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Strength Improvement of Black Cotton Soil by using Different Materials

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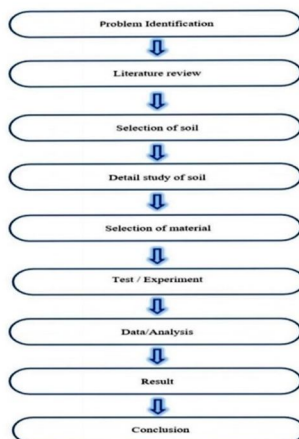
Abstract: This study examines the effect of geotextiles, plastic rings, plastic shavings and fibres on soil California bearing capacity (CBR). The experiment evaluates the effectiveness of these additions to improve the bearing capacity and reduce the sedimentation of the soil samples. Geotextiles are introduced to improve soil compaction and reduce lateral movement. Plastic rings and chips are added to create voids and improve drainage, which can reduce water content and improve strength. Polypropylene Fibres were added to study their effect on soil reinforcement and stress distribution improvement. CBR tests are performed on soil samples with hand without these additives to quantify the improvement in strength and deformation properties. The results of this study should provide valuable information on the potential benefits of using geotextiles, plastic rings, plastic chips and polypropylene fibres in pavement construction to improve soil CBR of soils in pavement applications

Keywords: CBR Test , Geotextiles, plastic chips, plastic rings, polypropylene fibres,

I. INTRODUCTION

- 1) Black Cotton Soil :Black cotton soil, also known as regur soil, is a type of soil found in the Deccan Plateau region of India. It is characterized by its brown-black color, high clay content, and high shrink-swell properties.
- 2) CBR Test : CBR (California Bearing Ratio) testing is performed primarily to provide information for pavement design. It was first developed by the California State Highway Department. It is a penetration or subsidence test under load, mainly used to evaluate the base strength of roads, pavements and foundations..
- 3) Geotextiles: Geotextiles are essentially strong fabrics used in construction projects. They are the most Versatile type of geosynthetic material, with a wide range of applications. Due to the variety of Geotextiles available, choosing the right one for a specific project is crucial.
- 4) Polypropylene Fibres: Experiments were conducted using different Percentages of polypropylene fibres mixed with compacted soil samples. The tests measured the Soil's strength, bearing capacity, and swelling behaviour. While the detailed results aren't provided. This research suggests that fibre reinforcement has promise for improving problematic soils.
- 5) Plastic bottle : The project involves mixing the soil with various percentages of these plastic strips. Tests like Compaction and California Bearing Ratio (CBR) will then be conducted to analyse the impact on Soil properties

II. METHODOLOGY



III. TESTS AND RESULTS

To determine the properties of soil tests we conducted on soil are:

1) Free Swell Index

FREE SWELL INDEX (As per IS 2720 part - 40)					
Lab Job No.:	235	Date of Sampling:	25/02/24		
Sample Description:	Black Cotton Soil	Date of Testing:	26/02/24		
Source/Location:	130+700 LHS	Sampled By:	Jointly		
Proposed Use:	Embankment/Subgrade	Tested By:	Jointly		
Sr. No	Determination	Test-1	Test-2	Average	
1	Volume of Specimen in Graduated Cylinder Containing Distilled Water after 24 hrs = (ml)	Vd	20	21	/
2	Volume of Specimen in Graduated Cylinder Containing Kerosene after 24 hrs = (ml)	Vk	13	13	
3	Difference of Volume in Water & Kerosene (ml)	Vd-Vk	7	8	
4	Free Swelling Index, [%] = $\frac{[(Vd-Vk)/Vk] \times 100}{}$		53.85	61.54	57.70

2) Liquid Limit And Plastic Limit Tests

ATTERBERG LIMITS

(As Per IS 2720 - Part 5)

(By Casagrande Apparatus)

Lab Job No.	235	Date of Sampling	25/02/24
Sample Description	Black Cotton Soil	Date of Testing	26/02/24
Source/Location	130+700 LHS	Sampled By	Jointly
Proposed Use	Emb/Sub.	Tested By	Jointly

Sr. No.	Determination	Liquid Limits				Plastic Limits	
		1	2	3	5	1	2
1	No. of Blows	32	27	22	18	—	—
2	Container Number	2	3	4	5	6	7
3	Weight of container (gm) W1	18.62	19.02	17.85	16.83	18.65	18.28
4	Wt. of Cont. + Wet Sample (gm) W2	46.83	49.32	49.49	48.25	28.08	30.40
5	Wt. of Cont. + Oven dry Sample W3	35.81	37.44	36.67	35.62	26.17	27.76
6	Wt. of Water W4 = W2-W3	11.02	11.88	12.82	12.63	1.91	2.64
7	Wt. of Dry Sample W5 = W3-W1	17.19	18.42	18.82	18.79	7.52	8.98
8	% Moisture content W4/WSX100	64.11	64.50	66.01	67.22	25.40	29.40
					Average	27.40	

LL: Moisture Content @ 25 Blows

RESULTS

Liquid Limit LL (%) = 65.50

Plastic Limit PL (%) = 27.40

Plasticity Index PI (%) = 38.10
(LL-PL)

The chart is a semi-logarithmic plot. The y-axis represents Moisture Content (%) ranging from 63 to 68. The x-axis represents No. of Blows (N) on a logarithmic scale from 10 to 100. Four data points are plotted: (20, 67.22), (25, 65.50), (30, 64.50), and (35, 63.50). A straight line is drawn through these points. The Plastic Limit (PL) is indicated at 27.40% moisture content for 25 blows.

