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Analysis of engineering properties of Black Cotton soil using Coal Mine Overburden Waste as Stabilizer

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Abstract : Black Cotton Soil, a type of expansive soil with rich proportion of montmorillonite shows high degree of expansiveness and so this swell shrunk behaviour makes this soil a not so preferable soil in its natural state. So a proper stabilization technique can significantly enhance the undesirable properties of black cotton soil such as lower shear strength , high compressibility, high permeability, different stabilizers readily used are cement, lime, fly ash, silica fume, ggbs, marble dust, gypsum etc. But here in this study we will be using coal mine overburden waste as a non-traditional stabilizers with increasing percentage from 5% to 20% of dry weight of soil. It can be inferred from the results obtained that adding coal mine overburden waste as a stabilizer substantially improved the engineering properties of black cotton soil.

***Keywords Black Cotton Soil, Coal Mine Overburden Waste, Stabilization*, engineering property.**

1.INTRODUCTION

Black cotton soils are inorganic clays of medium to high compressibility covering about 1/6th of India's land area mostly in deccan plateau region. Rich contents of montmorillonite and other minerals This soil exhibit peculiar behaviour of severe volume changes with change in moisture content and the undesirable swelling and shrinkage behaviour due to rich contents of montmorillonite. The civil engg. Structures erected in this expansive soil possess threat of collapsing and cracking. To eradicate this demerit of black cotton, soil stabilization is done to improve the engineering properties of weak and expansive soils. Soil stabilization is the method to enhance undesirable properties of soil sample by mixing with different additives and improving properties like compressibility problem permeability , shear strength, load bearing capacity etc. In this study effect of coal mine overburden waste in powdered form with varying proportions is considered. Overburden waste is devoid of actual soil characteristics , low nutrient content , silicate ,sulphate and clay mineral. Open cast mining is increasing now a days and so overburden which of no use currently is treated as a waste and so we have used this waste as a stabilizer , abundant ,cheap and eco-friendly.

2. MATERIALS USED:

Black Cotton Soil

The soil used for study was collected from Solapur district Maharashtra these soil are good for agricultural purpose but not for constructing any civil engineering structures. These soils are predominant in deccan trap plateau region i.e. in states of Andhra Pradesh, Gujrat , Maharashtra, north Karnataka Gwalior region.

Table 1.

S.no.	property	Value
1	Dry density	1300 to 1800 kg/m3
2	Fines (<75u)	60 to 100 %
3	Liquid limit	40 to 120 %
4	Plastic limit	20 to 60 %
5	Specific gravity	2.60 to 2.75
6	Optimum moisture content	20 to 35 %
7	Free swell index	40 to 180 %
8	CBR (soaked)	1.20 to 4.0

COAL MINE OVERBURDEN WASTE

Coal mine overburden waste, often referred to as overburden or spoil, is the material that lies above a coal seam in an underground or surface coal mine and needs to be removed to access the coal. This material typically consists of rocks, soil, clay, and other geological materials that are not economically valuable and must be excavated and disposed of to reach the coal reserves. Overburden removal is a necessary step in the coal mining process and is usually done using heavy equipment like bulldozers, excavators, and truck. overburden waste may contain trace amounts of elements that are naturally present in the surrounding geological formations.

Lab tests performed on black cotton soil. Table 2

Tests	IS Code
Specific Gravity	IS:2720 (part 3) 1980
Grain Size Analysis	IS: 2720 (part 4) 1985
Atterberg Limit	IS;2720 (part5) 1985
Differential Free Swell Index	IS:2720 (part 40) 1977
Standard Proctor Compaction Test	IS: 2720 (part 7) 1980
California Bearing Ratio	IS:2720 (part 16) 1987
Unconfined Compressive Strength	IS:2720 (part 10) 1973

3.METHOD OF WORKING

A.The Raw and disturbed soil sample brought from site is first tested to found basic geotechnical properties like liquid limit, plasticity index Maximum dry density Optimum Moisture Content Specific Gravity, California Bearing Ratio, Free Swell Test.

B. Again the soil sample is tested with the same basic tests performed initially but mixed with overburden waste with varying proportions increasing from 5% to 20%.

