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Stabilization of Clayey Soil by Lime & Coir

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ABSTRACT

The preliminary characteristics of Clayey soil is which it possess poor shear strength with high swelling & shrinkage, thus the behaviour of the soil under the application of load can be altered by changing its physical & engineering properties. When the clayey soil is exposed to variation in climatic condition that leads to increase or decrease in its swelling & shrinkage ratio, these variations can be minimised by natural admixtures such as Lime & Coconut coir fibres. The present study deals with evaluation of physical & engineering properties of clayey soil which is mixed with admixtures in a varying proportions & the results are tabulated by comparing it with standard codes & practises. The experimental study also revealed that with the increase of percentage of Lime & coir with Clayey soil, there is an increase in Maximum dry density values where as there is considerable reduction in optimum moisture content for the given clayey soil by conducting standard proctor test also with the conduction of CBR test by varying the percentage of admixtures, there is a gradual increase in the CBR values with the increase in percentage of stabilizers.

Key words*: *Soil stabilisation, admixtures, physical properties of soil, unconfined compressive strength, CBR.

I.INTRODUCTION

Clayey soil are considered as the problematic deposits for civil engineering constructions since they are susceptible for change in volume due to seasonal variations, change in the characteristics of clayey soil due to climatic variations will cause damage of facilities built on them. Therefore it is essential to stabilize the soil for supporting the sub structure, stabilization is to improve the strength or load bearing capacity & also to reduce plasticity index, shrink – swell properties of soil, better soil gradation with increase in durability by controlled compaction, proper proportioning and or the addition of suitable admixture for the soil, stabilization techniques for the clayey soil may be mechanical or chemical, or inclusive of both. Various methods are available to stabilize the soil and the method should be analysed in the laboratory initially with soil material before applying it on the field conditions.

Stabilization of soil should be cost-effective, long-term physical and chemical alteration of soil will enhance their physical properties which can improve shear and unconfined compressive strength and permanently lower the soil's permeability to water. Gradation of the soil is also a very important property in which the soil may be well-graded which is desirable as it has less number of voids or uniformly graded which though sounds stable

but has more voids thus, it is better to mix different types of soils together to improve the soil strength properties because it is very expensive to replace the inferior soil completely during construction.

Soil stabilization is used in many sectors of the construction industry, Roads, parking lots, airport runways, building sites, landfills, the use of soil stabilization for slope protection, dam cores, impervious liners are feasible based on both economical & service life considerations. Water infiltration weakens the underlying soil & variable vehicular wheel loads moving on the surface layer will damage the pavement structure, the use of chemical stabilization in roadway design speaks directly to these issues of long-term life-cycle stability of the soil.

Stabilization of soil can be done by adding additives or without additives, the following are major methods of soil stabilisation:

- Mechanical Stabilization is suitable for low volume roads which involves the correct proportioning of aggregates and soil which are adequately compacted to get mechanically stable layer.
- Soil Cement Stabilization is an intimate mix of soil, cement and water, compacted to form a strong base course & to increase compressive strength of the soil layer. Soil Cement can be used as a sub-base or base course for all types of Pavements.
- Soil Lime Stabilization Soil-Lime has been widely used as a modifier or a binder for a high plastic soils which imparts binding action even for a granular soils.
- Soil-Bituminous Stabilization Bitumen Stabilized layer may be used as Sub-base or base course for all the roads in which the basic principles of this stabilization are Water Proofing and Binding of soil components which enhances its strength & the most commonly used materials are cut back & emulsion.
- Lime Fly ash Stabilization Can be used for construction of Embankments, Rigid and semi-rigid pavements. Fly ash properties vary widely & thus to be characterized before it is used for stabilization of soil layer. The major constituents of fly ash are oxides of silica, aluminum, iron, calcium & magnesium which Possesses many favorable properties for embankment & road construction, fly ash is also termed as environmentally safe material which enhances the properties of soil.
- Chemical stabilization will occur due to chemical reaction between soil and stabilizer used in it. The stabilization of clayey soil chemically can be achieved by two ways, they are in situ stabilization & ex situ stabilization. In in-situ stabilization the soil is stabilised by mixing stabilizing agents to soil in the site itself but where as in ex situ stabilization the soil is mixed with admixture in remote area and then brought to the work site.

In the present study, the possibility of stabilizing clayey soil by improvising its physical properties with stabilizers such as lime and coconut coir are investigated whereas the lime is considered to be the most suitable stabilizing agent for clayey soil.

II.REVIEW OF LITERATURE

Presence of montmorillonite which is characterized by large volume change from wet to dry seasons and vice versa, black cotton soil facilitates compaction for obtaining the desired density with comparatively less effort. The characteristics of Clayey Soil is it forms a very poor foundation material for road construction & also possess low strength with excessive volume changes due to climatic variations. The properties of the clayey soil can be altered in many ways viz, mechanical thermal, chemical and other means stabilisation, it is important to investigate the physical and engineering properties associated with the black cotton soil. In the present study black cotton soil specimens are derived from depth of 1.0 m & were studied in the laboratory for investigation of physical and engineering properties. Various tests like grain size analysis, specific gravity, atterberg's limits, standard proctor compaction, consolidation and direct shear test were conducted on the soil specimens as per the Indian Standard Codes [1].

Clayey soil found in semi – arid regions of tropical and temperate climate zones will be having high evaporation percentage when compared to precipitation. The sticky plastic nature of it will make the soil extremely difficult to extract or dislodge & the cracks measuring 70 mm wide and over 1 m deep were observed in the study also it has shown that these cracks can extend up to 3m or more in case of high deposits [2].

The effect of coir fibres on strength properties of clayey soil is found by mixing it with various proportions to the dry weight of soil, by the experimental studies it is found that maximum dry density will decrease & optimum moisture content will increase with increase in fibre content also there is an increase in strength properties like CBR, compaction, shear strength with inclusion of fibres. The trend was same up to the addition of 0.5% fibres & above which it started decreasing [3].