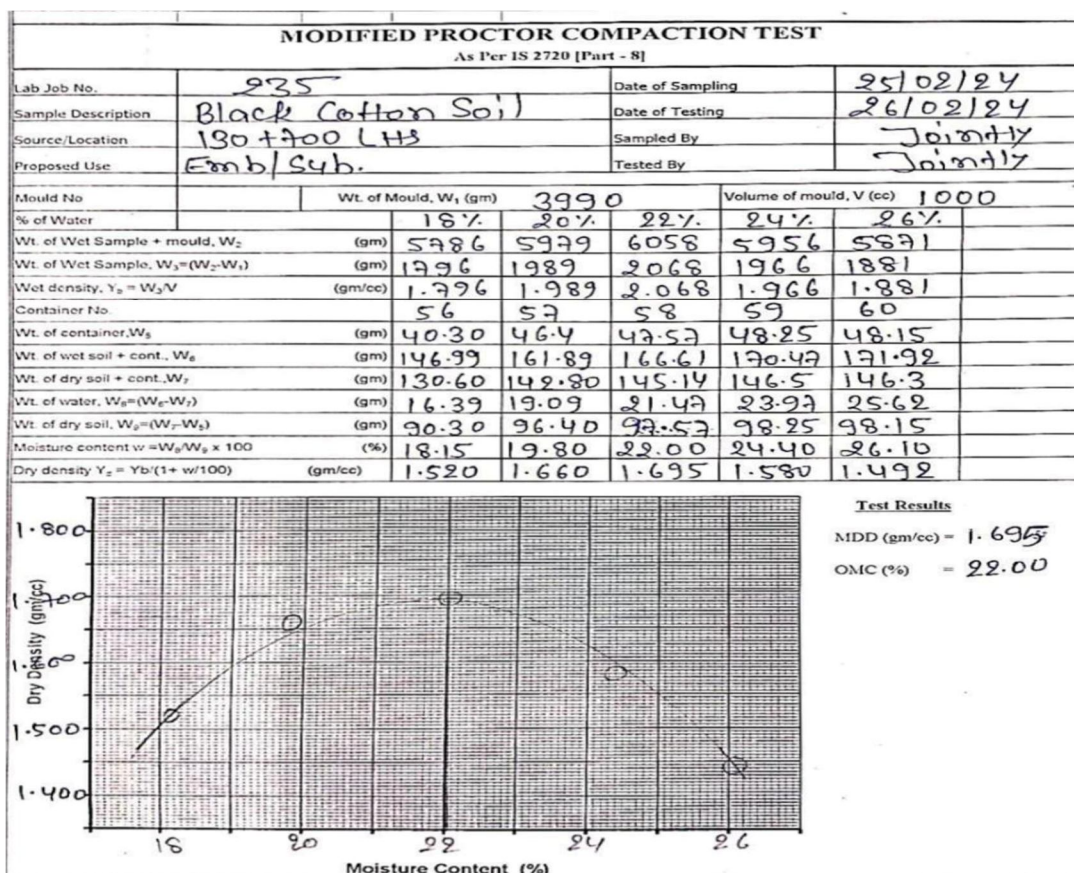
No. of Blows (N)	Moisture Content (%)
20	67.22
25	65.50
30	64.50
35	63.50

No. of Blows (N)

3) Grain Size Analysis

GRAIN SIZE ANALYSIS [As per IS 2720 (Part - 4)]					
Lab Job No.	235		Date of Sampling	25/02/24	
Sample Description	Black Cotton Soil		Date of Testing	26/02/24	
Source/Location	130+700 LHS		Sampled By	Jointly	
Proposed Use	Emb/ Sub.		Tested By	Jointly	
Wt. of Sample (gm)	1000 gms				
IS Sieve Size (mm)	Weight Retained (gm)	Cumulative Weight Retained (gm)	Cumulative Percentage Retained (%)	Cumulative Percentage Passing (%)	Remarks
100					
75					
19	0	0	0	100	
4.75	16	16	1.6	98.4	
2.0	9	25	2.50	97.5	
0.425	47	72	7.2	92.8	
0.075	53	125	12.5	87.5	
Pan					
DESCRIPTION OF PARTICLE		SIEVE SIZE (mm)		PERCENTAGE	
Gravel	Coarse	75 - 19		-	1.60
	Fine	19 - 4.75		1.60	
Sand	Coarse	4.75 - 2.00		0.90	10.9
	Medium	2.00 - 0.425		4.7	
	Fine	0.425 - 0.075		5.3	
Silt & Clay	Passing through 0.075				87.5

