STABILIZATION OF BLACK COTTON SOIL USING PLASTIC GRANULES AND WOOD ASH

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ABSTRACT

Due to its high compressibility, low shear strength, and high permeability, expansive soil presents a concern while building highways and other civil engineering projects. In these circumstances, the method of altering the soil's qualities through the blending of various foreign components is known as "soil stabilisation." In this work, wood ash and plastic are used to enhance the engineering qualities of black cotton soil. Additionally, it does away with the necessity for a place to store extra materials. ThisProject major objective is to measure the advantages of stabilising a black cotton soil in terms of its engineering features. Two stages of the investigation were completed. In the first phase, the geotechnical characteristics of the soil were ascertained without the addition of any additives (control experiment), and in the second phase, different percentages of additives were added (test experiment).

To stabilise the soil while the following tests (Atterberg's limit, Specific gravity, UC strength, vane shear, Compaction, and California Bearing Ratio) were run on the stabilised soil, wood ash and plastic were added to the soil sample in varied amounts (To the weight of sample).The use of plastic granules in place of wood ash has not only successfully reduced overall swelling but also significantly increased the soil's CBR value. The addition of wood ash and plastic granules to the pavement subgrade has reduced the thickness of the individual layers.

KEY WORDS: Black cotton soil, stabilization, wood ash, plastic granules and California bearing ratio.

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INTRODUCTION

Due to their poor engineering qualities, marginal and weak soils, such as soft clays, black cotton soil, organic deposits, and loose sand, are frequently inappropriate for construction. When the moisture content varies, expansive soil's volume fluctuates. The capacity of soils to hold water decreases during monsoon seasons as they absorb water, swell, and become soft. These soils become harder and shrink or lose volume during the dry seasons as a result of water evaporation. The soil is inappropriate for construction because of its particular property of great flexibility, excessive swelling, and shrinkage.

In India, black cotton soils make up a significant soil category. In order to improve the qualities of the soil for soil stabilisation, a specific quantity of additives must be added, although these additions ultimately prove to be more expensive. In contrast, in order to stabilise soil and increase its quality, inferior materials or certain agricultural or industrial waste might be utilised in place of cement or lime. Additionally, the country's growing development has created disposal risks in addition to environmental issues. The safe disposal of these materials is a top priority, and this issue can be resolved by using these materials extensively, particularly in the realm of civil engineering applications. Given the scarcity and high cost of conventional construction materials, the rising cost of transportation, and environmental concerns, the use of various waste products in civil engineering construction has recently attracted a lot of attention.

In order to improve the engineering qualities of soil, soil stabilisation uses chemical or mechanical manipulation to increase and maintain the stability of the soil mass. Stabilization thins the pavement and boosts the soil's shear strength and load-bearing capability. Utilizing diverse admixtures, various strategies are being used to stabilise such fragile soil. To enhance the characteristics of soil, such as CBR and UCS, additives can be applied, such as tyre granules, gypsum, fly ash, lime, geogrids, jute fibres, etc.

Wood is anaturally occurring material obtained from trees. Some of the trees are used for structural works, furniture works, cookin getc.It send product when burnt in the course of cooking gives a substance alled“woodash”.Wood ash generally has a pozzolanic feature that modifies the majority of soil qualities to make it acceptable for construction (Okagbue, 2012). The purpose of adding wood ash to the soil is to stabilise or condition it. Additionally, wood ash helps coagulate loose soil (Amu et al., 2005).

The impact of plastic granule addition on the engineering characteristics of black cotton soil is demonstrated in this experiment. The incorporation of plastic granules into a soil sample can be compared to other soil stabilising admixtures. Recycled materials from diverse sectors are used for stabilisation.The construction of the highway pavement is made up of layers of processed materials that are layered on top of the subgrade of natural soil. There are two different types of pavement: stiff pavement and flexible pavement. I had chosen pliable ground. The entire pavement thickness is calculated using flexible pavement design and the CBR approach.

