



STABILIZATION OF BLACK COTTON SOIL USING SUDDHA SOIL

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Abstract: Black cotton soils are not suitable for civil engineering applications due their high swelling and shrinkage nature they are not suitable for the construction works to improve the strength parameters of these type of soils soil stabilization is necessary. Soil stabilization means improvement of the stability (or) bearing capacity/power of the soil by the use of controlled compaction of suitable admixture – stabilizer. In present study dispersive suddha soil is used to stabilize the black cotton soil. The present study involves the study of behaviour of black cotton soil when mixed with dispersive suddha soil with varying percentage from 0 to 50% at 10% interval, by conducting all geo-technical lab tests like Atterberg's limits and determining the strength parameters. The present study envisages the effect of suddha soil mixed in the different percentages and feasibility of using suddha soil with expansive soil in construction.

Keywords: *Expansive Soil, Stabilization, Atterberg's Limits, Suddha Soil, Compaction and Unconfined Compression Strength.*

I. INTRODUCTION

Improvement of soil is the leading liability in present day construction happenings due to fast progress of urbanization and industrial development. Term soil improvement is used for the techniques which improve the index and other engineering properties. When flexible pavements are constructed over an expansive soil, pavement suffers from the problems of distorted pavement surface, longitudinal cracking of pavement along wheel tracks and there will be loss in effective thickness of pavement over a period of time, Montmorillonite mineral content is more in black cotton soil. These soils have high shrinkage and swelling characteristics, they are highly compressible and have very low bearing capacity and their shearing strength is low. These soils are residual deposits formed from the trap rocks. Expansive soils have a tendency to increase in their volume due to infiltration of water which is resisted by the structure resting on the soil and as a consequence vertical swelling pressure develop if the soil is not allowed to swell freely. The amount of swelling pressure depends on the extent to which the expansion permitted if the swelling pressure exerted by soil is not controlled, it may lead to uplift and distress in structure constructed. Soils which are susceptible to erosion and containing very high percentage of sodium ions are called dispersive soil and these soils are found extensively in US, Australia, Greece, India, Latin, America, South Africa and Thailand. These soils are erodible in nature and have tendency to segregate in presence of water and erode even under less seepage velocity. Sodium ions are quite mobile in the soil solution and so they accumulate in the lower parts of the land scape. Suddha soil is a dispersive soil which is collected from the place Nandagudi of Hoskote Taluk. Specific gravity ranging from 2.65 it is taken from the depth of 1.5m below the ground level. The present study involves the study of behavior of black cotton soil when mixed with dispersive suddha soil with varying percentage from 0 to 50% at 10% interval, and conducting all geotechnical investigations like Atterberg's limits and determining the strength parameters. The present study envisages the effect of suddha soil mixed in the different percentages and feasibility of using expansive with suddha soil in construction.

II. OBJECTIVES

1. To determine the geo-technical properties of BC soil and suddha soil.
2. To analyze the geo-technical properties of BC soil when treated with suddha soil at varying percentage.
3. To find the strength characteristics of BC soil when mixed with varying percentage of suddha soil.
4. To investigate the feasibility of stabilization of BC soil with suddha soil.

III. LITERATURE REVIEW

“Investigation on Engineering Properties of Soil Mixtures Comprising of Expansive Soils and a Cohesive Non Swelling Soil”, by Dr. Ch Sudharani^[3].

In this paper she made an investigation of soil mixture containing three expansive soils which are mixed with a cohesive non swelling soil pertaining to plasticity characteristics, compaction characteristics and soil mixture are prepared with

expansive soils by adding different amount of cohesive non swelling soil varying from 15 to 30% by weight with 5% intervals.

“Control Of Dispersivity Of Soil Using Lime And Cement”.[2] ,by Sivapullaiah, T S Umesha and SV Dinesh,et.al.(Issue 1, Volume 3, 2009) ^[2].

In their study they stabilize a soil called Suddha soil using lime and cement for various percentage of lime and cement. This study deals with stabilization of suddha soil which is found in southern parts of Karnataka with wide spread of 1.5 m below ground level and depth extends up to 10m. The soils that are dislodged easily and rapidly in flowing water to low salt concentration are called dispersive soil they erode even under small seepage velocity.