4) Modified Proctor Test



5) California Bearing Ratio Test

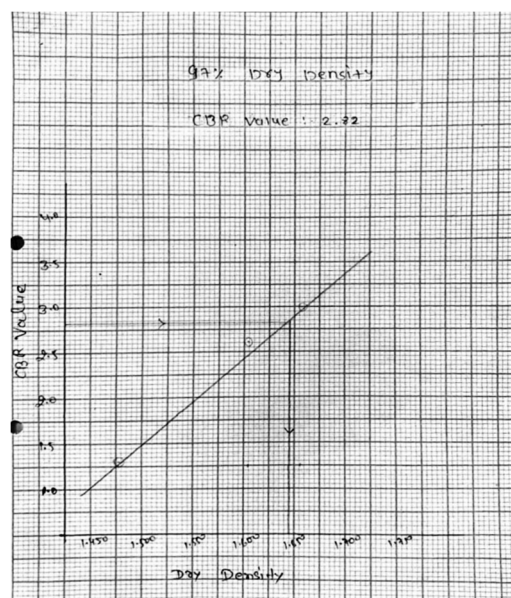
a) CBR Test With Normal Black Soil

Laboratory Job No.	235	Date of Sampling	25/02/24
Location/Source	130+700 LHS	Sampled by	Jointly
Type of Material	Normal Black soil	Tested by	Jointly
Proposed use		Date of Testing	28/02/24
Period of Soaking	96 Hours	Date of Testing	03/03/24

MOISTURE CONTENT AND UNIT WEIGHT OF TEST SAMPLES		Mould No. 25		Mould No. 46	
No. of layers	5	5	5	5	5
No. of blows per layer	10	10	30	30	65
CONDITION OF SAMPLE					
Before soaking					
After soaking					
Wt. of Mould + V	69.95	79.60	79.60	68.85	68.85
Wt. of Wet Sample + Mould, W_1 (gm)	107.7	112.2	123.90	114.1	114.93
Wt. of Wet Sample, $W_2 = (W_1 - W_1)$ (gm)	40.77	41.07	44.30	45.56	46.08
Volume of mould, V (cc)	2250	2250	2250	2250	2250
Wet Density, $\gamma_w = W_2/V$ (gm/cc)	1.812	1.824	1.969	2.025	2.048
MOISTURE DETERMINATION					
Before soaking					
After soaking					
Container No.	1	2	3	4	5
Wt. of container, W_3 (gm)	43.31	48.90	48.71	46.21	46.29
Wt. of Wet Sample + Cont., W_4 (gm)	241.15	245.55	248.35	250.34	253.45
Wt. of Dry Sample + Cont., W_5 (gm)	289.23	287.90	293.71	292.31	298.20
Wt. of water, $W_6 = (W_4 - W_5)$ (gm)	57.84	57.65	54.64	58.03	55.16
Wt. of Dry Sample, $W_7 = (W_5 - W_3)$ (gm)	245.94	239.0	245.0	246.10	252.0
Moisture content $w = W_6/W_7 \times 100$ (%)	23.52	24.12	22.30	23.59	21.89
Dry Density $\gamma_d = \gamma_w / (1 + w/100)$ (gm/cc)	1.492	1.478	1.610	1.605	1.661

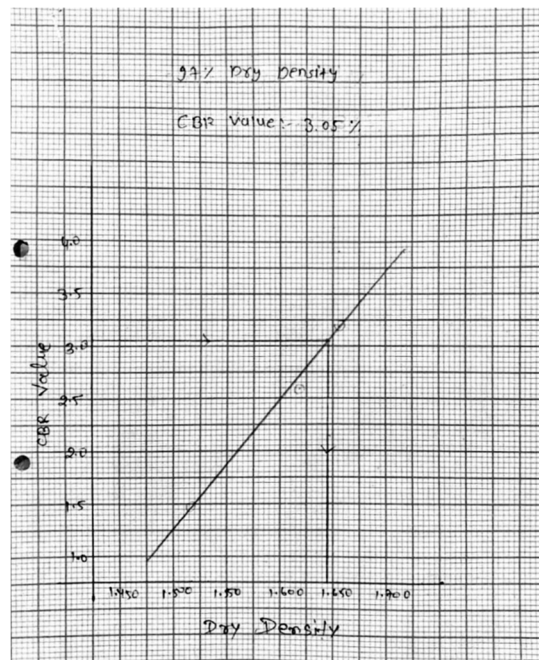
LOAD-PENETRATION TEST DATA:		Proving Ring Calibration Factor:	
Proving ring No.	1	2	3
Sl. No.	Penetration (mm)	Proving ring Reading (kg)	Corrected load (kg)
1	0.5	2.35	10.05
2	1.0	6.10	26.45
3	1.5	10.05	42.45
4	2.0	13.40	58.80
5	2.5	16.10	73.50
6	3.0	19.10	88.10
7	4.0	23.45	110.90
8	5.0	26.80	130.60
9	7.5	33.50	160.30
10	10.0	36.85	175.70
11	12.5	36.85	175.70