C. Obtained test results are compared with each other to interpret the correct proportions of stabilizer mixed with Black Cotton Soil at which soil is most stable.

4.RESULTS AND DISCUSSION

4.1 Specific Gravity

The specific gravity test of soil is a fundamental soil test used to determine the density and composition of soil particles. It is an important parameter in geotechnical engineering and is useful for various applications, including assessing soil compaction, moisture content, and the suitability of soil for construction purposes.

$$Specific\ gravity\ of\ soil = \frac{\text{Density of water at 27 C}}{\text{Weight of water of equal volume}}$$

$$= \frac{(W_2 - W_1)}{(W_4 - W_1) - (W_3 - W_2)}$$

$$= \frac{(W_2 - W_1)}{(W_2 - W_1) - (W_3 - W_4)}$$

This test was performed on black cotton soil sample using pycnometer method:

Table 3.

S.No.	Mass of empty pycnometer	Mass of pycnometer + dry soil sample	Mass of pycnometer+ soil sample + water	Mass of pycnometer + Water filled completely	Specific Gravity
1	590 gm	723	1532	1450	2.607
2	590 gm	713	1526	1450	2.617
3	590 gm	744	1546	1450	2.651

Average Specific Gravity of soil sample is : 2.625

4.2 Particle Size Distribution Curve

Table 4.

S. No.	Sieve size (mm)	Wt. retained (gm)	% wt retained	cumulative% weight retained	% finer
1	4.75 mm	70	8.75	8.75	91.25
2	2.36 mm	101	12.62	21.37	78.63
3	1.18 mm	190	23.75	45.12	54.88
4	600micron	131	16.37	61.49	38.51
5	300 micron	115	14.37	75.86	24.14
6	150 micron	103	12.87	88.73	11.27
7	75 micron	53	6.62	95.35	4.65
8	pan	37	4.62	99.97	0.03

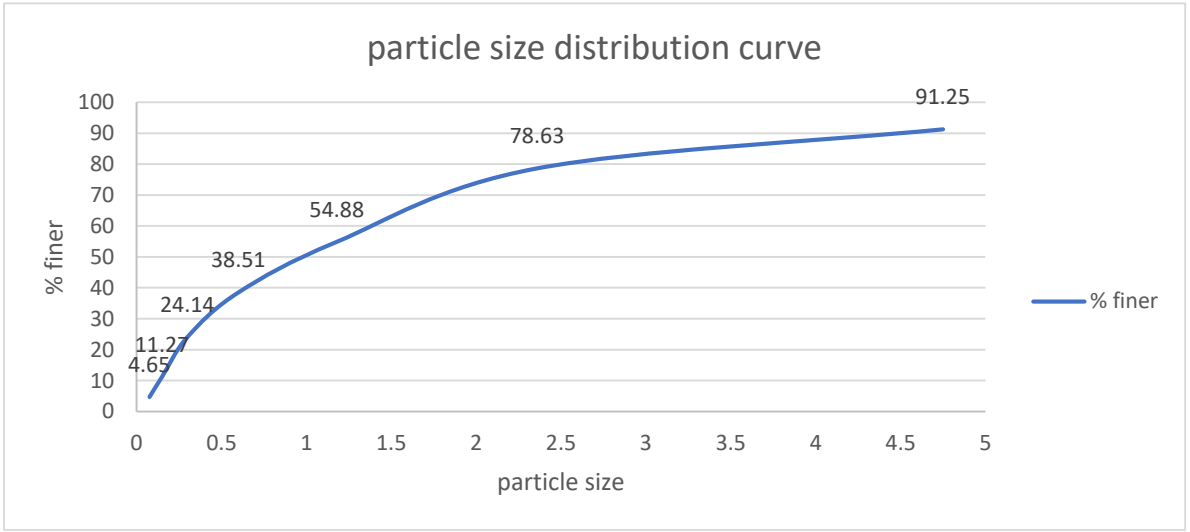
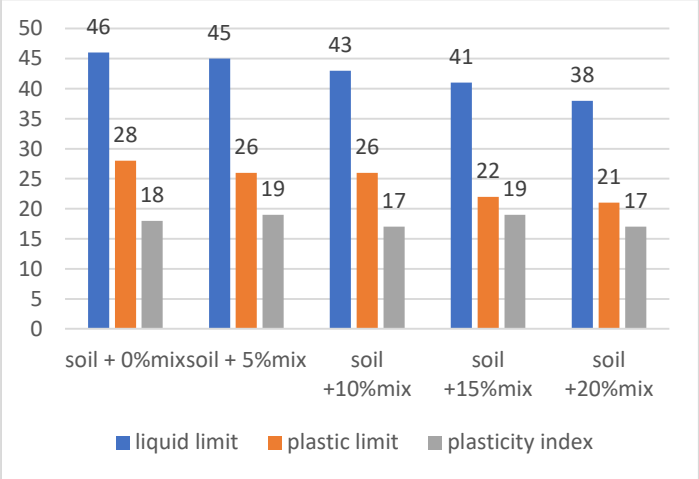