“Index Properties of Alkalies treated Expansive and Non-expansive Soil Contaminated With Acid”, by H N Ramesh, S D Venkataraju and Mohan,et.al. ^[9].

In their study they stabilized black cotton soil and red soil using chemicals like calcium carbonate, magnesium carbonate. The acids used in the study are H_2SO_4 and Ortho-Phosphoric acid methyl phosphate, the optimum % of magnesium carbonate & calcium carbonate to BC soil was 5% and 15% respectively.

“Investigation on Soil-Mixtures Comprising of Expansive Soils Mixed With A Cohesive Non-Swelling Soil”, by Sindhuja Kandhunuri and Dr.P.Rajasekhar,et.al. ^[6].

In this paper they focuses on possibility of using locally available cohesive soil to stabilize and improve the engineering behavior of expansive soil and determination of optimum percentage of Cohesive Non Swelling soil for better results. The paper emphasized on investigation of soil mixtures comprising of three expansive soils (S1, S2, S3) mixed with a Cohesive Non-Swelling (S4).

“Lime To Improve The Un-Confined Strength Of Acid Contaminated Soil”, by T.S Umesha, S.V Dinesh and P.V SivaPullaih,et.al. ^[4].

The soil is thoroughly mixed with three percent lime in dry condition the compacted specimens for strength test were prepared at respective optimum moisture content and maximum dry density corresponding to 5, 10 and 15 percentage of hydrochloric, phosphoric and sulphuric acid concentrations. The specimens were cured for 14 days by keeping in desiccators for performing un-confined compression test. It is observed that there was no improvement in peak strength of soil even after addition of 3 percent of lime. Better relationship is observed between the modulus of elasticity and UCS of contaminated soil and the soil stabilized with lime.

IV. MATERIALS AND METHODOLOGY

4.1. Materials

Black cotton soil is brought from KADUR of CHIKMAGALUR District, Black cotton soils are inorganic clays whose compressibility is high. Black cotton soils are characterized by high shrinkage and swelling properties, Black cotton soil approximately covers 20% of India which occurs mostly in central and western parts of India. Due to high shrinkage and swelling characteristics of Black cotton soil. Black Cotton soil has become great challenge to the highway engineers. Pavements constructed on such a soils may get cracked and damaged. Black cotton soils often expands by 10% (or) more during a rain fall when these soils dried out they shrink back to their original sizes. The soil used to stabilize the black cotton soil in the present study is locally called as Suddha Soil and it is collected from NANDAGUDI, HOSKOTE taluk. This soil is a dispersive soil it is wide spread below a depth of 1.5m from the ground level and extent to depth greater than 10m. It possesses the good strength in dry condition upon increase in moisture content soil loses its strength.

4.2. Methodology

Tests Conducted Are

1. Grain Size Analysis
2. Specific Gravity of Soil
3. Consistency Limits
 - a. Liquid Limit Test
 - b. Plastic Limit Test
 - c. Plasticity Index
 - d. Free Swelling Index
4. Compaction Test
5. CBR Test
6. Unconfined Compression Test

Table 1.1: Geotechnical Properties of Black Cotton Soil

Sl No.	Properties	Value
1	Soil classification	OH
2	Liquid limit(%)	64.63
3	Plastic limit(%)	26.19
4	Plastic index(%)	38.24
5	Free swell index(%)	114.29
6	Specific gravity	2.63
7	Compaction characteristics	
	Optimum moisture content (%)	22
	Maximum dry density(kN/m ³)	16.4
8	Unconfined compression strength(kN/m ²)	193
9	Califorina bearing ratio(%)	2.12

Table 1.2: Geotechnical Properties of Suddha Soil

Sl No.	Properties	Value
1	Soil classification	SM
2	Liquid limit(%)	38.26
3	Plastic limit(%)	20.56
4	Plastic index(%)	17.7
5	Free swell index(%)	8.8
6	Specific gravity	2.65
7	Compaction characteristics	
	Optimum moisture content (%)	22
	Maximum dry density(kN/m ³)	16.5
8	Unconfined compression strength(kN/m ²)	275.31
9	Califorina bearing ratio(%)	12.98

4.3. Atterberg's Limits for Different % of Suddha Soil.

Liquid limit, plastic limit, plasticity index are calculated for different percentage of suddha soil and are tabulated below.