CBR CALCULATION	
Mould No.	25
Corrected Load (kg)	175.70
CBR (%)	2.82



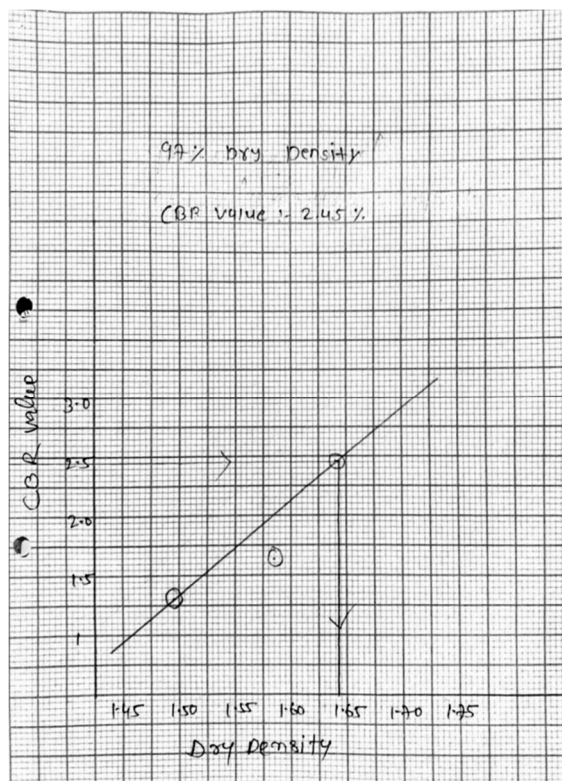
b) CBR Test with Geotextile

CALIFORNIA BEARING RATIO (IS 2710 (PART III) & ASTM D 1534)									
Laboratory Job No.	235		Date of Sampling :		25/02/24				
Location/Source	130+700 LHS		Sampled by :		Jointly				
Type of Material :	with textile		Tested by :		Jointly				
Proposed use :			Date of Casting :		4/03/24				
Period of Soaking :	96 Hours		Date of Testing :		8/03/24				
MOISTURE CONTENT AND UNIT WEIGHT OF TEST SAMPLES									
No. of layers	5		Mould No. 25		Mould No. 26		Mould No. 34		
No. of blows per layer	10	10	30	30	65	65			
CONDITION OF SAMPLE	Before soaking	After soaking	Before soaking	After soaking	Before soaking	After soaking			
Wt. of Mould, W _m (gm)	6741	6741	6880	6880	7070	7070			
Wt. of Wet Sample + Mould, W ₁ (gm)	10913	11016	11246	11403	11613	11620			
Wt. of Wet Sample, W ₁ - W _m (gm)	4172	4275	4466	4523	4543	4550			
Volume of mould, V (cc)	2250	2250	2250	2250	2250	2250			
Wet Density, $\gamma_w = W_1/V$ (gm/cc)	1.854	1.900	1.985	2.010	2.109	2.022			
MOISTURE DETERMINATION	Before soaking	After soaking	Before soaking	After soaking	Before soaking	After soaking			
Container No.	5	6	22	26	25	22			
Wt. of container, W _c (gm)	45.30	46.80	42.61	48.70	48.71	46.23			
Wt. of Wet Sample + Cont., W ₂ (gm)	292.56	292.06	310.58	353.95	307.01	303.79			
Wt. of Dry Sample + Cont., W ₃ (gm)	248.86	242.65	262.87	294.55	261.25	259.12			
Wt. of water, W _w = (W ₂ - W ₃) (gm)	43.70	49.41	47.71	59.40	45.76	44.67			
Wt. of Dry Sample, W _d = (W ₃ - W _c) (gm)	203.56	195.85	216.58	245.85	212.54	210.89			
Moisture content, W = W _w /W _d (%)	21.47	25.23	22.03	24.16	21.53	22.13			
Dry Density $\gamma_d = \gamma_w / (1 + W/100)$ (gm/cc)	1.526	1.517	1.627	1.619	1.661	1.656			
LOAD - PENETRATION TEST DATA :									
Proving ring Calibration Factor :									
Sr.No.	Penetration (mm)	Mould No. 25		Mould No. 26		Mould No. 34			
		Proving ring Reading	Corrected load (kg)	Proving ring Reading	Corrected load (kg)	Proving ring Reading	Corrected load (kg)		
1	0.5	1	3.35	2	10.05	3	10.05		
2	1.0	3	10.05	4	13.40	6	20.10		
3	1.5	4	13.40	5	16.75	9	30.15		
4	2.0	5	16.75	7	23.45	11	36.85		
5	2.5	6	20.10	9	30.15	13	43.55		
6	3.0	7	23.45	11	36.85	14	46.90		
7	4.0	8	26.80	12	40.20	16	53.60		
8	5.0	9	30.15	13	43.55	18	60.30		
9	7.5	10	33.50	18	50.25	21	60.35		
10	10.0	11	36.85	19	53.65	23	71.05		
11	12.5	12	36.85	20	67.00	24	80.40		
Note:									
1) Graph for load vs penetration attached									
2) CBR = (corrected load/standard load) × 100									
3) Standard unit load : @ 2.5 mm Penetration = 1370 Kg									
@ 5.0 mm Penetration = 2055 Kg									
CBR Value @ 97 % MDD 1.69 gm/cc = 22.00%									
Remarks:									



