Experimental investigation on stabilization of black cotton soil for different proportion of lime and fly ash using CBR test

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Abstract :In this research will be carried out to stabilize the soil using Fly ash and Lime. Experimental work has been carried out with 5%, 10%, 15%, 20%, 25% and 30% of Fly ash as well 5 %, 10 % and 15% of lime content for black cotton soil. The experimental work is based on different percentages of Fly ash and lime content in soil on tests for soil on California Bearing Ratio test. The aim of this project was done by utilizing fly ash and lime to improve the index properties of the black cotton soil. Stabilization of soil is important to enhance the index properties of expansive soil like strength, volume stability and durability. The Black cotton soils are very hard when dry, but lose its strength completely when in wet condition Expansive soils (black cotton soil) are a worldwide problem that poses several challenges for civil Engineers.

***Index Terms*- California Bearing Ratio, Optimum moisture content, Maximum Dry density, Uniformity coefficient, Coefficient of curvature.**

I. INTRODUCTION

The California Bearing Ratio devised by engineers of the California Division of Highways in 1938.

$$CBR = \frac{Test\ load}{Standard\ load} X\ 100$$

Code=IS : 2720(Part 16) - 1987

Most universally accepted pavement design methods.

The CBR test which can figure out the strength of a subgrade. The CBR test is done in a standard manner by which one can find out or design the strength or thickness of subgrade layer. CBR value is inversely proportional to thickness of the pavement layer.

II. NEED FOR STUDY

It is used for the evaluation of sub-grade strength of roads and pavements. The results obtained by these tests are used with the empirical curves to determine the thickness of pavement and it's component layers. Indian Roads Congress (IRC) has standardized the guidelines for the design of flexible pavements based on CBR test (IRC: 37-2001).The CBR test can be conducted for both sub-grade soil and Granular sub-base material.

III. OBJECT AND SCOPE

To determine the California bearing ratio of black cotton soil from Devrasan with different proportion of lime and fly ash. To improve the quality of sub grade soil. The aim of this project is utilizing stabilize soil material (lime + fly ash) to improve the engineering properties of the black cotton soil.

IV. RESEARCH METHODOLOGY

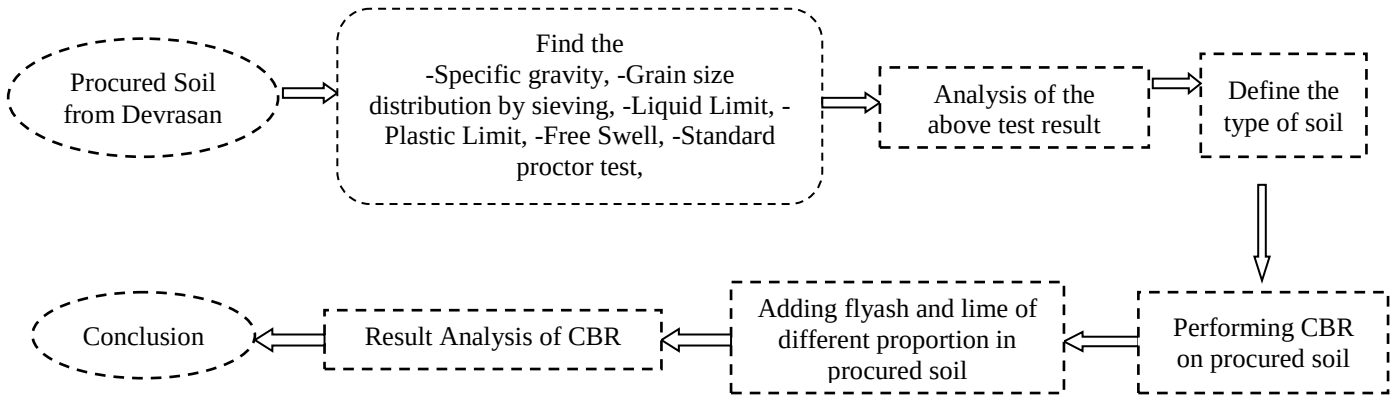


Fig 1: Methodology flowchart

V. DATA COLLECTION AND DATE ANALYSIS THE BASIC EXPERIMENT

5.1 Object of basic experiment

- **Specific gravity of soil by pycnometer:** To determine the specific gravity of soil fraction passing 4.75 mm sieve by Pycnometer.