4.3.1. Liquid Limit at Different % of Suddha Soil.

Table 1.3: Liquid Limit at Different % of Suddha Soil

% of suddha soil	10%	20%	30%	40%	50%
Liquid limit in %	60	58	44.5	40	38

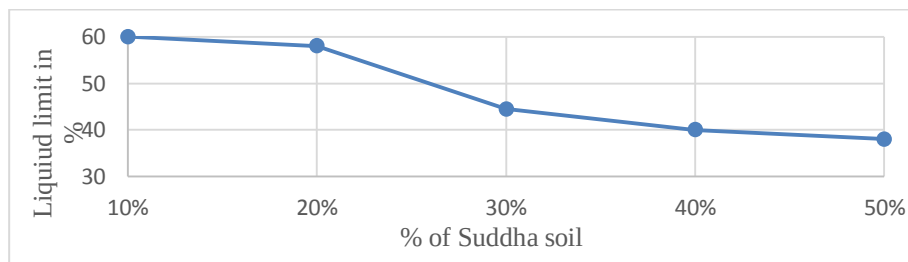


Figure 1: Liquid Limit at Different % of Suddha Soil

Above table and graph shows the liquid limit values for different percentage of suddha soil added. From the graph the minimum liquid limit value obtained was 38% at 50% of suddha soil.

4.3.2. Plastic Limit at Different % of Suddha Soil

Table 1.4: Plastic Limit at Different % of Suddha Soil

% of suddha soil	10%	20%	30%	40%	50%
Plastic limit in %	24.2	36	30	32	34

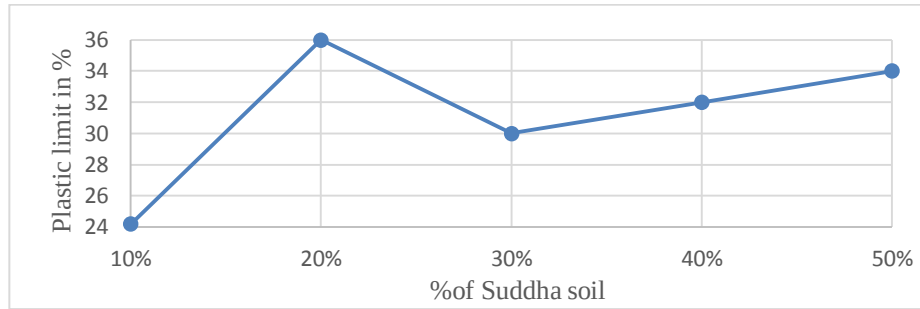


Figure 2: Plastic Limit at Different % of Suddha Soil

Above table and graph shows the plastic limit values for different percentage of suddha soil added. From the graph the maximum liquid limit value obtained was 36% when 20% of suddha soil.

4.3.3. Plasticity Index at Different % of Suddha Soil

Table 1.5: Plasticity Index at Different % of Suddha Soil

% of suddha soil	10%	20%	30%	40%	50%
Plasticity Index in %	35.8	22	14.5	8	4

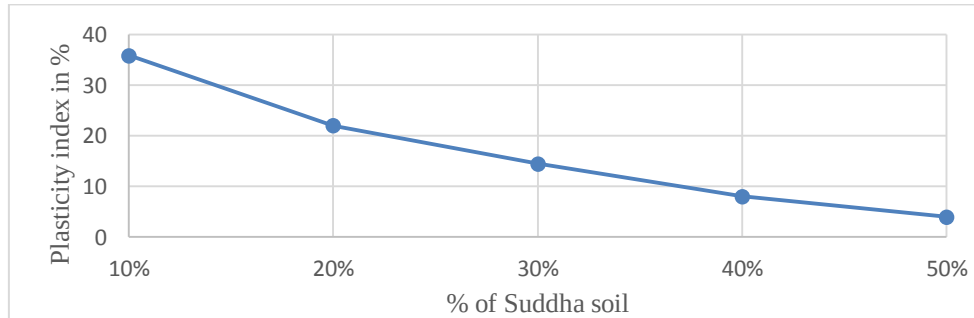


Figure 3: Plasticity Index at Different % of Suddha Soil

Above table and graph shows the plasticity index values for different percentage of suddha soil added. From the graph the minimum plasticity index obtained was 4%.