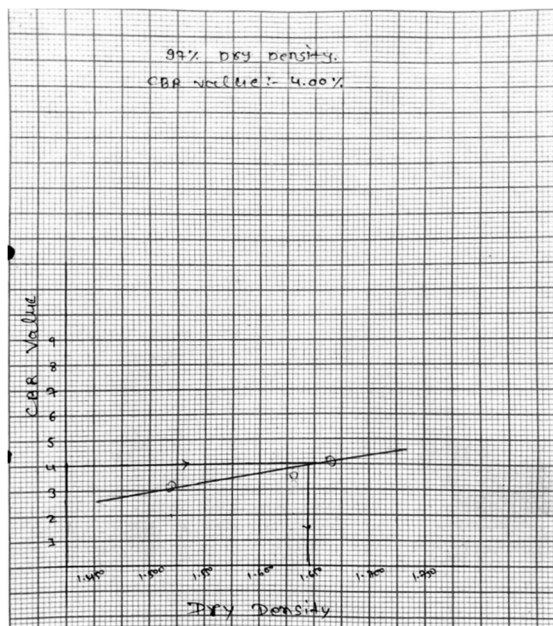
c) CBR Test with Fibre

CALIFORNIA BEARING RATIO (IS 2710 (PART III) & ASTM D 1534)									
Laboratory Job No.	235			Date of Sampling :		05/02/24			
Location/Source	130+700 LHS			Sampled by :		Jointly			
Type of Material :	with fibre			Tested by :		Jointly			
Proposed use :				Date of Casting :		08/03/24			
Period of Soaking :	96 Hours			Date of Testing :		12/03/24			
MOISTURE CONTENT AND UNIT WEIGHT OF TEST SAMPLES									
No. of layers	5	5		Mould No. 32	5	Mould No. 31	5	Mould No. 35	5
No. of blows per layer	10	10		30	30	65	65		
CONDITION OF SAMPLE	Before soaking	After soaking		Before soaking	After soaking	Before soaking	After soaking		
Wt. of Mould, W _m	6959	6959		7910	7910	7005	7005		
Wt. of Wet Sample + Mould, W ₁ (gm)	11097	11164		12277	12334	11521	11515		
Wt. of Wet Sample, W ₁ - W _m (gm)	4138	4205		4367	4424	4516	4510		
Volume of mould, V (cc)	2250	2250		2250	2250	2250	2250		
Wet Density, $\gamma_w = W_1/V$ (gm/cc)	1.839	1.869		1.941	1.966	2.007	2.030		
MOISTURE DETERMINATION	Before soaking	After soaking		Before soaking	After soaking	Before soaking	After soaking		
Container No.	28	27		26	32	39	38		
Wt. of container, W _c (gm)	49.80	48.15		48.87	48.69	47.37	47.37		
Wt. of Wet Sample + Cont., W ₂ (gm)	330.34	316.85		334.15	317.36	368.67	352.28		
Wt. of Dry Sample + Cont., W ₃ (gm)	279.94	263.2		282.49	265.27	310.62	293.88		
Wt. of water, W _w = (W ₂ - W ₃) (gm)	50.40	53.65		51.66	52.09	58.05	58.40		
Wt. of Dry Sample, W _d = (W ₃ - W _c) (gm)	230.14	215.05		234.12	216.58	263.25	246.51		
Moisture content, W = W _w /W _d (%)	21.90	24.95		21.85	24.05	22.05	23.69		
Dry Density $\gamma_d = \gamma_w / (1 + W/100)$ (gm/cc)	1.509	1.496		1.593	1.585	1.644	1.641		
LOAD - PENETRATION TEST DATA :									
Proving ring Calibration Factor :									
Sr.No.	Penetration (mm)	Mould No. 32		Mould No. 31		Mould No. 35			
		Proving ring Reading	Corrected load (kg)	Proving ring Reading	Corrected load (kg)	Proving ring Reading	Corrected load (kg)		
1	0.5	1	3.35	1	3.35	3	10.05		
2	1.0	2	10.05	2	10.05	5	16.75		
3	1.5	3	10.05	4	13.40	7	23.45		
4	2.0	4	13.40	5	16.75	8	26.80		
5	2.5	5	16.75	6	20.10	10	33.50		
6	3.0	6	20.10	7	23.45	11	36.85		
7	4.0	7	23.45	9	30.15	14	46.90		
8	5.0	8	26.80	10	33.50	15	50.25		
9	7.5	9	30.15	14	43.55	18	60.30		
10	10.0	10	33.50	14	46.90	19	63.65		
11	12.5	10	33.50	14	46.90	20	67.00		
CBR CALCULATION									
Mould No.	Corrected Unit Load in 5.0 mm (kg/cm ²)		CBR%	CBR % reported 9.45					
32	16.75	1.67	1.22						
31	16.75	1.67	1.22						
35	16.75	1.67	1.22						
Average	16.75	1.67	1.22						
Note :									
1) Graph for load vs penetration attached									
2) CBR = (corrected load/standard load) × 100									
3) Standard unit load : @ 2.5mm Penetration = 1370 Kg @ 5.0 mm Penetration = 2055 Kg									
CBR Value @ 97 % MDD 1.646 gm/cc = 24.00%									