- **Grain size distribution by sieve analysis:** To determines the grain size distribution of coursed grained soil by sieving.
- **Liquid limit by mechanical device:** To determine liquid limit of the soil sample, using Casagrande type / ASTM mechanical liquid limit apparatus.
- **Plastic limit determination:** To determine plastic limit of the soil sample.
- **Free swell test:** To determine the free swell index of procured soil.
- **Standard proctor test:** To determine the compaction characteristics of a soil specimen by Standard Proctor's test.

Table.1: Analysis of the test result

Sr. No.	Test		Result
1	Specific gravity of soil by pycnometer		2.67
2	Grain size distribution by sieve analysis		C_u = 5.33
			C_c = 0.75
3	Liquid limit by mechanical device		27.145 %
4	Plastic limit determination		21.42 %
5	Free swell test		41.66%
6	Standard proctor test	Max. dry density	1.861 kg/cm^3
		Optimum water content	16.66%

5.2 CBR test Procedure

- Take about 4.5 to 5.5 kg of soil and mix thoroughly with required water, different proportion of lime and fly ash. Fix the collar and the base plate to the mould .Insert the spacer disc over the base.
- Place the filter paper on the top of Spacer disc.
- Compact the mix soil in the mould using either light compaction or heavy compaction.
- For light compaction, compact the soil in 3 equal layers , each layer being given 55 blows by the 2.6 kg rammer.
- For heavy compaction, compact the soil in 5 equal layers , each layer being given 56 blows by the 4.89 kg rammer.
- Remove the collar and trim off soil. Turn the mould upside down and remove the base plate and the displacer disc.
- Weight the mould with compacted soil and determine the bulk density and dry density.
- Put filter paper on the top of compacted soil and clamp the perforated base plate on to it.
- Place the mould assembly with surcharge weight on the penetration test machine.
- Set the penetration piston at the centre of the specimen with the smallest possible load, but in no case in excess of 4 kg so that full contact of the piston on the sample is established.
- Set the dial gauge to zero.
- Apply the load on the piston so that the penetration rate is about 1.25 mm/min.
- Record the load readings at penetrations of 0.5, 1.0 , 1.50, 2.0 ,2.50, 3.0, 4.0, 5.0, 7.50, 10.0 and 12.5 mm.
- Note the maximum load and corresponding penetration if it occurs for the penetration less than 12.5 mm.
- Detach the mould from the loading equipment.
- Take about 20 to 50 g of soil from the top 3 cm layer and determine the moisture content.