MATERIALS USED BLACK COTTON SOIL

The wide nature of black cotton soils or the presence of huge settlements make building infrastructural facilities on them one of India's largest soil deposits and a difficult endeavour. Black cotton soils are more common in India's central and western regions. These soils are essentially leftover residues from the basaltic rocks' chemical disintegration that were left where they formed. After being carried by wind and water to low-lying, flat locations where they grow over alluvium, they travel deep and often average 5 metres. While lacking in phosphorus, nitrogen, and organic matter, these soils are typically rich in lime, iron, magnesium, and aluminium oxide. Due to its properties of swelling and contraction, the black cotton soil (BC soil) has presented a difficult task to highway engineers.
At a depth of 2 metres below ground level, the expanding soil employed in the experimental activity was transported from a location 30 kilometres from Pedatadepalli. According to the IS code of practise, expansive soil's Index and engineering properties are assessed.

Types of properties of soil

PHYSICALPROPERTIES	INDEXPROPERTIES	ENGINEERINGPROPERTIES
Specific Gravity	Free Swell Index	Compaction Test
Moisture Content	Atterberg limits	Unconfined Compressive Strength
	Sieve Analysis	California Bearing Ratio

PREPARATION OF TEST SAMPLES

For experimental study different samples have been prepared with different proportions of soil, Wood Ash and Plastic granules.
Preparationoftest samples

S.NO	SampleType	Detailofthe additiveaddedwiththesoil	
		Soil(%)	Wood Ash (%)By Weightofsoil
1.	S1	100	0
2.	S2	97	3
3.	S3	94	6
4.	S4	91	9
5.	S5	88	12

This soilis tested for different experiment a land compressive strength and other different properties are increased by using stabilization. Our main objective of stabilization is to increase the engineering properties of the soil an duse it as a sub-grade course in road construction.

WOODASH

The fine residue left over from burning wood, whether it is in a fireplace, a campfire, or a commercial power plant, is known as wood ash. Along with other non-combustible trace elements found in the wood, it is primarily made of calcium compounds. It has served a variety of functions throughout history.
From the hotels and food canteens in the area, wood ash was gathered. It is essential to maintain uniformity between the sample preparations in order to analyse how the wood ash affects the treated samples' mechanical properties. It was determined that by regulating the mixing water, uniformity could be achieved between the samples. In order to preserve uniformity, samples for this inquiry were prepared using their appropriate optimal moisture content (OMC). On untreated as well as ash-treated soils, a number of laboratory tests were carried out, including index testing, compaction testing, UCS testing, Atterberg limits testing, and CBR testing. The project's primary goal was to assess how the addition of wood ash and plastic granules affected the soil's qualities. The study primarily focused on the strength attribute.

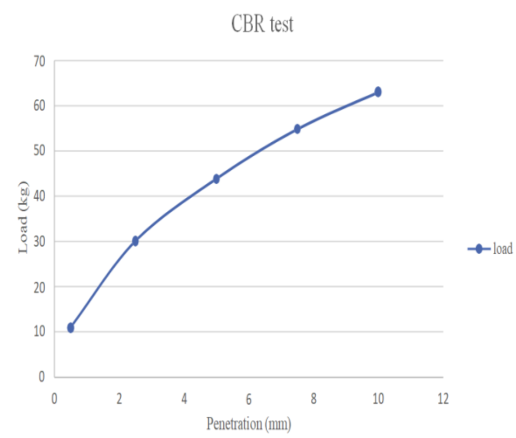
PLASTICGRANULES

For the experimental experiments, different weight percentages of the soil containing waste plastic that is being transformed into plastic granules were used. The plastic used in the current investigation was purchased from a company that grinds up waste plastic. The plastic is in the form of granules that go through an IS sieve with a 4.75 mm mesh size. Plastic granules were chosen for stabilisation primarily because they are locally accessible and less expensive than any other traditional stabilising materials. Plastic has also shown to be an effective stabilising material. Therefore, plastic is utilised to stabilise the soil in Black Cotton.