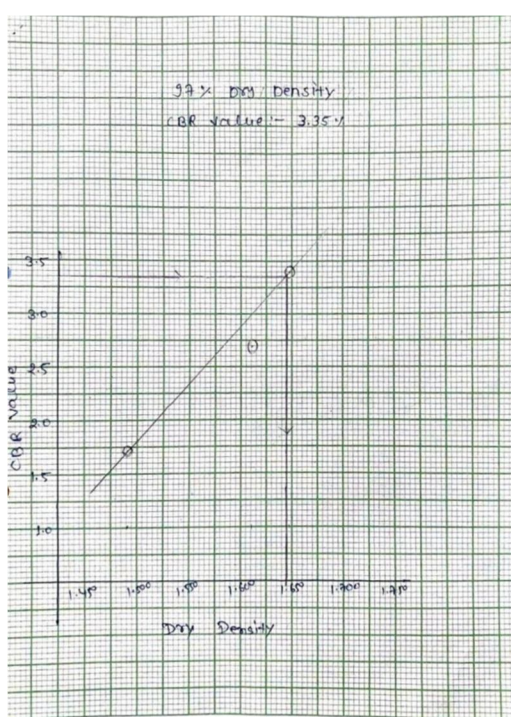
d) CBR Test Black with Plastic Bottle Chips

CALIFORNIA BEARING RATIO (PART 10 & 11) (ASTM D 1557)												
Laboratory Job No.	235	Date of Sampling	25/02/24									
Location/Source	130 + 700 LHS	Sampled by	Tamirah									
Type of Material	Black Soil + Plastic chips	Tested by	Tamirah									
Proposed use		Year of Casting	28/02/24									
Period of Soaking	96 Hours	Date of Testing	03/03/24									
MOISTURE CONTENT AND UNIT WEIGHT OF TEST SAMPLES												
No. of Layers	5	10	20	30	40	50	60	70	80			
CONSTRUCTION OF SAMPLE	Before soaking	After soaking	Before soaking	After soaking	Before soaking	After soaking	Before soaking	After soaking	After soaking			
Wt. of Mould, W _m (gm)	707.2	707.2	679.5	679.5	692.5	692.5	692.5	692.5	692.5			
Wt. of Wet Sample + Mould, W ₁ (gm)	1114.9	1122.8	1126.6	1131.8	1149.0	1151.1	1151.1	1151.1	1151.1			
Wt. of Wet Sample, W ₁ - W _m (gm)	417.7	426.6	447.1	452.3	456.5	458.6	458.6	458.6	458.6			
Volume of mould, V (cc)	2250	2250	2250	2250	2250	2250	2250	2250	2250			
Wet Density, ρ _w = W ₁ /V (gm/cc)	1.853	1.896	1.987	2.010	2.029	2.038	2.038	2.038	2.038			
MOISTURE DETERMINATION												
Container No.	31	35	38	28	27	30						
Wt. of container, W _c (gm)	48.21	50.20	47.37	48.31	48.40	47.39						
Wt. of Wet Sample + Cont., W ₂ (gm)	274.71	288.09	285.23	292.8	293.78	291.9						
Wt. of Dry Sample + Cont., W ₃ (gm)	236.77	248.78	243.22	246.84	243.65	242.74						
Wt. of water, W _w = W ₂ - W ₃ (gm)	37.94	39.31	42.01	45.96	49.13	49.15						
Wt. of Dry Sample, W _d = W ₃ - W _c (gm)	188.56	198.52	195.85	198.53	195.25	195.35						
Moisture content, w = W _w /W _d (%)	20.12	23.56	21.45	23.15	25.10	25.41						
Dry Density, ρ _d = W _d /V (gm/cc)	1.534	1.520	1.636	1.632	1.67	1.665						
LOAD - PENETRATION TEST DATA												
Proving Ring Calibration Factor: 3.35												
Proving Ring No.	1	2	3	4	5	6	7	8	9			
Penetration (mm)	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5			
Proving ring Reading	13.10	20.10	26.15	32.20	38.25	44.30	50.35	56.40	62.45			
Corrected load (kg)	10.05	16.15	22.15	28.15	34.15	40.15	46.15	52.15	58.15			
Standard unit load	1370 kg	2055 kg	2740 kg	3425 kg	4110 kg	4795 kg	5480 kg	6165 kg	6850 kg			
CBR Value @ 1.675 gm/cc	4.00%	6.00%	8.00%	10.00%	12.00%	14.00%	16.00%	18.00%	20.00%			