VI. Data Collection and Date Analysis The CBR Test

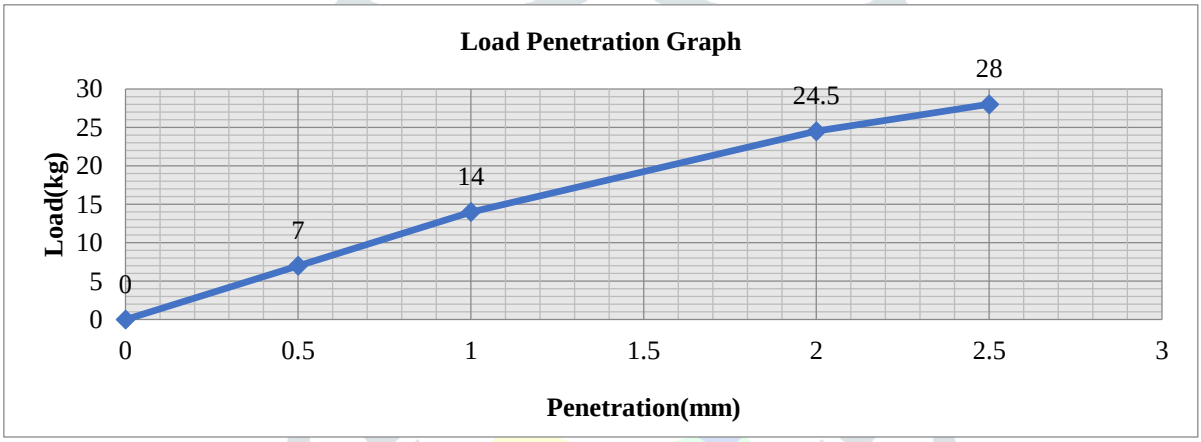
6.1CBR Test for Virgin soil

Table.2: Observation Table of CBR Test for Virgin soil

Mould No.	A
Container No.	1
Wt. of container with wet soil(X)gm	69
Wt. of container with dry soil(Y)gm	63
Wt. of empty container(Z)gm	30
Wt. of water(W_w)gm	6
Wt. of dry soil (W_s) gm	33
Moisture content(m) = (W_w/ W_s)*100%	18.18
Volume of mould(V_m)cc	3092.50
Weight of mould+ Base Plate (W_m)gm	6533
Weight of mould + Base Plate+compacted soil (W_{bs}) gm	10948
wt.density (γm) = (Wbs-Wm)/Vm (gm/cc)	1.427
Dry density (γd)=γm/(1+m)(gm/cc)	1.20

Table.3: Observation during penetration and determination of CBR Test for virgin soil

Virgin soil			
Sr.No.	**Penetration (mm)**	**Proving ring dial gauge reading (R)**	**Load on plunger (Pt) =R×F = R×3.5 (kgf)**
1	0	0	0
2	0.5	2	7
3	1	4	14
4	2	7	24.5
5	2.5	8	28
6	3.5	8	28
7	4	8	28
8	5	8	28
9	7.5	8	28
10	10	8	28
11	12.4	8	28



Graph-1: Standard load values on virgin soil for different penetration values

6.2 Calculation

Table-4: Calculation of the CBR value for virgin soil at 2.5 mm and 5mm penetration

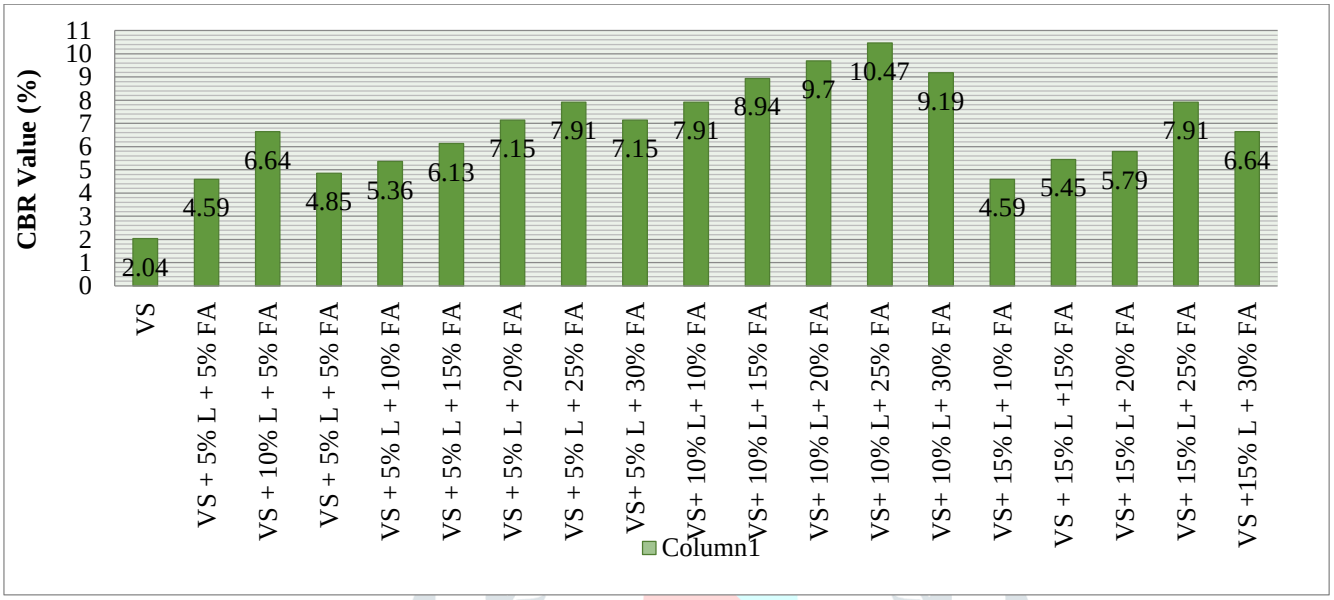
Sr. No.	Penetration (mm)	Standard load value (Ps) kgf	Load on plunger (Pt)	CBR= (Pt/Ps)*100%
1	2.5	1370	28	2.04
2	5	2055	28	1.36