4.4. Compaction

Table 1.6: Compaction characteristics for Different % of Suddha Soil

%of Suddha soil	Optimum moisture content (%)	Maximum dry density in kN/m ³
10	18	15.9
20	18	16.2
30	14	17.5
40	22	17
50	22	16.5

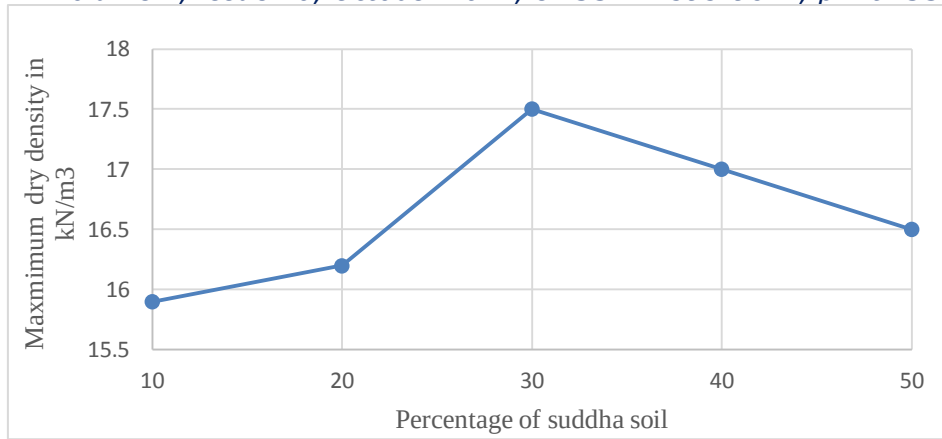


Figure 4: Variation in MDD of Black Cotton Soil When Treated With Varying Percentage of Suddha Soil

Above graph shows the variation of MDD as the percentage of suddha soil varied. From the graph maximum dry density 17.5kN/m³ was obtained when 30% of suddha soil was added.

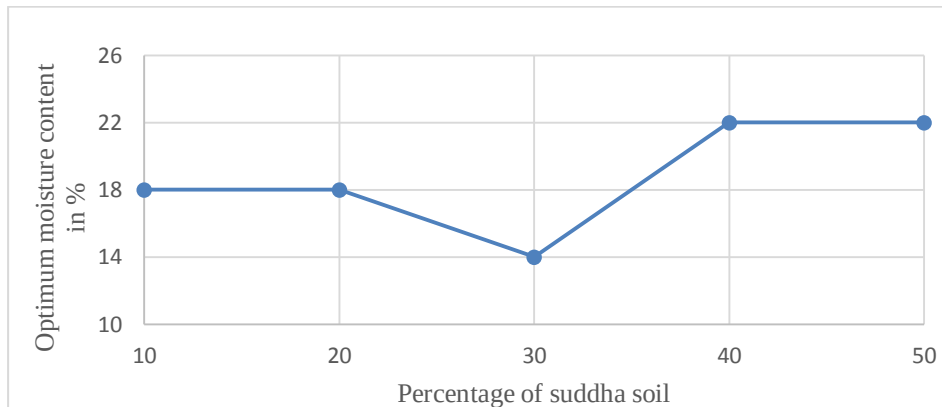


Figure 5: OMC at Different % of Suddha Soil

Above graph shows the variation of OMC as the percentage of suddha soil varied. From the graph minimum optimum moisture content of 14% was obtained when 30% of suddha soil was added.

