolanic Reaction, Swelling, Shrinkage.*

I. INTRODUCTION

Soil stabilization is the process of blending and mixing materials with a soil to improve certain properties of the soil. The process may include the blending of soils to achieve a desired gradation or the mixing of commercially available additives that may alter the gradation, texture or plasticity, or act as a binder for cementation of the soil. It is a collective term for any physical, chemical, or biological method, or any combination of such methods that may be used to improve certain properties of a natural soil to make it serve adequately an intended engineering purpose [1]. The process used depends on the type of soil at the site, the time available to execute the project and the stabilization cost compared to the overall cost of the project and to the cost of full replacement of the soil at the site [2].

There are two major concepts which are taken in to consideration in the construction where the soil is used as a construction material. One is maximum use of local resources so that local employment and economy may improve; another is to maintain economical construction cost as well as easy construction procedure by utilizing the available soil [3]. The objective of the present study is to stabilize the B.C. soil using lime and stone dust. This also solves the problem of disposal of stone dust which is a byproduct of mining industry. 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. Stone dust is also a solid waste material that is generated from stone crushing industry which is abundantly available in India. Stone dust is a material that possesses pozzolanic as well as coarser contents in it while other materials like fly ash possesses only pozzolanic property and no coarser soil particles [4].

II. BACK GROUND

The main benefits of using lime to stabilize clays are improved workability, increased strength, and volume stability. Workability is improved because flocculation makes the clay more friable; this assists combination for effective mixing and compaction [1]. The strength and load carrying capacity of expansive soils can be improved besides reducing the swelling properties of the soils by the addition of granite stone dust [5]. There was a maximum improvement in strength, compaction and CBR properties for the combination of lime and stone dust as compared to stone dust, added separately [2].

Addition of stone dust reduces plasticity characteristics and improves CBR of the mixes [6]. Addition of 25-35% of stone dust makes the gravel soil meet the specification of morth as sub-base material. A study also reveals the fact that with increase in percentage of stone dust in soil, the optimum moisture content decreases which are helps in decreasing water quantity required during compaction. Adding small percentage of stone dust increases its maximum dry density and CBR [7].

III. MATERIALS AND METHODS

The Soil sample was obtained from Kopparthi, Kadapa District, Andhra Pradesh. The soil was collected from a depth of 2m below the ground level, since the top soil is under disturbed condition likely to contain organic matter, other foreign materials and hence fairly homogeneous sample can be available at depth. The soil so obtained is air dried, crushed with wooden mallet and passed through 4.75mm sieve and stored in polythene bags for further testing.

Lime was collected from Ootukuru in Kadapa, Andhra Pradesh. Lime slurries of varying concentration were prepared by mixing lime depending on the percentage of lime required with water at optimum moisture content. This slurry method is recommended where dust is a problem and also promotes more uniform distribution of lime. This method proves disadvantageous on wet soils and during wet weather.

Granite stone dust is another admixture was collected from Guvvala Cheruvu, Kadapa District, Andhra Pradesh. This Granite stone dust, which comes from open cast mines located nearby. This is a raw material collected after crushing the Granite stone and is a byproduct of mining industry.

Lime and stone dust were used as stabilizers to improve the properties of B.C. soil. Usage of lime around 6% seems to be beneficial in stabilization of B.C. soil [8]. Therefore lime content varying from 3 to 9% has chosen for the present study along with various percentages of stone dust. An experimental study is carried out to improve various properties of B.C. soil and to understand the effect of addition of lime and stone dust together varying from 3 to 9% and 5 to 25% respectively on soil and there by determining their effect on liquid limit, plasticity index, optimum moisture content, maximum dry density, and CBR characteristics after 7days of curing. All mixes were prepared at optimum moisture content.

IV. RESULTS AND DISCUSSIONS

Tests on soil, stone dust and soil-lime-stone dust mixes are conducted as per IS Codes of Practice. Table 1 & 2 show the properties of B.C. soil and stone dust respectively. The liquid limit, plasticity index, OMC, MDD and CBR values of different mixes (soil-lime-stone dust mix) are presented in Table 3.