e) CBR test with Plastic Bottle Ring

CALIFORNIA BEARING RATIO (PART 10 & 11) (ASTM D 1557)												
Laboratory Job No.	235	Date of Sampling	25/02/24									
Location/Source	130 + 700 LHS	Sampled by	Tamirah									
Type of Material	Black Soil + Plastic Bottle	Tested by	Tamirah									
Proposed use		Year of Casting	28/02/24									
Period of Soaking	96 Hours	Date of Testing	03/03/24									
MOISTURE CONTENT AND UNIT WEIGHT OF TEST SAMPLES												
No. of Layers	5	10	20	30	40	50	60	70	80			
CONSTRUCTION OF SAMPLE	Before soaking	After soaking	Before soaking	After soaking	Before soaking	After soaking	Before soaking	After soaking	After soaking			
Wt. of Mould, W _m (gm)	700.0	700.0	700.0	700.0	700.0	700.0	700.0	700.0	700.0			
Wt. of Wet Sample + Mould, W ₁ (gm)	1100.0	1100.0	1100.0	1100.0	1100.0	1100.0	1100.0	1100.0	1100.0			
Wt. of Wet Sample, W ₁ - W _m (gm)	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0			
Volume of mould, V (cc)	2250	2250	2250	2250	2250	2250	2250	2250	2250			
Wet Density, ρ _w = W ₁ /V (gm/cc)	1.850	1.850	1.850	1.850	1.850	1.850	1.850	1.850	1.850			
MOISTURE DETERMINATION												
Container No.	31	34	38	28	27	30						
Wt. of container, W _c (gm)	47.21	48.40	48.77	48.31	48.40	48.40						
Wt. of Wet Sample + Cont., W ₂ (gm)	281.21	281.21	281.21	281.21	281.21	281.21						
Wt. of Dry Sample + Cont., W ₃ (gm)	236.77	236.77	236.77	236.77	236.77	236.77						
Wt. of water, W _w = W ₂ - W ₃ (gm)	44.44	44.44	44.44	44.44	44.44	44.44						
Wt. of Dry Sample, W _d = W ₃ - W _c (gm)	189.56	189.56	189.56	189.56	189.56	189.56						
Moisture content, w = W _w /W _d (%)	23.45	23.45	23.45	23.45	23.45	23.45						
Dry Density, ρ _d = W _d /V (gm/cc)	1.500	1.500	1.500	1.500	1.500	1.500						
LOAD - PENETRATION TEST DATA												
Proving Ring Calibration Factor: 3.35												
Proving Ring No.	1	2	3	4	5	6	7	8	9			
Penetration (mm)	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5			
Proving ring Reading	13.10	20.10	26.15	32.20	38.25	44.30	50.35	56.40	62.45			
Corrected load (kg)	10.05	16.15	22.15	28.15	34.15	40.15	46.15	52.15	58.15			
Standard unit load	1370 kg	2055 kg	2740 kg	3425 kg	4110 kg	4795 kg	5480 kg	6165 kg	6850 kg			
CBR Value @ 1.675 gm/cc	4.00%	6.00%	8.00%	10.00%	12.00%	14.00%	16.00%	18.00%	20.00%			



IV. RESULT ANALYSIS

A. Free Swell Index Result Analysis

Here's an analysis of the Free Swell Index test results :

- Free Swell Index: The Free Swell Index of the soil sample is 57.70%. A free swell index greater than 30% indicates a high swelling potential
- Interpretation:

The high Free Swell Index suggests that the soil sample has a high potential to swell when saturated with water. This can cause problems with foundations and other structures built on this soil, as the swelling soil can cause cracking and movement.

B. Liquid Limit Result Analysis

Atterberg Limits

- Liquid Limit (LL): The Liquid Limit is 65.50%. This is the moisture content at which the soil changes from a liquid state to a plastic state
- Plastic Limit (PL): The Plastic Limit is 27.40%. This is the moisture content at which the Soil changes from a plastic state to a brittle state .
- Plasticity Index (PI): The Plasticity Index (PI) is calculated as the difference between the
- Liquid Limit (LL) and the Plastic Limit (PL). In this case, the PI is $65.50\% - 27.40\% = 38.10\%$. A higher PI value indicates a more plastic soil.

C. Grain Size Analysis Result Analysis

Here's an analysis of the grain size distribution:

- Gravel(75-19 mm): 1.60% of the sample falls into the gravel size category.
- Sand (4.75-0.075 mm): 10.9% of the sample falls into the sand size category. This can be Further broken down into: Coarse sand (4.75-2.00 mm): 0.90% ,Medium sand (2.00-0.425 mm): 4.7% &Fine sand (0.425-0.075 mm): 5.3%
- Silt and Clay (particles smaller than 0.075 mm): 87.5% of the sample falls into the silt And clay size category.