The mechanical behaviour of expensive soils on addition of coir fibres were studied in which the first phase of work includes compaction characteristics of soil by the addition of different percentages of coir fibres in to the soil whereas the second phase covers unconfined California Bearing Ratio test for reinforced and unreinforced soil specimens. From the results obtained, the maximum dry density of soil mixture will decrease with addition of fibres whereas optimum moisture content will remain same. The maximum CBR strength was obtained for mixture which contains 1.0% of geo synthetic fibres [4].

The property of clayey soil can be effectively improved by using varying percentage of lime contents from 3% to 5%. By the experimental analysis in the laboratory it was observed that on an addition of 3% of lime to the clayey soil there is a considerable decreases the liquid limit by 2.70% while with 5% addition of lime reflects a decrease 15.27% also there is an increase in MDD by 6.29% and 5.59% at 3% and 5% lime content respectively. The C.B.R. values of black cotton soil is improved considerably to 3.25 times and 4.76 times with the addition of 3% and 5% lime to the clayey soil respectively [5].

The effect of lime in addition with clayey soil in an incremental manner up to 6% to a high expansive clayey soil used in the laboratory for investigation in the prevailing conditions (temperature and humidity) which will enhance the strength, penetration resistance and reduce swelling & shrinkage behaviour. Quick lime can be successfully used for treatment of BC Soil, which is a cost effective when compared to other admixtures such as cement and asphalt which will provide long life to the structures with least maintenance. If the soil is non-plastic

and is having low plasticity index, lime alone is not satisfactory for stabilization but an addition of fly ash is needed to improvise the necessary changes in the soil [6].

The Liquid Limit of black cotton Soil continuously decreases with increase in percentage of lime content and Electric arc furnace (EAF) dust content, Plasticity index of black cotton soil will also decrease with increase in EAF dust & lime fine content. Optimum moisture content increases with decrease in dry density for an increase in lime content in the soil. Whereas the Optimum moisture content decreases with increase in MDD for an increase in EAF dust content. Unconfined compressive strength value of black cotton soil increases with increase in EAF dust content up to 6% of lime and then it decreases with increase in EAF dust content also the unconfined compressive strength value of black cotton soil increases with increase in curing period for the BC soil. Higher CBR value leads to lower total pavement thickness of flexible pavements which is economical for overall project as the materials required for construction is reduced [7].

With the presence of clayey content in soil & by conducting physical property tests there is an increase in the plasticity index by classifying the Soil specimens as A, B and C which retains almost same percentage of clay particles and have medium range of plastic indices. Whereas Liquid limit, Plastic limit, Specific Gravity and Dry Density of soil specimen A was found to be higher than the soil specimen B and C. The value of value of angle of internal friction of soil specimen C was observed to be higher than soil specimens B and A. Predicted values of the parameters viz. Plasticity index (PI), Optimum Moisture Content (OMC), Compression Index (Cc) and Angle of Internal Friction (ϕ) for the soil specimens A, B and C from empirical models derived through regression analysis were observed to be very close to the experimental values. With the increase in the plasticity index induces decrease in the angle of internal friction and the compaction Characteristics were observed to be fair for black cotton soils [8].

Quantity of lime is varied from 2% to 4% of BC soil to observe the corresponding physical & engineering changes in the properties of soil. The value of MDD increases with increase in percentage of lime whereas OMC decreases and Swelling pressure is lowered by 29% at 4% lime & also there is considerable reduction in compressibility value of the soil which can be stabilised by fly ash or other organic material [9].

The liquid limit can be considered as the measure of quantity of water attracted by soil particles for a given value of shear strength thus making it possible to correlate with compressibility. The clayey soil is very hard when it is dry but loses its strength completely in wet condition. Studies has shown that 40 to 60% of black cotton soil will have its particle size less than 0.001 mm [10].

The laboratory tests were conducted to investigate the influence of lime and coir fibres on clayey soil with varying length of coir fibres and varying percentages, the moisture density relationship was affected by addition of fibres to mixture of soil also Maximum dry density and optimum moisture content were decreased with addition of lime and fibres to soil. Increase in CBR strength was observed with addition of fibres due to increase in compressive strength and ductility of soil. With the increase in fibre length above 12mm did not support much on the strength properties of soil. The best CBR value was also achieved by adding 1% of fibre having 5mm length [11].

The tests were conducted on influence of coir fibres to the strength properties of clay soil in which the California Bearing Ratio Test for different percentage of coir fibres with different percentage of lime resulted in increase of lime percentage up to 6% to clay soil will increase the Strength of soil, with addition of 0.25% coir fibres with 1% of lime to clayey soil showed the maximum strength [12].

III.MATERIALS & METHODOLOGY

1. Materials

a) Clayey Soil of pertaining Sieve size as per IS standards.
b) Lime.
c) Coir fibres.
d) Potable water for mixing the constituents.

2. Methodology

Preliminary tests were conducted on the materials as per IS standards & specifications where the clayey soil was initially tested for its physical properties & then it is tested for engineering properties by Compaction & CBR test. Initially Lime additive is added to the clayey soil by varying its proportion by 2%, 4% & 6% for conducting CBR test, after obtaining the optimum percentage of lime Coconut coir is added to the soil & lime mix by 0.5%, 1.0%, 1.5% & 2% to evaluate the characteristics of strength variation by Compaction & CBR test.

The main aim of the methodology is to -

- To evaluate the strength characteristics of Clayey soil with different percentages of Lime & Coir.
- To improve the engineering properties of the BC soil by adding admixtures and make it suitable for construction.
- To reduce the volume of voids & porosity of clayey soil by suitable admixtures.

