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Effect of Lime & Sisal Fibre on Volume Change and Compressibility Change in Expansive Soils

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ABSTRACT

Soil improvement is of significant worry in the development exercises because of fast development of urbanization and industrialization. Particularly far reaching soils are overall tricky soil which is related with huge volume change conduct when it experiences an adjustment in the water content. Among those, dark cotton soil are one sort of far reaching soils and they shows high swell shrinkage conduct attributable to fluctuating water content. In India, dark cotton soil covers as high as 20% of the complete land zone and significantly in focal and south India. In the event that it ought to be utilized as establishment material, Improvement of soil should be finished by receiving different strategies like soil adjustment, support and so forth. Use of locally accessible admixtures is successful regarding simple versatility and economy.

In present examination, the dirt examples arranged with expansion of sisal filaments by 0.25%, 0.5%, 0.75%, and 1% at 4% lime as steady added substance. The normal length of sisal fiber is going to use in this examination is around 10-15mm. From the start, Optimum Moisture Content (OMC) was resolved through delegate test. At those OMC, a few tests like CBR, UCS, Consolidations tests were directed. CBR test was conveyed in both un splashed and doused condition and Consolidation characters are additionally improved for all examples.

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INTRODUCTION

Soil improvement is of major concern in the construction activities due to rapid growth of urbanization and industrialization. The term soil improvement is used for the techniques which improve the index properties and other engineering characteristic of expansive soils. Expansive soils are worldwide problematic soil which is associated with large volume change behavior when it undergoes a change in the water content. When expansive soils are exposed to high water content, the exhibit high selling characteristics. And when the presence of low water content, the shows low shear strength. These soils pose several problems to the structures due to their volume changes. Among those, black cotton soil are one type of expansive soils and they shows high swell shrinkage behavior owing to fluctuating water content. In India, black cotton soil covers as high as 20% of the total land area and majorly in central and south India. They are predominant in the states of Gujarat, Maharashtra, Madhya Pradesh, Andhra Pradesh, Karnataka and Tamil Nadu. These soils have high swelling and shrinkage characteristics and extremely low CBR value and shear strength. If it should be used as foundation material, Improvement of soil need to be done by adopting various techniques like soil stabilization, reinforcement etc. One method of controlling volume changes is to stabilize the soils with admixtures that prevent volume changes are adequately modify the volume change characteristics of soft clayey soil (Kehew 1995).

MATERIALS

Sisal Fibre:

Sisal fibre is the natural fibre obtained from the sisal plant. The production of sisal fibre was increasing in south India. The average diameter of sisal fiber will be 0.2mm. The average length of the sisal fibre is used in this study is about 10 – 15 mm. Sisal fiber used in this study was collected from Sri Lakshmi Groups, Fiber production Unit, Cherakupalli, Guntur, Andhra Pradesh.

Fig-1 Sisal fibre

Lime:
Soil stabilization occurs when lime is added to a reactive soil to generate long term strength gain through a pozzolanic reaction. Locally available fine lime stone powder was used in this present study and it was collected from Supraja Enterprises, Vijayawada, Andhra Pradesh.

Methodology:
Black cotton soil was collected and it was subjected to air dried to carry the whole study. The whole study was carried in 3 phases.