VII. DATA COLLECTION AND DATE ANALYSIS THE CBR TEST FOR ADDING FLY ASH (FA) AND LIME (L) OF DIFFERENT PROPORTION IN VIRGIN SOIL (VS)

Table-5: CBR value for different proportion of fly ash and different proportion of lime at 2.5 mm penetration

SR.NO.	SAMPLES	RESULT (%)
	Penetration (Y)mm	**2.5**
1	VS	2.04
2	VS + 5% L + 5% FA	4.59
3	VS + 5% L + 10% FA	5.36
4	VS+ 5% L + 15% FA	6.13
5	VS + 5% L + 20% FA	7.15
6	VS + 5% L + 25% FA	7.91
7	VS + 5% L + 30% FA	7.15
8	VS + 10% L+ 5% FA	6.64
9	VS+ 10% L + 10% FA	7.91
10	VS + 10% L+ 15% FA	8.94
11	VS + 10% L + 20% FA	9.7
12	VS + 10% L + 25% FA	10.47

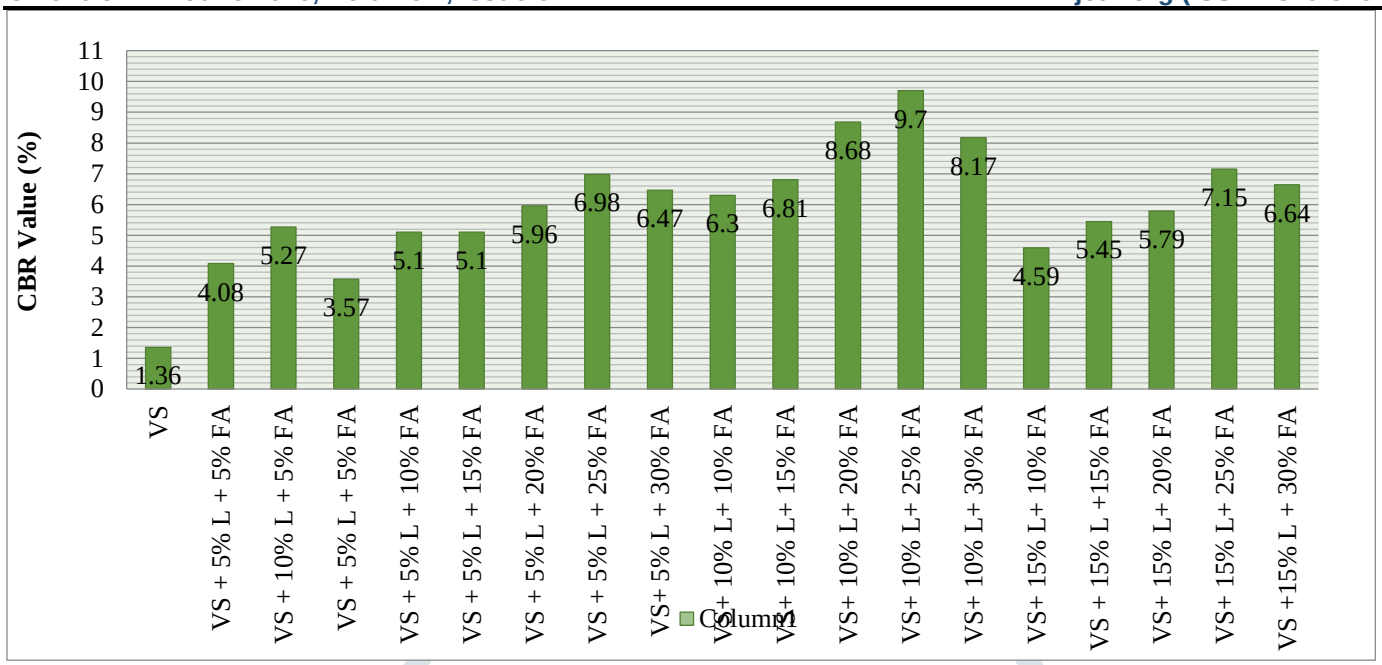
13	VS + 10% L + 30% FA	9.19
14	VS + 15% L + 5% FA	4.85
15	VS + 15% L + 10% FA	5.62
16	VS + 15% L+ 15% FA	6.38
17	VS + 15% L + 20% FA	6.89
18	VS + 15% L + 25% FA	7.91
19	VS + 15% L + 30% FA	6.64