3. Tests (physical properties) conducted on Clayey soil

- Specific Gravity Test by Density bottle method.
- Moisture content.
- Particle Size Distribution.
- Liquid limit test.
- Plastic limit
- Shrinkage limit.

The above tests were conducted as per ASTM standards with 4 trials on each tests & the average results are tabulated.

4. Tests (Engineering properties) conducted on Clayey soil with admixtures

- Stage – 1: Varying percentage of Lime & conducting CBR test.
- Stage – 2: Varying percentage of Coir & keeping optimum lime content for conduction of Standard proctor & CBR test.

TABLE:1 PHYSICAL PROPERTIES OF CLAYEY SOIL

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Si no	Properties		Test method	Average Value	Permissible value
1	Colour			Brown	
2	Specific Gravity		IS-2720 Part-3 (1980)	2.31	2.6-2.75
3	Moisture content			46.95%	-
4	Grain size distribution	Coefficient of uniformity (C_U)	IS-2720 Part-4 (1985)	5.19	> 1
		Coefficient of Curvature (C_C)		1.2	Between 1 & 3
5	Atterberg limits	Liquid limit	IS-2720 Part-5 (1985)	52%	35-50%
		Plastic limit		14.28%	Less than or equal to 40
		Shrinkage limit	IS:2720 (Part 6) – 1972	22.76%	--
6	Standard Proctor Compaction Test		IS:2720 (Part 29) - 1975	OMC = 20 %	Up to 21%
				MDD = 2.02 g/cc	1.92 to 2.02
7	CBR Test		IS:2720 (Part 16) - 1987	2.5 mm penetration = 2.0 %	--
				5.0 mm penetration = 1.7 %	

TABLE: 2 TABULAR COLUMN OF STANDARD PROCTOR TEST FOR CLAYEY SOIL

% Of water added to the soil	12 %	14%	16%	18%	20%	22%	24%	26%

Wt of empty Mould (W_1) in Kgs	5.61	5.61	5.61	5.61	5.61	5.61	5.61	5.61
Wt of mould + compacted soil (W_2) in Kgs	7.54	7.69	8.2	7.54	7.52	7.51	7.49	7.47
Wt of soil only (W_s) in Kgs	1.89	1.91	1.93	1.95	2.02	1.91	1.89	1.87
Bulk Density γb = Ws / V (gm /cc)	1.88	1.92	1.94	1.96	1.98	1.94	1.92	1.9
Dry Density γd = (γb / 1 + W) gm /cc	1.76	1.8	1.93	1.98	2.02	2.0	1.98	1.97

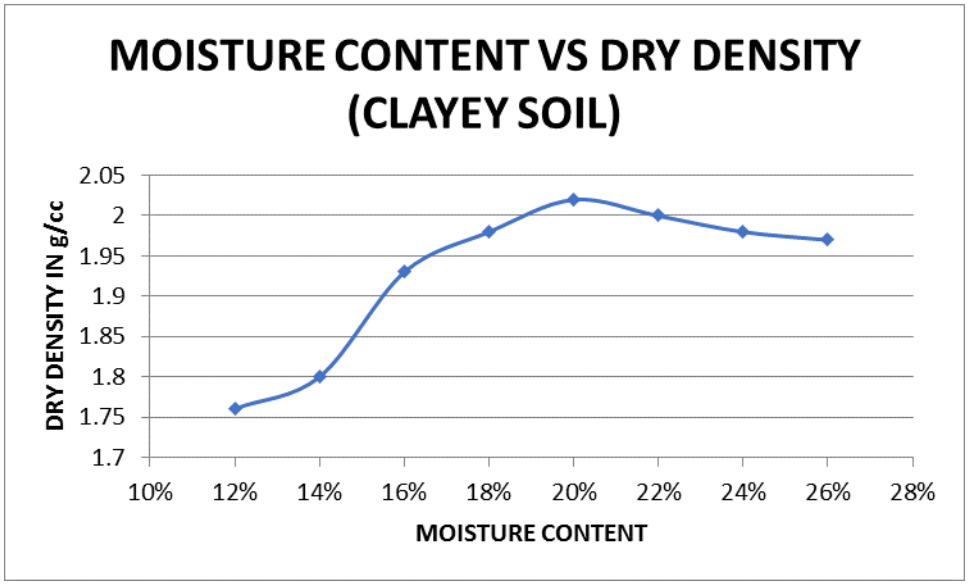

FIG:1 MOISTURE CONTENT VS DRY DENSITY (g/cc) FOR CLAYEY SOIL

TABLE: 3 TABULAR COLUMN OF CBR TEST FOR CLAYEY SOIL

Dial gauge reading in mm	Proving ring reading		Load (P) in Kgs
	DIV	DIV*PRC	
0	1.0	58.8	5.99
0.5	2.4	164.6	16.78
1.0	3	176.4	17.98
1.5	3.4	199.2	20.3
2.0	4	235.2	23.97
2.5	4.6	270.4	27.57
3.0	5.2	305.7	31.16
3.5	5.8	341.0	34.76
4.0	6.2	364.5	37.16
4.5	6.6	388.0	39.56
5.0	6.8	399.8	40.75