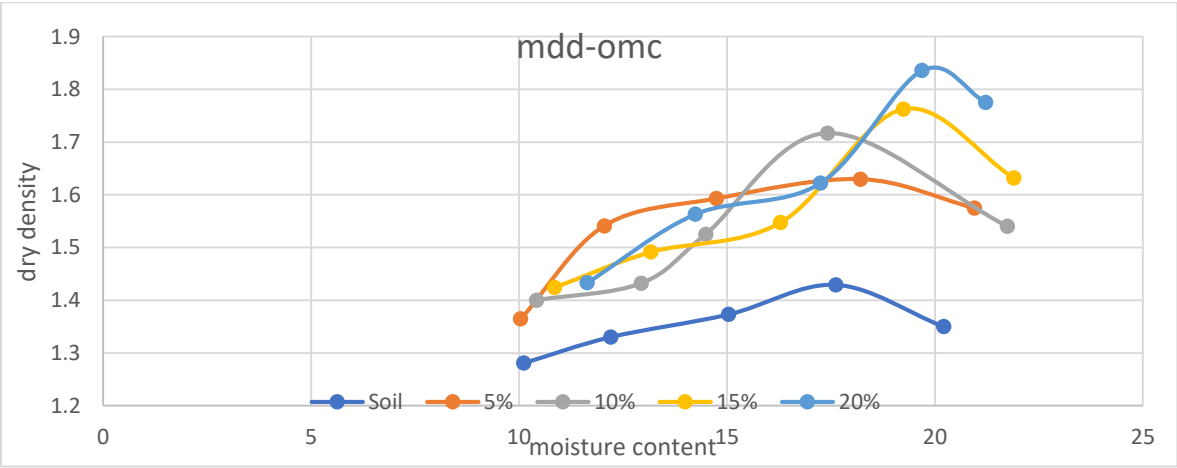
Table 5.

S.No.	Property	Virgin Soil	Soil + 5% mix	Soil + 10% mix	Soil + 15% mix	Soil +20 % mix
1	Liquid limit	46	45	43	41	38
2	Plastic limit	28	26	26	22	21
3	Plasticity Index	18	19	17	19	17



4.3 PROCTOR COMPACTION TEST

The Proctor compaction test, also known as the standard Proctor test, is a laboratory soil compaction test used to determine the optimal moisture content and maximum dry density for a particular type of soil.



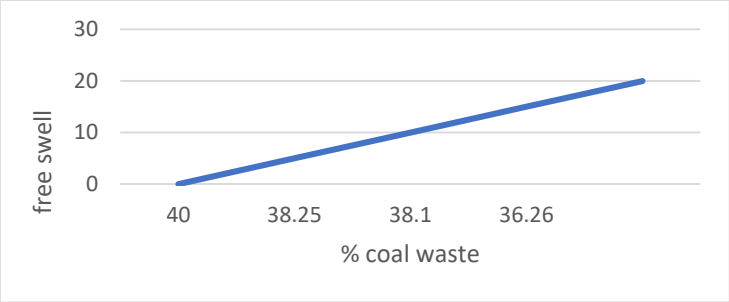
	soil	Soil +5% mix	Soil +10 %mix	Soil +15%mix	Soil +20% mix
Omc (%)	17.62	18.21	17.42	19.24	19.69
Mdd((gm/cc)	1.429	1.6296	1.717	1.7625	1.8355

4.4 Differential Free Swell Test

It is a laboratory test used to determine the swell potential of a soil sample when it comes into contact with water. It is particularly important in geotechnical engineering and soil science, as it helps assess the suitability of a soil for construction projects, especially when it comes to designing foundations and assessing potential soil expansion and contraction.