Graph-2: CBR value for different proportion of fly ash and different proportion of lime at 2.5 mm penetration by Graph

Table-6: CBR value for different proportion of fly ash and different proportion of lime at 5 mm penetration

SR.NO.	**SAMPLES**	**RESULT (%)**
	Penetration (Y)mm	**5**
1	VS	1.36
2	VS + 5% L + 5% FA	4.08
3	VS + 5% L + 10% FA	5.10
4	VS+ 5% L + 15% FA	5.10
5	VS + 5% L + 20% FA	5.96
6	VS + 5% L + 25% FA	6.98
7	VS + 5% L + 30% FA	6.47
8	VS + 10% L+ 5% FA	5.27
9	VS+ 10% L + 10% FA	6.30
10	VS + 10% L+ 15% FA	6.81
11	VS + 10% L + 20% FA	8.68
12	VS + 10% L + 25% FA	9.70
13	VS + 10% L + 30% FA	8.17
14	VS + 15% L + 5% FA	3.57
15	VS + 15% L + 10% FA	4.59
16	VS + 15% L+ 15% FA	5.45
17	VS + 15% L + 20% FA	5.79
18	VS + 15% L + 25% FA	7.15
19	VS + 15% L + 30% FA	6.64



Graph-3: CBR value for different proportion of fly ash and different proportion of lime at 5 mm penetration by Graph

VIII. CONCLUSION

- The index property of virgin soil like Specific Gravity, Liquid limit, Plastic limit, Free swell index, maximum dry density and optimum water content are 2.67, 27.145%, 21.42%, 41.66%, 1.861 kg/cm^3 and 16.66% respectively. Stabilize the procured black cotton soil by adding proper proportion of fly ash and lime which improve the index properties of black cotton soil.
- Addition of fly ash and lime reduce the plasticity characteristics of Black Cotton Soil and make non plastic material.
- CBR value of Black Cotton soil also increases with increasing varying % of [lime + fly ash] at 2.5 mm penetration .The optimum percentage of mixture [10 % lime + 25 % fly ash] which gives the maximum CBR value 10.47 % at 2.5 mm penetration.
- This is the best result for sub grade soil. CBR value of Black Cotton soil also increases with increasing varying % 0f [lime + fly ash] at 5 mm penetration .The optimum percentage of mixture [10 % lime + 25 % fly ash] which gives the maximum CBR value 9.7 % at 5 mm penetration. This is the best result for sub grade soil.

IX. REFERENCES

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