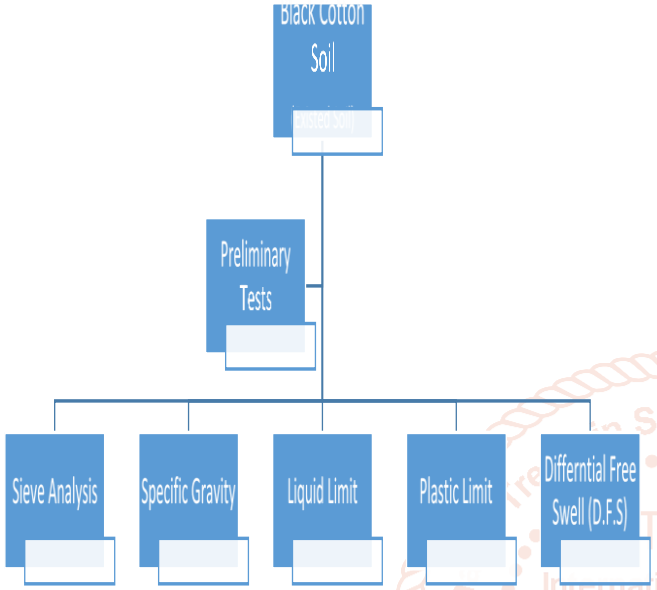

Fig -2Schematic representation of test carried in PHASE – 1

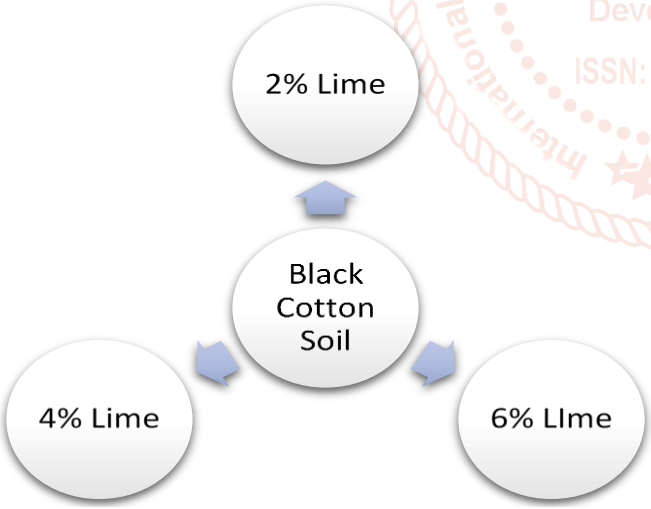

Fig-3 Schematic Representation of Compaction Test Sample prepared With variation of Lime%

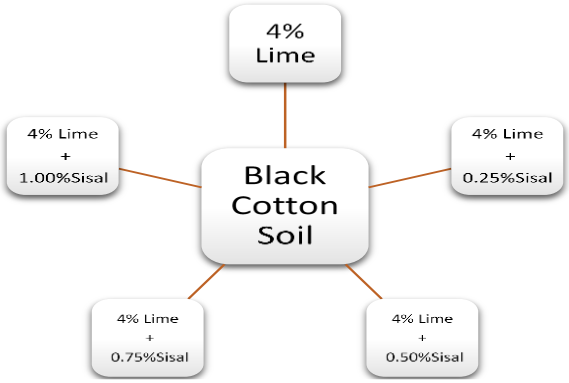

Fig-4: Schematic Representation of Samples prepared in PHASE 3

Laboratory experimental study
The list of experiments performed on different samples of black cotton soil along with the addition of lime and sisal fiber at different percentages were explained.

1. Sieve analysis
2. Specific gravity
3. Liquid limit
4. Plastic Limit
5. Plasticity index
6. Differential Free swells

Table-1: Relation between D.F.S and Degree of Expansion

S. no	Degree of Expansion	D.F.S
1	Low	< 20%
2	Moderate	20 – 35 %
3	High	35 – 50%
4	Very High	>50%

Consolidation Test:
Consolidation of a saturated soil occurs due to expulsion of water under a static, sustained load. The consolidation characteristics of soils are required to predict the magnitude and the rate of settlement. The following characteristics are obtained from the consolidation test.

Coefficient of Compressibility, $a_v = -\Delta e/\Delta\sigma^-$

Coefficient of Volume Change, $m_v = \frac{-\Delta e}{1+e}\left[\frac{1}{\Delta\bar{\sigma}}\right]$

Compression index, $C_c = \frac{-\Delta e}{\log_{10}\frac{(\bar{\sigma}_0 + \Delta\bar{\sigma})}{\bar{\sigma}_0}}$

Coefficient of Consolidation, $C_v = T_v\, d^2/t$

RESULTS AND DISCCUSSIONS

Table-2 Liquid Limit Test Observations:

S. no	Observations & Calculations	Test 1	Test 2	Test 3	Test 4
1	Number of Blows	35	27	12	6
2	Mass of Empty Container (M1)g	24	32	28	21
3	Mass of Container + Wet Soil (M2)g	62	78	69	72
4	Mass of Container + Dry Soil (M3)g	45	41	34	37
5	Water Content W = (Mw/Md)x100 %	49.62	54.17	56.50	59.23

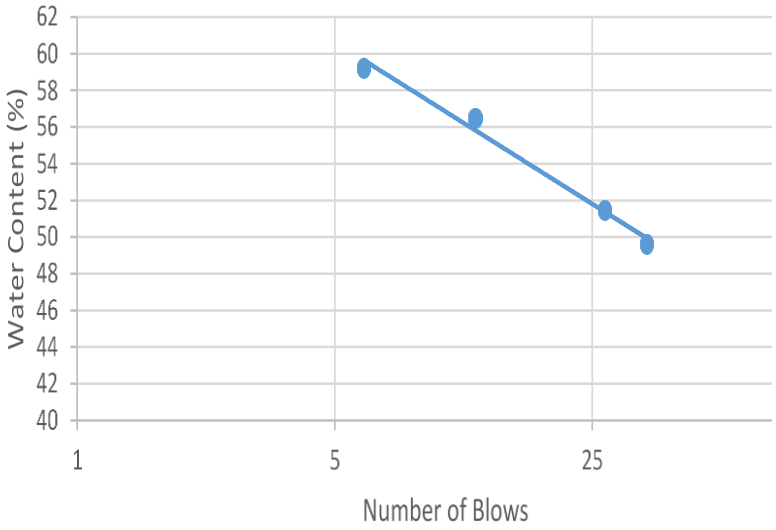

Fig-5 Liquid Limit representation Graph

Compaction Test Results of Black Cotton Soil:

Table-3 Compaction test observations

BC: Black cotton Soil					
Observations & Calculations	Water Content				
	14%	17%	20%	23%	26%
Weight of the Mould + Soil (g)	8631	8810	9003	9025	9067
Weight of the Compacted Soil (g)	3651	3830	4023	4045	4087
Bulk Density (g/cc)	1.62	1.70	1.79	1.80	1.82
Water Content Determination					
Weight of the empty Cup (g)	22	29	35	26	30
Weight of the Cup + Wet Soil (g)	58	72	83	79	63
Weight of the Cup + Dry Soil (g)	49	58	64	60	44
Water Content (%)	13.28	16.41	19.53	22.39	25.16
Dry Density(g/cc)	1.43	1.46	1.50	1.47	1.45

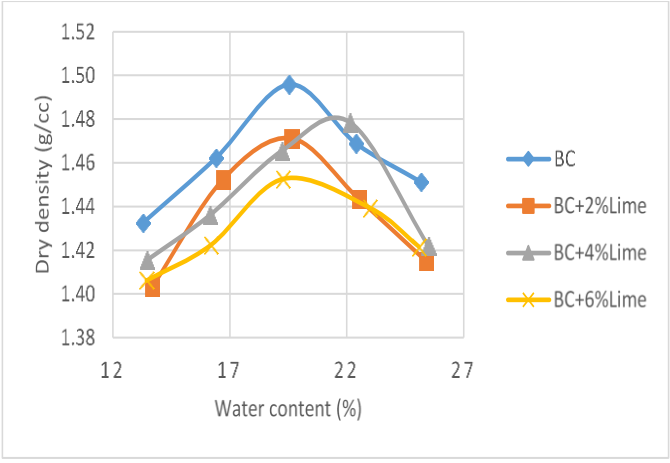

Fig-6 Compaction curves for soil samples with 0%,2%,4%,6% of Lime

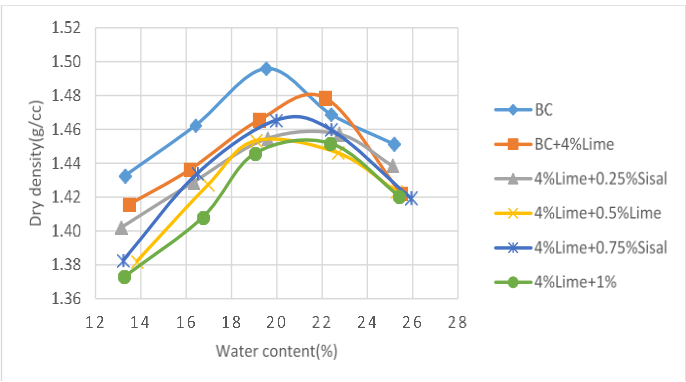

Fig-7 Compaction curves for soil samples with 0%,2%,4%,6% of Lime

Table-4 OMC and MDD values of BC + Lime% +Sisal%

S. no	Sample	OMC (%)	MDD (g/cc)
1	Black Cotton Soil	20	1.50
2	BC + 4% Lime	21	1.48
3	BC + 4% Lime + 0.25% Sisal	21.5	1.46
4	BC + 4% Lime + 0.50% Sisal	21.5	1.45
5	BC + 4% Lime + 0.75% Sisal	22	1.47
6	BC + 4% Lime + 1.00% Sisal	22.5	1.45