PLASTIC GRANULES WOOD ASH ANALYSIS AND RESULTS CBR TEST

CBR readings for soil

Penetration(mm)	Provingring reading (divisions)	Load(kg)
0.4	0.4	10.98
2.5	1.1	30.1
5	1.6	43.9
7.5	2	54.9
10	2.3	63.1

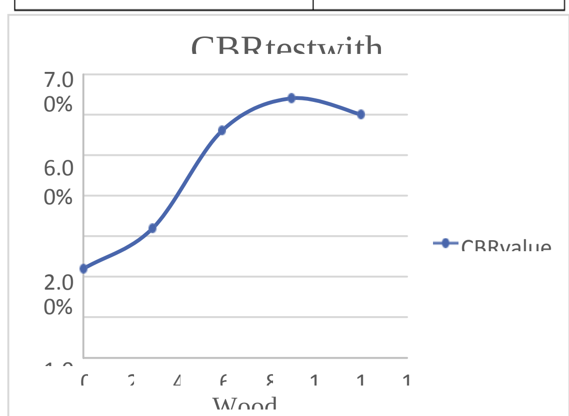


The graph is plotted between penetration (mm) and load (Kg) For2.5,CBR=2.20% For 5.0,CBR=2.13%

COMPARISON BETWEEN DIFFERENTIAL PROPORTION OF WOOD ASH AND CBR AT 2.5

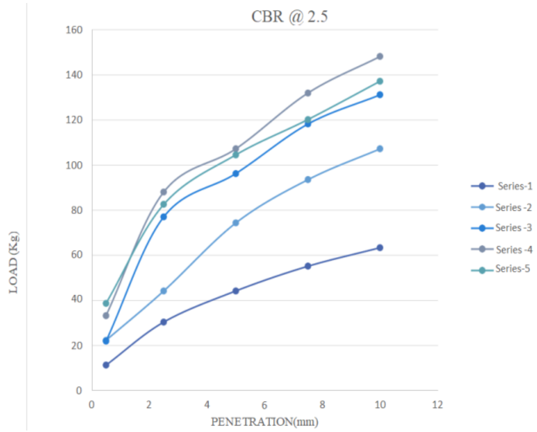
CBR readings of soil with different proportions of wood ash

Percentageofwoodash addedtosoil	Percentageof CBRValueat2.5mm
0%	2.20%
3%	3.20%
6%	5.61%
9%	6.41%
12%	6.01%



Comparison of CBR values at different proportions of wood ash added to the soil

COMPARISON OF CBR VALUES OF EVERY SAMPLE IN A GRAPH: (SOAKED CONDITION)

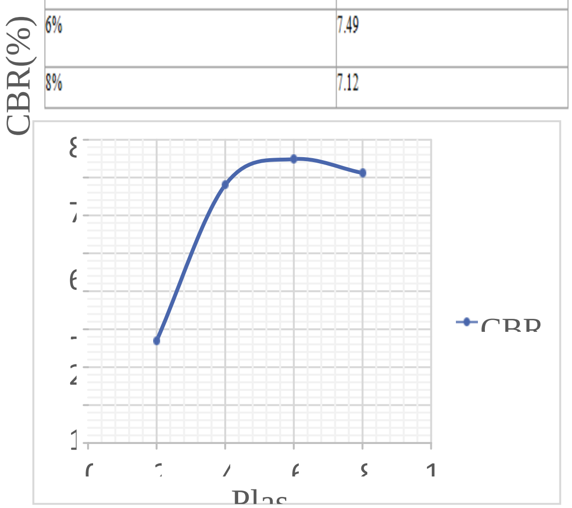


Comparison of CBR graph of every sample in a graph: (Soaked condition) Series-1 refers to Normal soil.
Series-2 refers to Soil+3% Wood ash
Series-3referstoSoil+6%Woodash
Series-4referstoSoil+9%Woodash
Series-5referstoSoil+12%Woodash

COMPARISIONOFCBRTESTVALUESATVARIOUSPROPORTIONSOFPLASTICGRANULES

Comparison of CBR values

PERCENTAGE OF PLASTICGRANULESADDEDTOSOIL+9%WOOD ASH	CBR(%)
2%	6.46
4%	6.81
6%	7.49
8%	7.12



Comparison of CBR graph at different proportions of plastic granules+9% of wood ash added to the soil