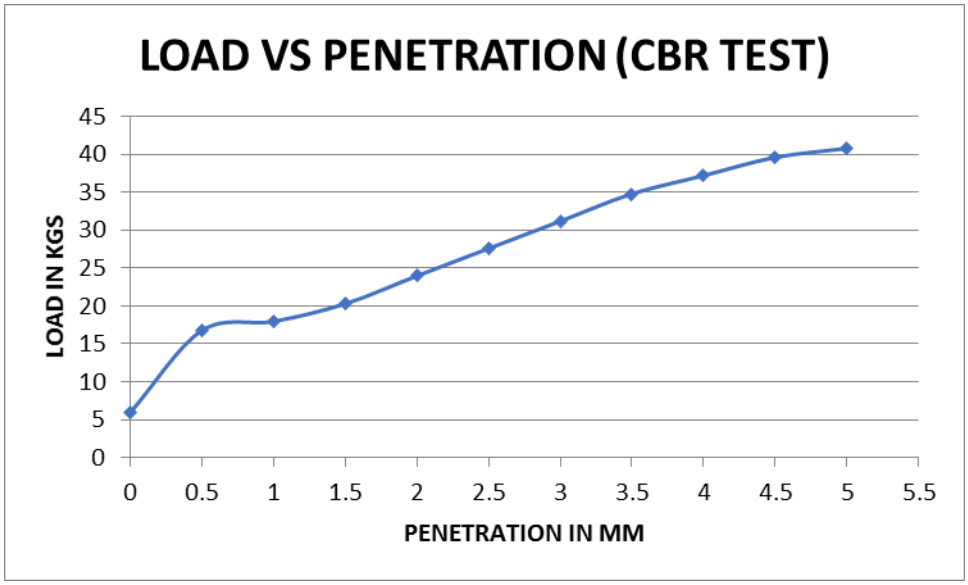

FIG:2 LOAD VS PENETRATION FOR CLAYEY SOIL

IV. EXPERIMENTAL DESIGN

MIX DESIGN

The properties of natural clayey soil (passing through 425µ IS sieve) are determined & then it is tested for its physical properties, additives such as Lime is added in various proportions like 2%, 4% & 6% for analysing the optimum dosage of lime by conducting CBR test as per IS specifications. The clayey soil is also stabilised by adding Coir of varying percentages like 0.5, 1.0 1.5 & 2.0% keeping Lime percentage as 4 % & analysed for standard proctor test & CBR test as per IS specifications & the results are tabulated.

The proportions of mix samples were prepared and a set of laboratory tests were performed to determine the index properties with CBR & maximum dry density values.

The varying proportions of admixtures in Clayey soil is listed below:

1. Clayey soil.
2. Clayey soil + 2% Lime
3. Clayey soil + 4% Lime
4. Clayey soil + 6% Lime

The above variations of Lime percentage is mixed with clayey soil & tested for CBR values.

1. Clayey soil +4% Lime + 0.5% Coir
2. Clayey soil + 4% Lime + 1.0% Coir
3. Clayey soil + 4% Lime + 1.5% Coir
4. Clayey soil + 4% Lime + 2.0% Coir

The above variations of Lime percentage with coir is mixed with clayey soil & tested for both proctor & CBR values.

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V.RESULTS & DISCUSSION

1. California Bearing ratio Test conducted on clayey soil with varying percentage of admixtures

With the varying percentages of Lime is added for the calculation of Maximum dry density & Optimum moisture content. It has been found that with the increase in percentage of Lime there is an decrease in both 2.5 mm & 5.0 mm penetration values for the given clayey soil.

TABLE: 4 ENGINEERING PROPERTIES OF CLAYEY SOIL WITH LIME AS ADMIXTURE IN VARYING PERCENTAGES

Si no	Properties	Test method	% of Lime	Average value	Permissible value
1	CBR Test	IS:2720 (Part 16) - 1987	**2%**	2.5 mm penetration = 2.02 %	--
				5.0 mm penetration = 3.5 %	--
2	CBR Test	IS:2720 (Part 16) - 1987	**4%**	2.5 mm penetration = 1.78%	--
				5.0 mm penetration = 2.68 %	--
3	CBR Test	IS:2720 (Part 16) - 1987	**6%**	2.5 mm penetration = 1.5%	--
				5.0 mm penetration = 2.3 %	--

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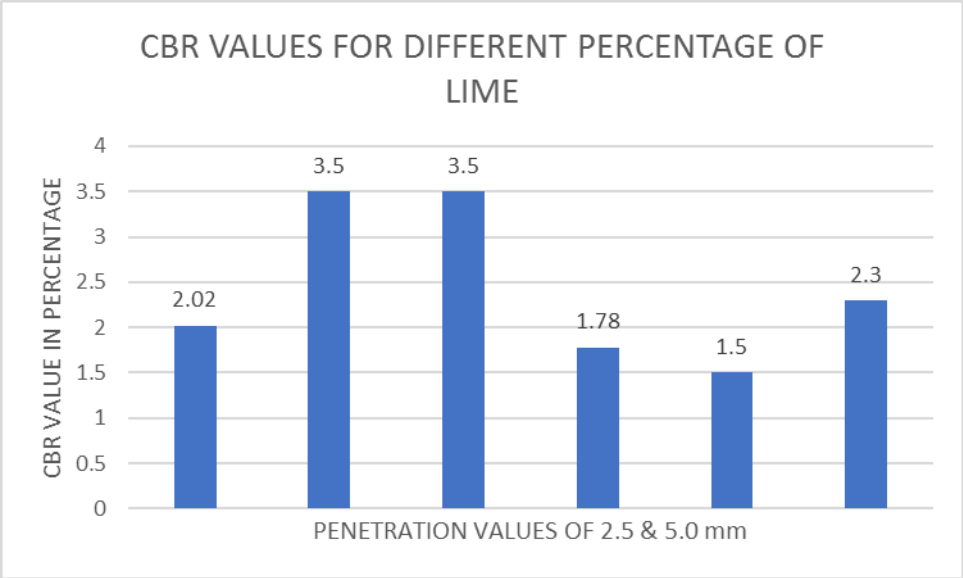

FIG: 3 Comparison Of Penetration Values Of 2.5 & 5.0 Mm Values With Respect To Load By Cbr Test

2. Standard proctor test conducted on clayey with varying percentage of coir fibres

By keeping lime percentage as 4 as an optimum content of admixture the coir fibres are increased from 0.5 % to 2.0 % to analyse the percentage of water content & maximum dry density values.