Table 6

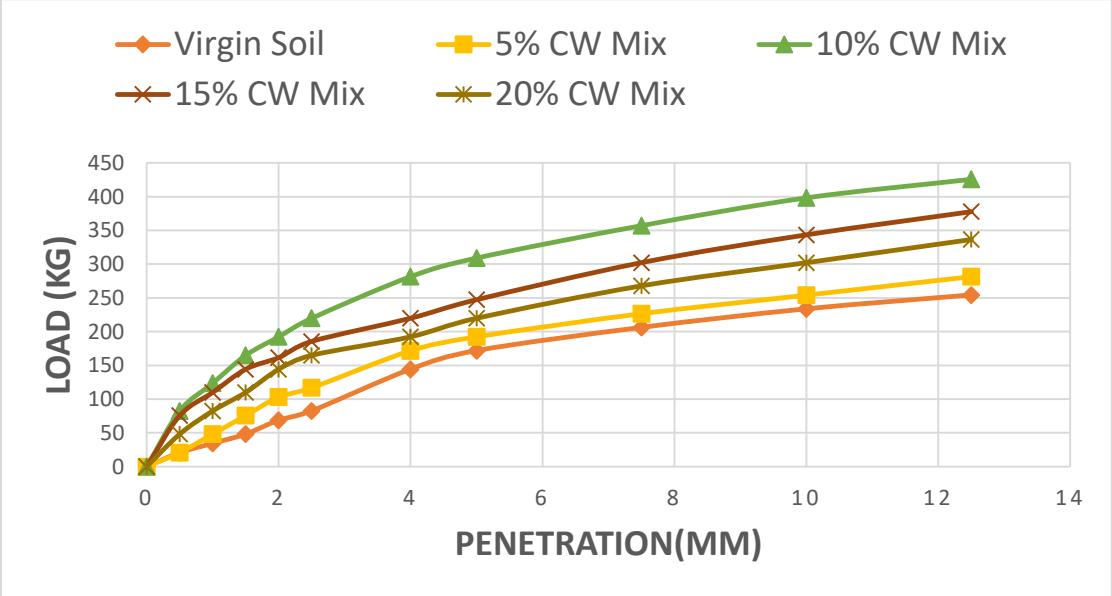
% of Coal waste	FREE SWELL
0	40
5	38.25
10	38.10
15	36.26



4.5 California Bearing Ratio Test

California Bearing Ratio (CBR) test is a common laboratory test used to evaluate the mechanical strength of soil, especially for road construction and pavement design. The CBR test provides information about the load-bearing capacity of soil and its suitability for construction.

CBR	Raw soil	Soil+ 5% mix	Soil+10%mix	Soil+15% mix	Soil+ 20%mix
2.5	6.1250	9.8569	18.1452	16.1269	14.7853
5.0	8.3654	11.2587	17.9852	16.1052	13.2694



5. Conclusions

From the study it has been observed that mixing coal mine overburden waste has substantially improved the properties of Black cotton Soil by the varying proportions of additive FROM 5% to 10%.

1. It has been found that an on addition of stabilizer liquid limit has decreased by rate of 5%.
2.Maximum dry density increased on addition by approx..10% but its rate of increase decreases as we keep on increasing the percentage of stabilizer. So 10% by weight of stabilizer is optimum amount to be mixed.
3. It can be inferred that omc increased on adding the soil stabilizer but rate of increasing was very less.
4.CBR value of black cotton Soil at 10% of mixing by weight of soil was optimum at both penetrations i.e. 2.5 and 5.0 mm.

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