Variation of test results for different proportions of wood ash blended with the soil:

TESTNAME	SOIL	SOIL+WOODASH(3%)	SOIL+WOODASH(6%)	SOIL+WOODASH(9%)	SOIL+WOODASH(12%)
LIQUID LIMIT(%)	64	47.10	38.70	25.66	27.35
PLASTICLIMIT(%)	36.3	31.36	28.56	22.4	23.8
SPECIFICGRAVITY(G)	2.26	2.28	2.31	2.37	2.28
FREESWELLINDEX (%)	70	40.6	37	33.5	29
MDD(g/cc)	1.60	1.62	1.67	1.80	1.76
OPTIMUMWATERCONTENT(%)	14.57	17	15.8	16.6	16.2
CBR(%)	2.20	3.20	5.61	6.41	6.01
UCS(N/mm^2)	0.051	0.058	0.061	0.07	0.067

Variation of test results for different proportions of plastic granules+9% wood ash blended with the soil

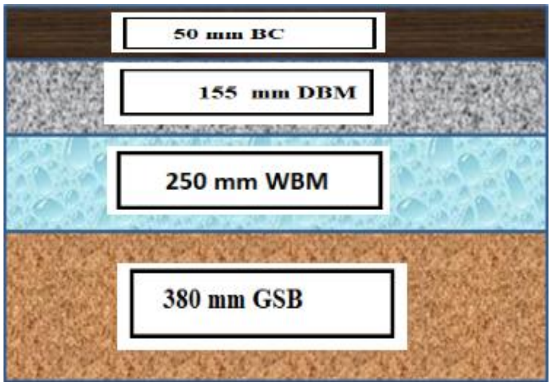
TESTNAME	SOIL	SOIL+ WOODASH(9%)	SOIL+WOODASH (9%) +PLASTICGRANULES2%	SOIL+WOODASH (9%) +PLASTICGRANULES4%	SOIL+WOODASH (9%) +PLASTICGRANULES6%	SOIL+WOODASH (9%) +PLASTICGRANULES8%
MDD(g/cc)	1.60	1.80	1.81	1.83	1.85	1.83
OPTIMUMWATERCONTENT(%)	14.57	16.6	15.4	15.2	14.53	15.6
CBR(%)	2.20	6.41	6.46	6.81	7.49	7.12
UCS(N/mm^2)	0.051	0.07	0.068	0.073	0.079	0.081

FLEXIBLE PAVEMENT

The kind of pavement, whose structural response under loads is relatively flexible and whose flexural strength is insignificant. In flexible pavement, the layers reflect the deformation of the lower layer onto the layer's surface. This shows that the surface of flexible pavement also becomes undulated if the lower layer of the pavement or subgrade is undulated.

Design of Flexible Pavement (IRC37-2012)

For unstabilized soil, the CBR is 2.22 percent. based on the IRC: 37-2012 chart Bituminous course was 50 mm thick, dense bituminous macadam was 155 mm thick, water-bound macadam was 250 mm thick, granular sub-base was 380 mm thick, and subgrade was 500 mm thick. The pavement segment for this project was constructed using black cotton soil (CBR = 2.22%).



Pavement section showing thickness of layers for un-stabilized BCS

Adding 9% wood ash to stabilised soil (CBR=6.41%) based on the IRC: 37-2012 chart Bituminous course (BC) thickness is 50 mm, while dense bituminous macadam (DBM)thickness is 125 mm.Water-Bound Macadam (WBM) is 250 mm thick.Granular Sub-base (GSB) Thickness: 260 mm (SG) thickness = 500 mm demonstrates the pavement segment for which black cotton soil and 9% wood ash were combined (CBR = 6.41%).