D. Modified Proctor Test Result Analysis

- Dry Density (g/cm^3): The data sheet shows the Dry Density for five different moisture Content values. The Dry Density increases as the moisture content increases up to a certain Point, and then starts to decrease. The highest Dry Density is 1.695 g/cm^3 at a moisture Content of 22.00%, which is considered the Maximum Dry Density (MDD).
- Optimum Moisture Content (OMC): The Optimum Moisture Content (OMC) is the Moisture content at which the Maximum Dry Density (MDD) is achieved. In this case, the OMC is 22.00%

E. Cbr Test Result Analysis Noramal Black Soil

The report shows the results of the CBR test for three soil samples (moulds 24, 25, and 26).

The CBR values for the three samples are:

- Mould 24: 16.75 corrected load at 2.5 mm penetration, 26.80 corrected load at 5.0 mm Penetration
- Mould 25: 33.50 corrected load at 2.5 mm penetration, 53.60 corrected load at 5.0mm penetration
- Mould 26: 40.20 corrected load at 2.5 mm penetration, 60.30 corrected load at 5.0 mm penetration
- The CBR values are all relatively low, which indicates that the soils are weak and may not be Suitable for use in pavements without additional treatment. The report does not specify what The soils will be used for, but the CBR values are typically used to design the thickness of Pavement layers.
- CBR VALUE IS :- 2.82%

F. CBR Test Result Analysis Black Soil + Geotextile

The report shows the results of the CBR test for three soil samples (moulds, 25, 26, and 34). The

CBR values for the three samples are:

- Penetration Mould 25: 20.10corrected load at 2.5 mm penetration, 30.15 corrected Load at 5.0 mm
- Penetration Mould 26: 30.15 corrected load at 2.5 mmpenetrationloa50.25 corrected Load at 5.0 mm
- Penetration Mould 34: 43.55 corrected load at 2.5 mm penetration, 60.30 corrected Load at 5.0 mm
- Penetration The CBR values are all relatively low, which indicates that the soils are weak and

May not be suitable for use in pavements without additional treatment. The report does not

Specify what the soils will be used for, but the CBR values are typically used to design the

Thickness of Pavement layers

CBR VALUE IS :- 3.05%

G. CBR Test Result Analysis Black Soil + Fiber

The report shows the results of the CBR test for three soil samples (moulds, 33, 31, and 35). The CBR values for the three samples are:

- Penetration Mould 33: 16.75 corrected load at 2.5 mm penetration, 26.80 corrected load at 5.0 mm
- Penetration Mould 31: 20.10 corrected load at 2.5 mm penetration, 33.50 corrected load at 5.0 mm
- Penetration Mould 35: 33.50 corrected load at 2.5 mm penetration, 50.25 corrected load at 5.0 mm
- Penetration The CBR values are all relatively low, which indicates that the soils are weak and may not be suitable for use in pavements without additional treatment. The report does not specify what the soils will be used for, but the CBR values are typically used to design the thickness of Pavement layers
- CBR VALUE IS :- 2.40%

H. CBR Test Result Analysis Black Soil + Plastic Chips

The report shows the results of the CBR test for three soil samples (moulds, 20, 21, and 25). The CBR values for the three samples are:

- Penetration Mould 20: 43.55 corrected load at 2.5 mm penetration, 60.30 corrected load at 5.0 mm
- Penetration Mould 21: 46.90 corrected load at 2.5 mm penetration, 67.00 corrected load at 5.0 mm
- Penetration Mould 25: 56.95 corrected load at 2.5 mm penetration, 73.70 corrected load at 5.0 mm
- Penetration The CBR values are all relatively low, which indicates that the soils are weak and may not be suitable for use in pavements without additional treatment. The report does not specify what the soils will be used for, but the CBR values are typically used to design the thickness of Pavement layers
- CBR VALUE IS : 4.00 %

I. CBR Test Result Analysis Black Soil + Plastic Rings

The report shows the results of the CBR test for three soil samples (moulds, 30, 34, and 31). The CBR values for the three samples are:

- Penetration Mould 25: 23.45 corrected load at 2.5 mm penetration, 33.50 corrected load at 5.0 mm
- Penetration Mould 26: 36.85 corrected load at 2.5 mm penetration, 60.30 corrected load at 5.0 mm
- Penetration Mould 34: 46.90 corrected load at 2.5 mm penetration, 63.65 corrected load at 5.0 mm
- Penetration The CBR values are all relatively low, which indicates that the soils are weak and May not be suitable for use in pavements without additional treatment. The report does not Specify what the soils will be used for, but the CBR values are typically used to design the Thickness of Pavement layers
- CBR VALUE IS :- 3.35 %

V. CONCLUSION

Black cotton soil, despite its weakness, can be boosted for embankments using plastic waste. Crushed plastic or strips mixed in the soil improve its strength and reduce swelling. This creates a Stronger, more stable material for building embankments. However, this method doesn't address the core issue for subgrades – shrinkage and swelling with Moisture changes. Embankments sit above ground with less water exposure, but subgrades are Directly impacted by seasonal variations. The treated soil might still experience these drastic volume Changes, causing cracks and compromising the structural integrity of the road or building above.

In short, plastic waste strengthens black cotton soil for embankments, but it doesn't address the Moisture sensitivity that plagues subgrades.

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