TABLE:5 TABULAR COLUMN OF STANDARD PROCTOR TEST FOR Clayey Soil +4% Lime +0.5% Coir

% Of water added to the soil	12 %	14%	16%	18%	20%	22%	24%	26%	28%	30%
Wt of empty Mould (W_1) in Kgs	5.57	5.57	5.57	5.57	5.57	5.57	5.57	5.57	5.57	5.57
Wt of mould + compacted soil (W_2) in Kgs	7.54	7.55	7.57	7.64	7.63	7.58	7.54	7.5	7.48	7.44
Wt of soil only (W_s) in Kgs	1.97	1.98	2	2.06	2.04	2.01	1.97	1.93	1.91	1.87
Bulk Density γb = Ws / V (gm	2	2.01	2.03	2.09	2.05	2.04	2	1.96	1.94	1.9

/cc)										
Dry Density γd = (γb / 1 + W) gm /cc	1.97	1.98	2.01	2.04	2.03	2.02	2.01	1.99	1.98	1.96

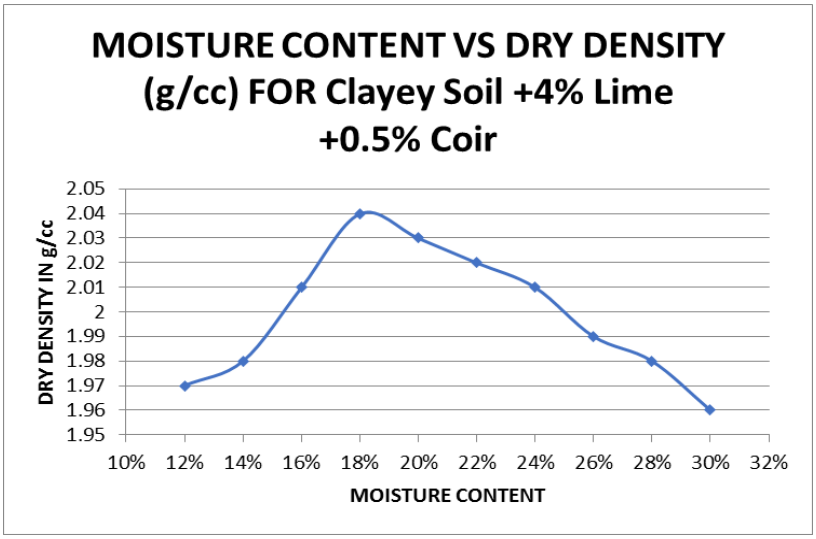

FIG:4 MOISTURE CONTENT VS DRY DENSITY (g/cc) FOR Clayey Soil +4% Lime +0.5% Coir

TABLE:6 TABULAR COLUMN OF STANDARD PROCTOR TEST FOR Clayey Soil +4% Lime +1% Coir

% Of water added to the soil	12 %	14%	16%	18%	20%	22%	24%	26%	28%	30%
Wt of empty Mould (W_1) in Kgs	5.57	5.57	5.57	5.57	5.57	5.57	5.57	5.57	5.57	5.57
Wt of mould + compacted soil (W_2) in Kgs	7.55	7.58	7.62	7.61	7.61	7.53	7.45	7.43	7.42	7.4
Wt of soil only (W_s) in Kgs	1.98	2.01	2.05	2.04	2.04	1.96	1.88	1.86	1.85	1.83

Bulk Density γb = Ws / V (gm /cc)	2.01	2.04	2.08	2.07	2.07	1.99	1.91	1.89	1.88	1.86
Dry Density γd = (γb / 1 + W) gm /cc	2.03	2.04	2.06	2.03	2.02	2.01	2	1.98	1.97	1.96

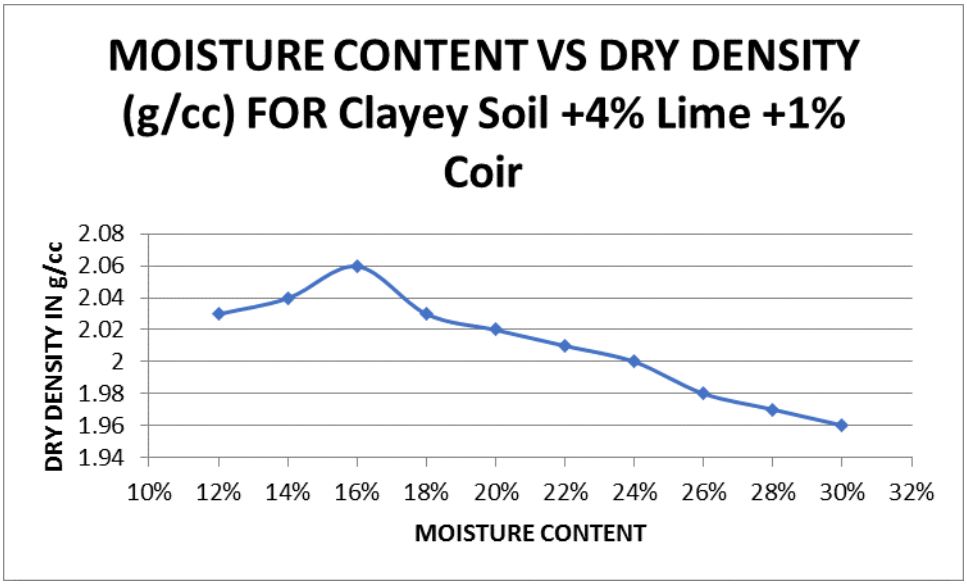

FIG:5 MOISTURE CONTENT VS DRY DENSITY (g/cc) FOR Clayey Soil +4% Lime +1% Coir

TABLE:7 TABULAR COLUMN OF STANDARD PROCTOR TEST FOR Clayey Soil +4% Lime +1.5% Coir