Table 1. Properties of Black Cotton Soil

S. No.	Property	Value
1	Specific Gravity, G	2.61
2	Free swell Index	110%
3	Fines(<75μ)	90%
4	2μ Fraction	40%
5	Liquid limit	52%
6	Plastic Limit	30%
7	Plasticity Index	22%
8	Soil Classification	CH
9	Optimum moisture content	18%
10	Maximum Dry Density	1.6 gm/cc
11	CBR	1.70

Table 2. Properties of Stone Dust

S.No.	Property	Value
1	Specific Gravity, G	2.75
2	Sand	98 %
3	Fines(<75μ)	2 %
4	Liquid limit	NP
5	Plastic Limit	NP
6	Plasticity Index	NP
7	Optimum moisture content	12%
8	Maximum Dry Density	1.83 g/cc
9	CBR	15 %

The workability of a soil is closely related to its plasticity characteristics that primarily depend on the water holding capacity of the soil and is quantified through index properties such as liquid limit, plastic limit and plasticity index [9]. Figure 1 shows the variation of liquid limit when lime and stone dust are used as stabilizers to the B.C. soil. In all, the below shown, the liquid limit gradually decreases upon the addition of lime and stone dust together to the soil. The liquid limit, irrespective of the clay soils, initially reduces with increase in lime content. The reduction is attributed to the reduction in the thickness of double layer.

Figure 2 gives an indication that, when lime and stone dust combinely used as stabilizer the results obtained mostly are of non plastic in nature. This indicates that the stone dust could be of inert material.

Figure 3 shows the variation of OMC of B.C. soil with lime and stone dust percentage. The OMC decreases continuously with increase in lime and stone dust percentage. Figure 4 shows the variation of MDD with percentage of lime and stone dust. The MDD gradually increased with increase in percentage of admixtures.

Table 3. Test Results of Different Mixes

S.No	Mix	Liquid Limit (%)	Plasticity Index (%)	OMC (%)	MDD (g/c)	CBR (%)
1	S +3% L+5% SD	41	15	16	1.66	7
2	S +3%L+10% SD	40	13	15	1.7	9.56
3	S +3%L+15% SD	39	8	13	1.72	12.54
4	S +3%L+20% SD	37	NP	12	1.73	13.58
5	S +3%L+25% SD	33	NP	10	1.75	14.6
6	S+6% L+5% SD	38	10	15	1.66	7.36
7	S+6% L+10% SD	36	7	13	1.72	10.54
8	S+6% L+15% SD	35	6	11.5	1.75	13.7
9	S+6% L+20% SD	32	NP	10	1.81	20.76
10	S+6% L+25% SD	30	NP	9	1.84	21.13
11	S+9% L+5% SD	38	9	13	1.68	9.84
12	S+9% L+10% SD	35	6	11	1.73	12.36
13	S+9% L+15% SD	34	NP	10	1.82	17.8
14	S+9% L+20% SD	31	NP	9	1.87	21.89
15	S+9% L+25% SD	30	NP	9	1.9	22.76

With increase in lime content the concentration of cations increases near the negatively charged clay surfaces. This difference of charged concentration leads to osmosis. Since the ions are under influence of charge on clay surface they are restrained against diffusion, the water molecules diffuse towards clay surface to equalize charge concentration [10]. This leads to separation of clay particles that produces more dispersed soil structure, thereby permits the particles to slide part over each other into a more oriented and denser matrix.

Figure 5 shows the variation of CBR with lime and stone dust. The CBR values increase upon the addition of lime and stone dust to the B.C. soil. The resistance to penetration of plunger is found increasing. It is found that there is constant increase in strength with increase in percentage of lime and stone dust.

V. CONCLUSIONS

The liquid limit and plasticity index have decreased gradually upon the addition of lime and stone dust together to the soil and this reduction is attributed to the reduction in the thickness of double layer. The results obtained are mostly of non plastic in nature. The OMC has decreased continuously with increase in lime and stone dust percentage. The MDD and CBR values increase upon the addition of lime and stone dust to the B.C. soil.