4.5. California Bearing Ratio (CBR)

Table 1.7: CBR for Different % of Suddha Soil

Penetration in mm	Dial gauge reading				
	percentage of suddha soil				
	10%	20%	30%	40%	50%
0	0	0	0	0	0
0.5	6	8	15	5	6
1	10	15	28	9	8
1.5	14	20.5	36	15	10
2	18	27	50	24	14
2.5	28	36	65	38	20
3	30	38	70	40	22
3.5	32	39	72	41	22
4	32	41	74	42	24
4.5	34	43	76	42	26

5	36	45	80	44	28
5.5	36	46	82	48	30
6	36	46	82	48	30
CBR@2.5mm in %	7.42	9.54	17.22	10.07	5.30
CBR@5mm in %	6.36	7.95	14.13	7.77	4.95

Above table shows the CBR values for different percentage of Suddha soil. The maximum CBR value was 17.22% at 30% of suddha soil.

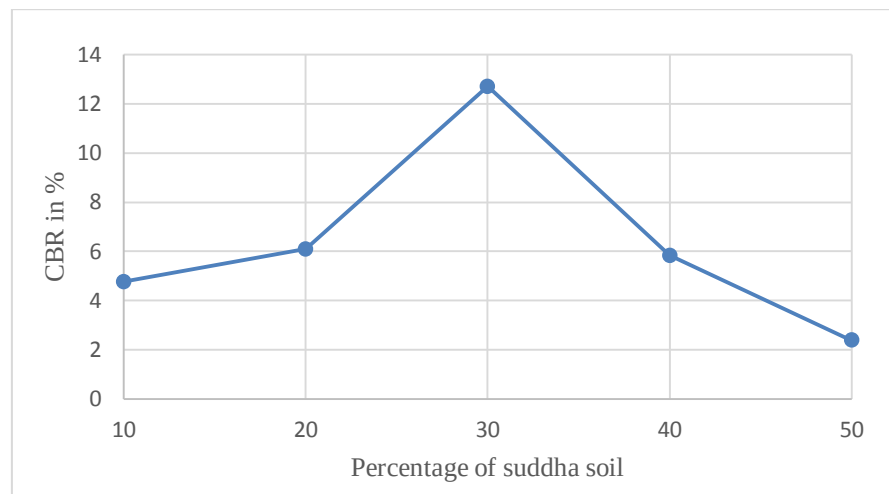


Figure 6: CBR for Different % of Suddha Soil.

Above graph shows the CBR values for different percentage of Suddha soil the maximum CBR value obtained was 17.22% for 30% of suddha soil.

4.6. Un-Confined Compression Strength

Table 1.8: Un-Confined Compression Strength Test Results

Mixture	Un-confined compression strength in kN/m ²				
	Curing period				
	0-day	3-days	7-days	14-days	28-days
Black cotton soil	123.88	114.33	129.39	137.75	193
Suddha soil	216.65	218.84	236.14	239.59	275.31
Black cotton soil+10%SS	306.78	319.7	236.89	223.97	230.24
Black cotton soil+20%SS	275.31	299.86	273.87	288.76	351.83
Black cotton soil+30%SS	343.14	356.42	368.48	351.13	383.76
Black cotton soil+40%SS	367.9	293.04	266.33	274.95	343.33
Black cotton soil+50%SS	285.01	283.44	331.08	353.68	284.93

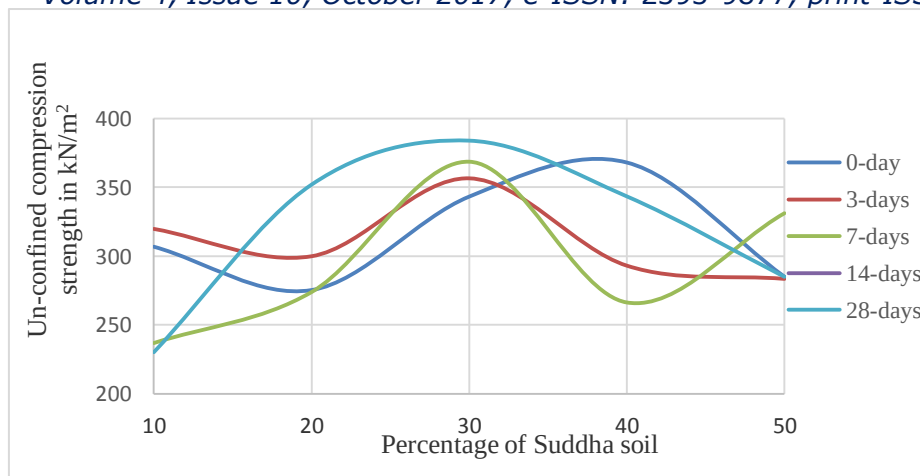


Figure 7: Variation in Un-Confined Compression Strength of Black Cotton Soil

Above figure shows variation in un-confined compression strength of black cotton soil with different percentage of suddha soil on 0, 3, 7, 14 and 28 days of curing.