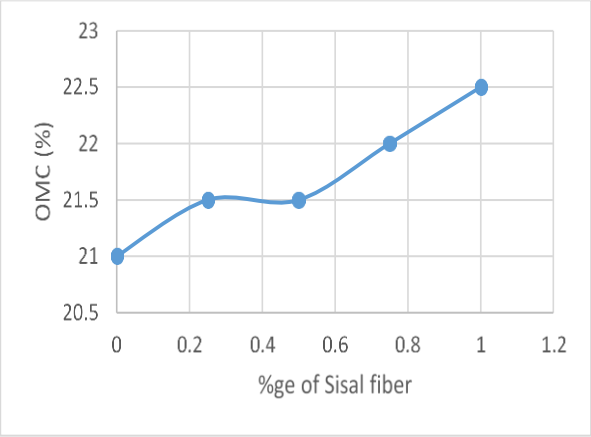

Fig-8 Variation of OMC with different %ge of Sisal Fiber at 4% Lime

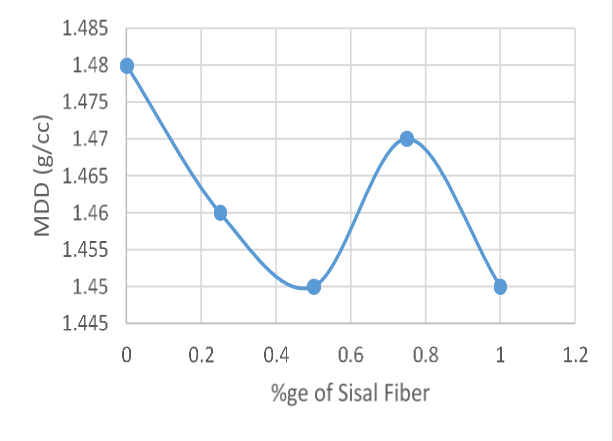

Fig-9Variation of MDD with different %ge of Sisal Fiber at 4% Lime

Table 5: Unsoaked and Soaked CBR values at different percentages of Lime and Sisal Fiber

S. no	Sample	CBR	
		Unsoaked	Soaked
1	Black Cotton Soil	2.2	1.4
2	Black Cotton Soil+ 4% Lime	2.9	2.1
3	BC + 4% Lime + 0.25% Sisal	3.5	2.6
4	BC + 4% Lime + 0.50% Sisal	3.8	3.2
5	BC + 4% Lime + 0.75% Sisal	4.4	3.9
6	BC + 4% Lime + 1.00% Sisal	4.1	3.4

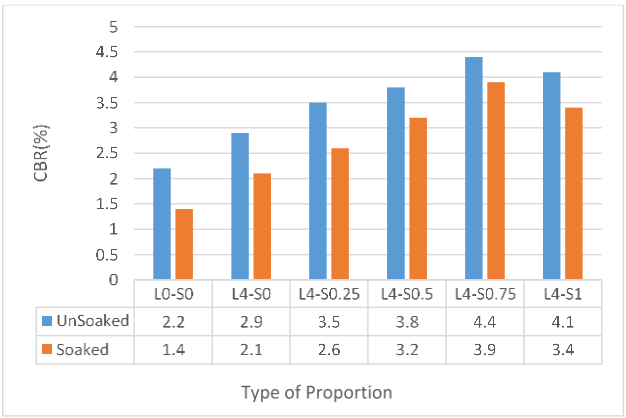

Fig-10 Unsoaked and Soaked CBR values at different percentages of Lime and Sisal Fiber

CONCLUSIONS

In this study, the major properties studied are OMC, MDD, CBR, UCS, and Consolidation. Based on the all investigations on all samples and when compared with normal soil, following conclusions were made.

Optimum Moisture Content: (OMC)

- Optimum moisture content (OMC) was increase with the addition of sisal fiber.
- For normal soil, OMC observed at 20% and it is increased to 21.5, 21.5, 22, and 22.5% with the addition of 0.25%, 0.5%, 0.75% and 1% sisal fiber at 4% Lime respectively

Maximum Dry Density: (MDD)

- Maximum dry density was decreased with the addition of sisal fiber and lime
- When 2%, 4%, 6% lime added, higher MDD observed for 4% of lime addition
- When Sisal fiber added, MDD value were decreased. But, at 0.75% sisal fiber addition was increased when compared to other sisal fiber additions.

California bearing ratio: (CBR)

- Both the Unsoaked and soaked condition of CBR were studied and Peak value was obtained at 0.75% sisal fiber addition in both conditions.
- From 0 to 0.75% addition of sisal fiber, CBR value was gradually increased in both unsoaked and soaked condition.
- But, CBR value was decreased after 0.75% of sisal fiber addition (i.e., at 1%)

Unconfined Compressive Strength: (UCS)

- UCS was calculated for 0, 3, 7, 14, 28 curing days.
- UCS values are gradually increased 0, 3, 7 curing days for respective addition of fibers and lime.
- At 14 days curing period maximum value is attained for 0.75% sisal fiber addition. And But, 28 days UCS was decreased for this combination.
- At 0.75% and 1% addition of sisal fiber, UCS was decreased for 28days curing period. But the values were improved when compared to normal soil.
- Gradual increment in UCS at all curing days was observed at 0.25%, 0.5% addition of sisal fiber. In those, maximum value is attained for 0.5% addition.
- With overall observations of UCS, 0.5% and 0.75% addition was good, and more than that was not good.

Consolidation Characteristics:

Coefficient of Compressibility, Compression index, Coefficient of Volume change were calculated for all samples. And observed that, there is decrement in all coefficients with addition of sisal fiber and lime. i.e., consolidation characteristics are improved through the addition of these additives.

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