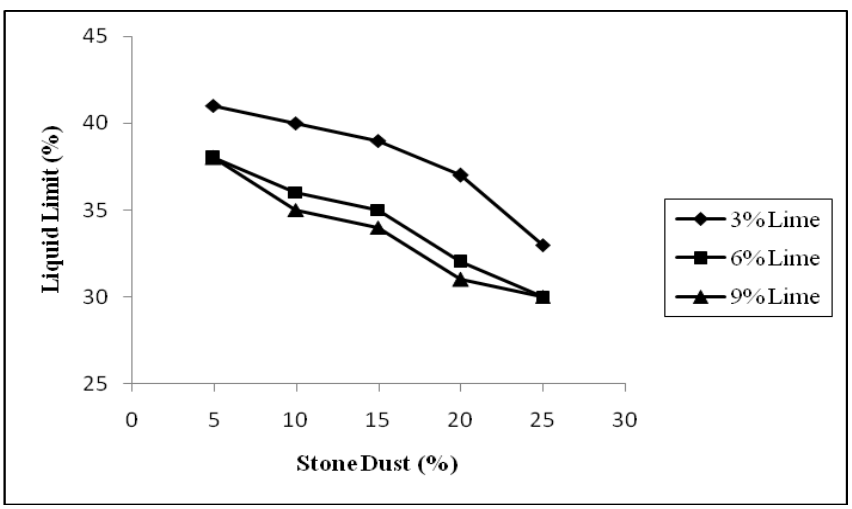

Figure 1. Variation in Liquid Limit

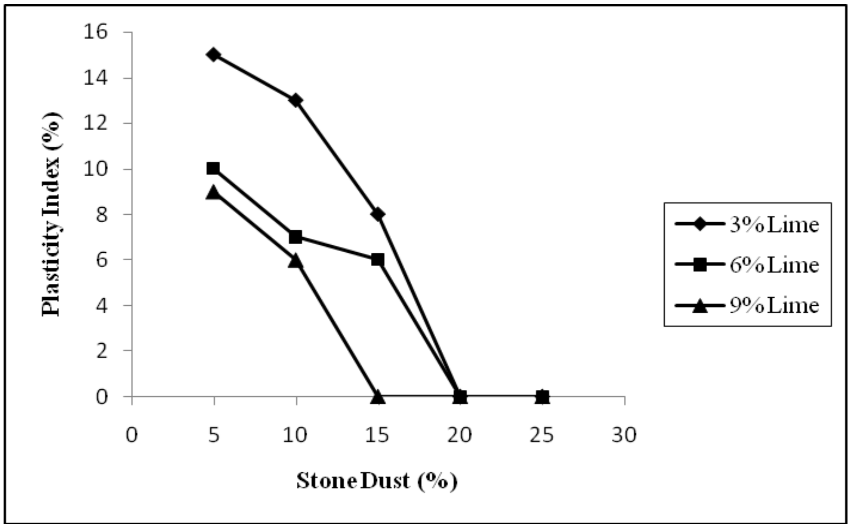

Figure 2. Variation in Plasticity Index

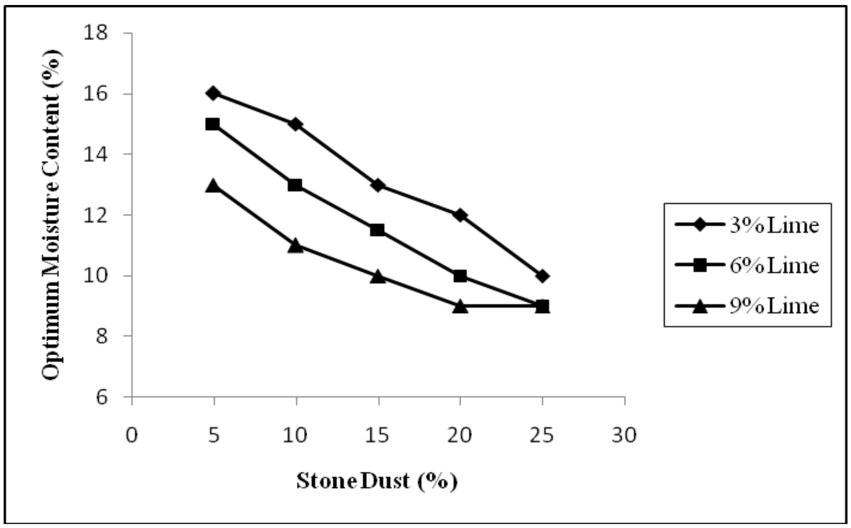

Figure 3. Variation in Optimum Moisture Content

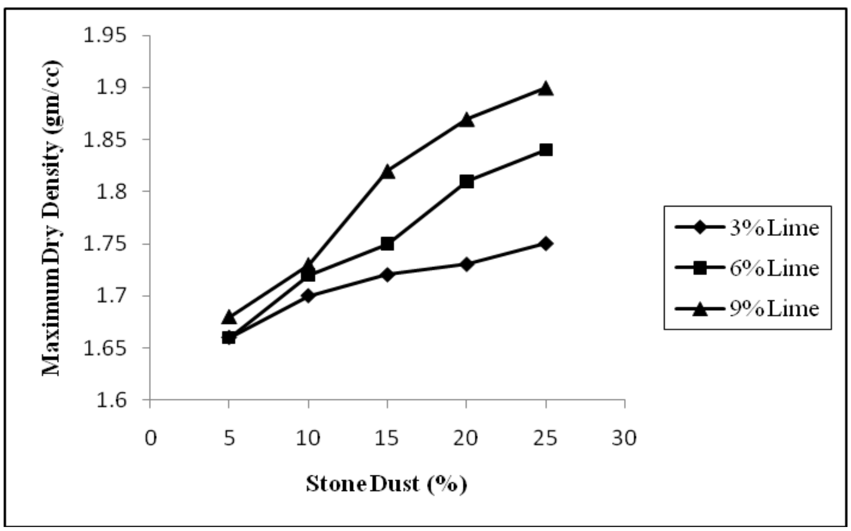

Figure 4. Variation in Maximum Dry Density

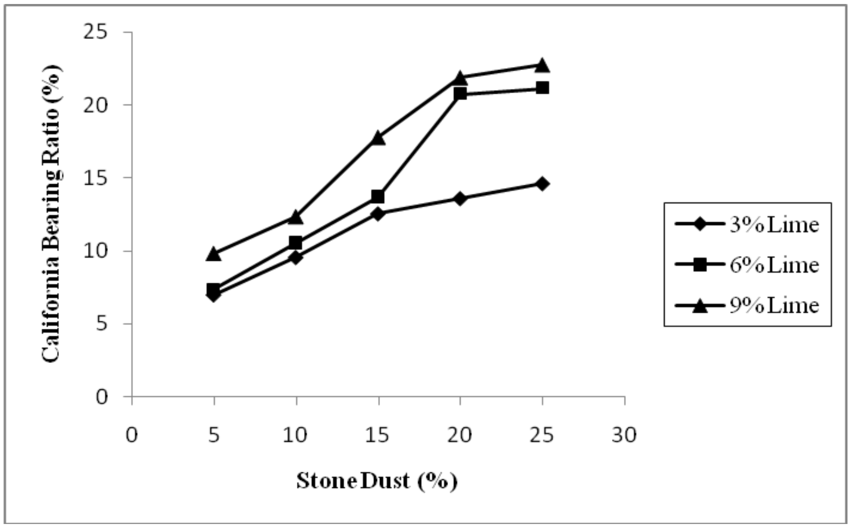

Figure 5. Variation in California Bearing Ratio

REFERENCES

[1] K.A. Nadgouda and R.A. Hegde, "The Effect of Lime Stabilization on Properties of Black Cotton Soil", Indian Geotechnical Conference, GEOtrendz, IGS Mumbai Chapter & IIT Bombay, 511-514, 2010.

[2] Nabil Al-Joulani, "Effect of Stone Powder and Lime on Strength, Compaction and CBR Properties of Fine Soils", Jordan Journal of Civil Engineering, Volume 6, No. 1, 1-16, 2012.

[3] Rohit Mahent and Rajesh Joshi, "Improvement of Soil Index Properties by Adding Stone Dust Mix", IJSTE - International Journal of Science Technology & Engineering, Volume 2, Issue 02, August 2015, 61-68, 2015.

[4] Naman Agarwal, "Effect of Stone Dust On Some Geotechnical properties Of Soil", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), Volume 12, Issue 1, 61-64, 2015.