% Of water added to the soil	12 %	14%	16%	18%	20%	22%	24%	26%	28%	30%
Wt of empty Mould (W_1) in	5.68	5.68	5.68	5.68	5.68	5.68	5.68	5.68	5.68	5.68

Kgs										
Wt of mould + compacted soil (W_2) in Kgs	7.58	7.64	7.62	7.61	7.61	7.53	7.45	7.43	7.42	7.4
Wt of soil only (W_s) in Kgs	1.9	1.96	1.94	1.93	1.93	1.85	1.88	1.75	1.74	1.72
Bulk Density γb = Ws / V (gm /cc)	2.04	2.08	2.06	2.05	2.04	2.03	1.98	1.96	1.92	1.88
Dry Density γd = (γb / 1 + W) gm /cc	2.03	2.065	2.05	2.03	2.02	2.01	2	1.98	1.97	1.96

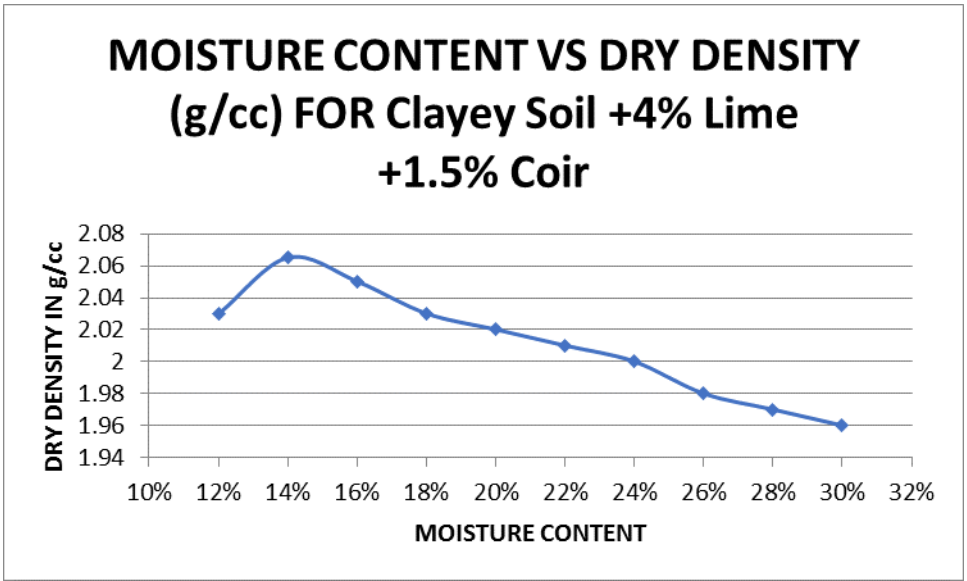

FIG:6 MOISTURE CONTENT VS DRY DENSITY (g/cc) FOR Clayey Soil +4% Lime +1.5% Coir

TABLE:8 TABULAR COLUMN OF STANDARD PROCTOR TEST FOR Clayey Soil +4% Lime +2 % Coir

% Of water added to the soil	12 %	14%	16%	18%	20%	22%	24%	26%	28%	30%
Wt of empty Mould (W_1) in Kgs	5.68	5.68	5.68	5.68	5.68	5.68	5.68	5.68	5.68	5.68
Wt of mould + compacted soil (W_2) in Kgs	7.64	7.62	7.61	7.6	7.59	7.57	7.55	7.52	7.49	7.44
Wt of soil only (W_s) in Kgs	1.96	1.94	1.93	1.9	1.89	1.87	1.85	1.82	1.79	1.74
Bulk Density γb = Ws / V (gm /cc)	2.08	2.07	2.06	2.05	2.04	2.03	1.98	1.96	1.92	1.88
Dry Density γd = (γb / 1 + W) gm /cc	2.07	2.06	2.065	2.03	2.02	2.01	2	1.98	1.97	1.96

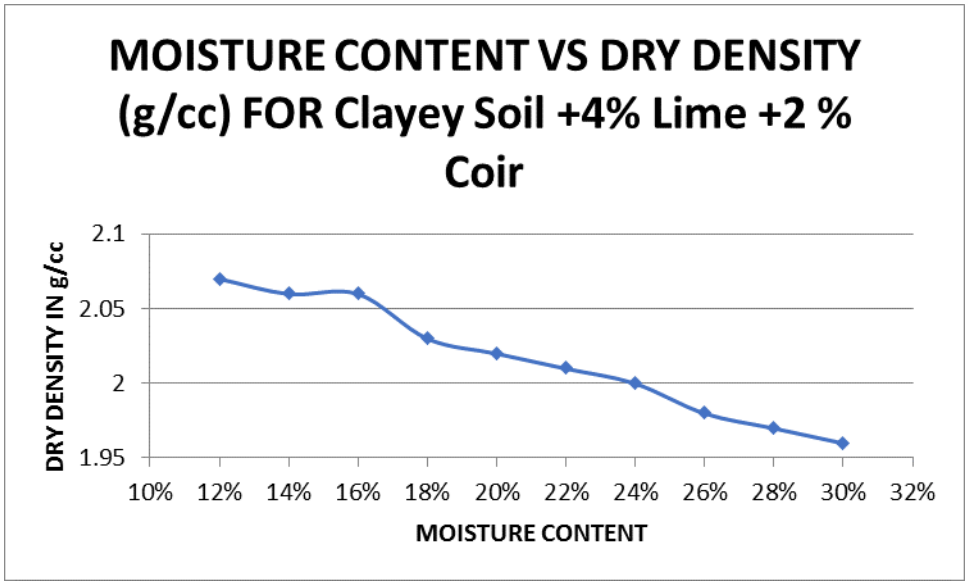

FIG:7 MOISTURE CONTENT VS DRY DENSITY (g/cc) FOR Clayey Soil +4% Lime +2 % Coir

TABLE:9 STANDARD PROCTOR RESULTS FOR VARIOUS COMBINATION OF ADMIXTURES

Si no	Type of soil	OMC in %	MDD (g/cc)
1	Clayey soil + 4% Lime + 0.5% Coir	18	2.04
2	Clayey soil + 4% Lime + 1.0% Coir	16	2.06
3	Clayey soil + 4% Lime + 1.5% Coir	14	2.065
4	Clayey soil + 4% Lime + 2.0% Coir	16	2.065