V. CONCLUSION

Below conclusions are drawn based on the experimental results, they are

1. As the content of suddha soil increases the strength of BC soil also increases. It is observed that the strength of BC increases up to 30% of suddha soil and then it decreases.
2. The Liquid limit, Plastic limit and Plastic index value obtained for 30% of suddha soil are 44.5, 30 and 14.5 respectively.
3. From the compaction test the maximum dry density of 17.5 kN/m^3 is obtained when 30% of suddha soil is added at an optimum moisture content of 14%.
4. From the CBR test the maximum CBR value obtained is 17.22% for 30% suddha soil it implies that the maximum strength of black cotton can be increased by 87.68%.
5. Maximum unconfined compressive strength obtained is 383.7 kN/m^2 when 30% of suddha soil is added to the black cotton soil. That is an increase is of about 50% at 28 days of curing.
6. From all the above points it is clear that the strength of BC soil can be increased by adding 30% of suddha soil to it.
7. Hence stabilization of BC soil using suddha soil can be adopted as an effective method.

VI. REFERENCES

[1]. IS 2720 CODES

- [2]. **Umesha.T.S, Dinesh.S.V, and Sivapullaiah.P.V** (*International Journal Of Geology, Issue 1, Volume 3, 2009*), "Control of Dispersivity of Soil Using Lime and Cement".
- [3]. **Dr. Ch. Sudha Rani**, "Investigation on Engineering Properties of Soil-Mixtures Comprising of Expansive Soils and a Cohesive Non-Swelling Soil".
- [4]. **Umesha.T.S, Dinesh.S.V and Sivapullaiah.P.V** (*International Journal of Geology, Issue 2, Volume 7, 2013*), "Lime to improve the unconfined compressive strength of acid contaminated soil".
- [5]. **P.V. Sivapullaiah** (IGC 2009, Guntur, INDIA) "Effects of Soil Pollution on Geotechnical Behaviour of Soils".
- [6]. **Sindhuja Kandhuni and Dr.P.Rajasekhar** "Investigation on Soil-Mixtures Comprising of Expansive Soils Mixed with a Cohesive Non-Swelling Soil".
- [7]. **Kavish S. Mehta, Rutvij J. Sonecha, Parth D. Daxini, Parth B. Ratanpara, Miss Kapilani S. and Gaikwadhave** "Analysis of Engineering Properties of Black Cotton Soil & Stabilization Using By Lime.".
- [8]. **Ramesh.H,N, Krishnaiah.A.J and S.Shilpashet** "Effect of Lime on the Index Properties of Black Cotton Soil and Mine tailings mixtures."
- [9]. **Mekkiyah, H. M and Al-Khazragie** "Behavior of clay soil mixed with fine sand during consolidation".
- [10]. **Mr Vismay J shah, Abhijitsinh Parmar and Ankit Patel** "Improvement of C.B.R in Black cotton Soil having high Salinity using different Materials".
- [11]. **Pramod Kilabanur, Tanveer Ahmad, Dorothy Bhagabati, Nitesh Kumar and Ysaswini S** "Stabilization Of Black Cotton Soil Using Envirobase And Sodium Silicate With Lime".
- [12]. **G.L.Oyekan, E.A.Meshida and A. O. Ogundalu** "Effect of ground polyvinyl waste on the strength characteristics of black cotton clay soil".
- [13]. **Ramesh.H.N., S.D.Venkatarama and Mohan**, "Index properties of alkalis treated expansive and non-expansive soil contaminated with acids"
- [14]. **Umesha.T.S, Dinesh.S.V and Sivapullaiah.P.V** "Effects of acids on geotechnical properties of black cotton soil".