[5] Chowdary, A.K., "Influence of Flyash on the characteristics of Expansive soil", Indian Geotechnical conference, Warangal, pp.215-218, 1994.

[6] Satyanarayana, P.V.V., Raghu, P., Kumar, R.A. and Pradeep, N., "Performance of Crusher Dust in High Plastic Gravel soils as road construction material", IOSR Journal of mechanical and civil engineering, vol.10, issue 3, 01-05, 2013.

[7] Naman Agarwal, Ashish Murari and Ajit Kumar, "Effect of Stone Dust on Geotechnical Properties of Soil", SSRG International Journal of Civil Engineering (SSRG-IJCE), 54-57, 2015.

[8] Pradeep Kumar. P. and Sandhya Rani. R., "Improvement in Properties of Black Cotton Soil using Lime and Granite Stone Dust", International Journal of Scientific Research and Review, Volume 7, Issue 3, 57-62, 2018.

[9] Hussain, M. and Dash, S.K., "Influence of Lime on Plasticity Behavior of Soils Indian Geotechnical Conference", GeoTrendz, Dec 16^{th} –18^{th} , IGS Mumbai Chapter & IIT Bombay, 537-540, 2010.

[10] Mitchell, K.J. and Soga, K., "Fundamentals of Soil Behaviour", 3rd edition, John Wiley and Sons, New York, 2005.