3. California Bearing Ratio Test conducted on clayey with varying percentage of coir fibres

By considering the 2.5mm & 5.0mm penetration values for the soil mixture it has been noticed that CBR values for 2.5mm penetration is more than 5.0mm penetration values. With the conduction of CBR test by varying the percentage of admixtures like Coir & Lime in the soil mix, there is an increase in the CBR values with the increase in percentage of stabilizers.

TABLE:10 TABULAR COLUMN OF CBR TEST FOR Clayey Soil +4% Lime +0.5% Coir

Dial gauge reading in mm	Proving ring reading		Load (P) in Kgs
	DIV	DIV*PRC	
0	1	129.36	13.18
0.5	4.1	241.08	24.57
1.0	4.8	287.75	28.77

1.5	5.4	217.52	32.36
2.0	6.2	364.56	37.17
2.5	8.15	479.78	48.9
3.0	9.2	540.96	55.14
3.5	9.6	564.48	57.54
4.0	10.1	593.88	60.53
4.5	10.4	611.52	62.33
5.0	10.8	635.04	64.73

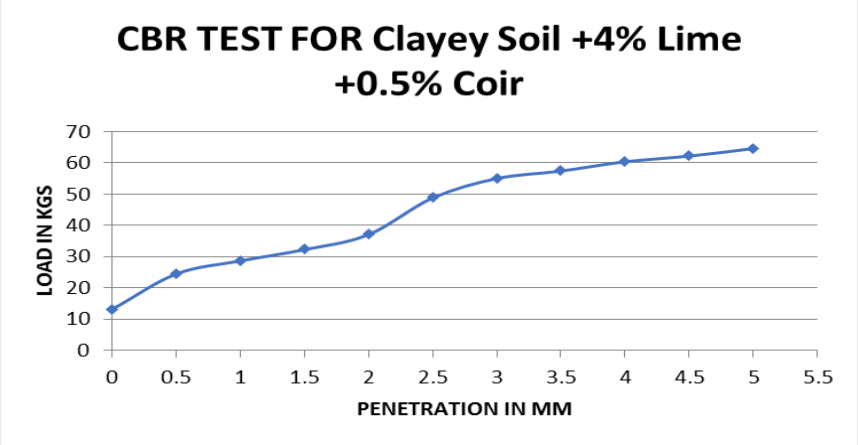

FIG:8 LOAD VS PENETRATION FOR Clayey Soil +4% Lime +0.5% Coir

TABLE:11 TABULAR COLUMN OF CBR TEST FOR Clayey Soil +4% Lime +1% Coir

Dial gauge reading in mm	**Proving ring reading**		**Load (P) in Kgs**
	DIV	**DIV*PRC**	
0	1.8	105.84	10.78
0.5	1.8	105.84	10.78
1.0	3.2	188.16	19.18
1.5	5.6	329.28	33.56
2.0	8.8	517.44	52.74
2.5	11.72	689.45	70.281
3.0	13	764.4	77.7
3.5	14.2	834.96	85.11
4.0	15.4	905.52	92.3
4.5	16.2	952.52	97
5.0	17.2	1011.36	103.09

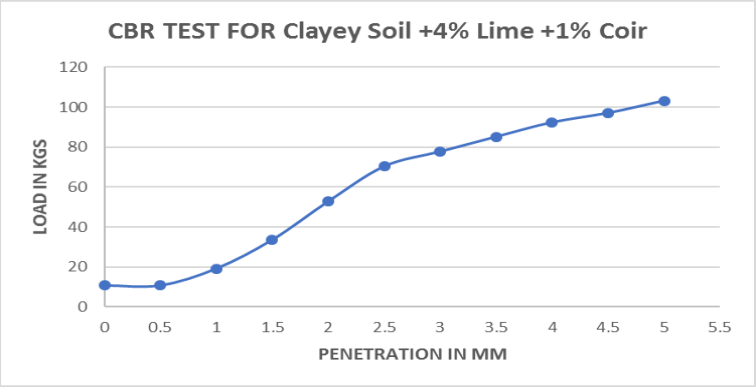

FIG:9 LOAD VS PENETRATION FOR Clayey Soil +4% Lime +1% Coir

TABLE:12 TABULAR COLUMN OF CBR TEST FOR Clayey Soil +4% Lime +1.5% Coir.

Dial gauge reading in mm	Proving ring reading		Load (P) in Kgs
	DIV	DIV*PRC	
0	0	0	0
0.5	4	235.2	23.97
1.0	7.8	458.64	46.75
1.5	9.8	576.24	58.74
2.0	11	646.8	65.96
2.5	12.04	708.18	72.19
3.0	13	764.4	77.92
3.5	14.8	870.24	88.7
4.0	15.2	893.76	91.10
4.5	16	940.8	95.9
5.0	17.55	1031.94	105.19

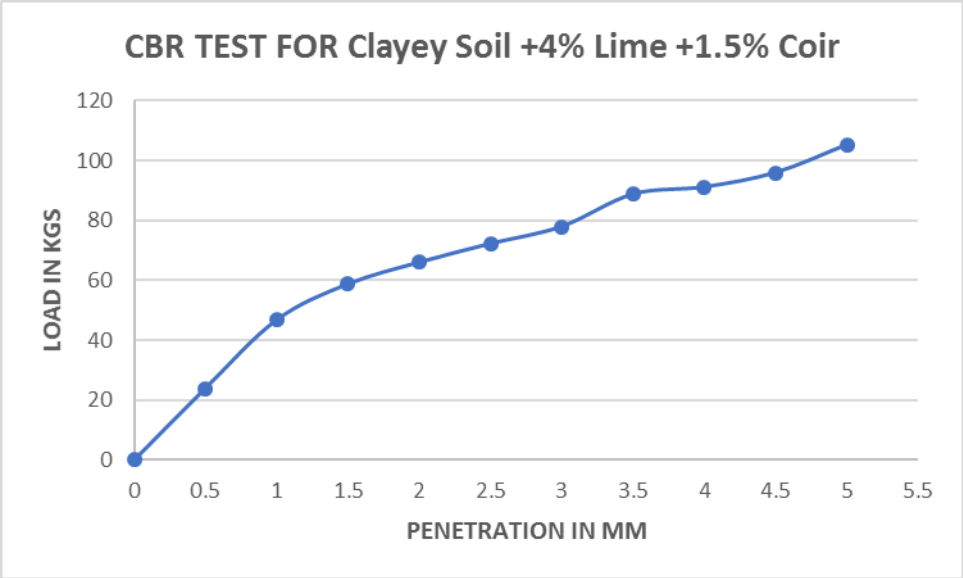

FIG:10 LOAD VS PENETRATION FOR Clayey Soil +4% Lime +1.5% Coir

TABLE:13 TABULAR COLUMN OF CBR TEST FOR Clayey Soil +4% Lime +2% Coir

Dial gauge reading in mm	Proving ring reading		Load (P) in Kgs
	DIV	DIV*PRC	
0	0	0	0
0.5	6.4	376.32	38.32
1.0	8.2	482.16	49.15
1.5	10.9	640.92	65.34
2.0	12.02	706.97	72.04
2.5	12.61	741.83	75.62
3.0	13.4	787.92	80.31
3.5	14.8	870.24	88.7
4.0	15.6	917.28	93.5
4.5	16.8	987.84	100.69
5.0	17.93	1050.57	107.5

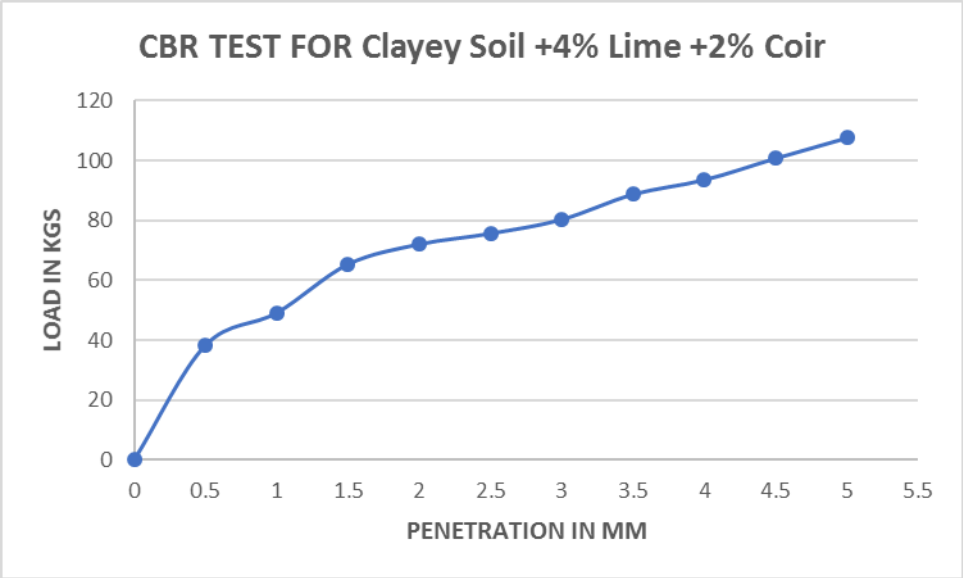

FIG:11 LOAD VS PENETRATION FOR Clayey Soil +4% Lime +2% Coir

TABLE:14 CBR TEST RESULTS FOR VARIOUS COMBINATION OF ADMIXTURES

Si no	Type of soil	CBR % FOR 2.5 mm PENETRATION	CBR % FOR 5.0 mm PENETRATION
1	Clayey soil + 4% Lime + 0.5% Coir	3.57	3.15
2	Clayey soil + 4% Lime + 1.0% Coir	5.13	5.01
3	Clayey soil + 4% Lime + 1.5% Coir	5.27	5.11
4	Clayey soil + 4% Lime + 2.0% Coir	5.52	5.23

VII.CONCLUSION

Based on the various laboratory tests as per IS standards for the porous concrete by varying the composition the following conclusions are drawn:

1. Initially with the replacement of some percentage of Lime with clayey soil, there is an increase of CBR values for the clayey soil which shows there is an increase in its stability.
2. With further increase in Lime content in the clayey soil & is analysed for its engineering properties there is a considerable decrease in its CBR values.
3. Lime acts an additive in the clayey soil in which its presence in short term function affects the plasticity of the soil & long term function will affects its strength & durability.
4. It is one of the economical method of soil stabilisation of clayey soil where the raw materials like coir & Lime are cheaper when compared to other methods of stabilisation of soil.
5. Lime & Coir are naturally occurring materials & can be used for construction purposes which also leads to increase in bonding properties of clayey soil which also leads to reduction in swell & shrink behaviour of clayey soil.

6. It has been found that with the increase in percentage of Lime & Coir there is an increase in CBR values of 2.5 mm & 5.0mm penetration when compared to conventional Clayey soil.

7. By the above investigations of physical & engineering properties of clayey soil it has been found that the addition of 1 % Lime & 0.5% coir fibre can be used as optimum dosage for stabilising the clayey soil.

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Bibilography

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