S.No	Description	Layers	Thickness(mm)
1	Un-stabilizedsoil(CBR=2.22%)	GSB	380
		WBM	250
		DBM	155
		BC	50
		TOTAL	835
2	Stabilized soil(CBR= 6.41%) (soil+wood ash)	GSB	260
		WBM	250
		DBM	125
		BC	50
		TOTAL	685
3	Stabilized soil (CBR=7.49%) (soil+wood ash+plastic granules)	GSB	230
		WBM	250
		DBM	120
		BC	50
		TOTAL	650

Pavement Section showing thickness of layers for stabilized BCS

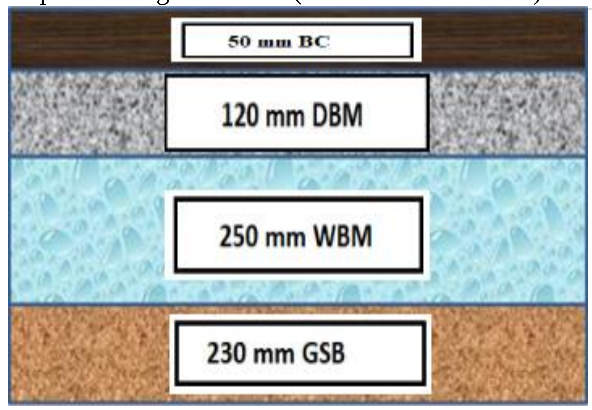
For soil that has been stabilised (CBR = 7.49%) based on the IRC: 37-2012 chart

Thickness of bituminous course (BC) = 50 mm • Thickness of Dense Bituminous Macadam (DBM) = 120 mm Water-Bound Macadam (WBM) is 250 mm thick.

Thickness of Granular Sub-base (GSB) = 230 mm

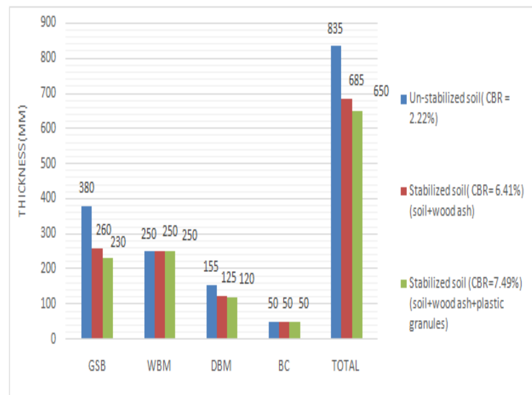
Thickness of Subgrade (SG) = 500 mm

the pavement section for which was made up of black cotton soil mixed with 9%wood ash + 8%plastic granules (CBR = 7.49%)



Pavement Section showing thickness of layers for stabilized BCS

Thickness of various layers of pavement for CBR



Variation of thickness of various layers before & after stabilizing Saving in pavement thickness

The overall pavement thickness for unstabilized sub-grade is 835 mm (CBR), however for stabilised sub-grade, the thickness is lowered to 650 mm. Pavement thickness is reduced by 185 mm when the black cotton soil is stabilised using wood ash and plastic granules.

CONCLUSION

From the results of the investigation carried of the study the following conclusions are drawn When 9% wood ash was applied to the soil, the liquid limit value dropped from 64% to 25.66% and the plastic limit value from 36.3% to 22.4%. The value has increased as we have increased the proportion of wood ash.

The addition of Wood ash percentage ranges from 0-9% to the black cotton soil caused the free swell index value to fall from 70% to 33.5%.

It has been found that adding wood ash at 9%

increases the California bearing ratio (CBR) of a soaked sample for 2.5 mm penetration from 2.20% to 6.41%, and that the value falls as the amount of wood ash is raised further.

By adding wood ash at a rate of 9%, the maximum dry density value increases from 1.60 g/cc to 1.80 g/cc. The value of MDD declines as we progressively raise the value percentage of Wood ash.

By adding wood ash at a rate of 9%, it has been noticed that the soil's UCS value has grown from 0.051N/mm2 to 0.07N/mm2. The value of strength declines as we further raise the percentage of wood ash.It is observed that the California bearing ratio (CBR) of a soaked sample for 2.5mmPenetration, value is increased from 2.20% to 7.49% with addition of Plastic granules at6% along with 9% Wood ash and the value decreases if we further increase the value of Plastic granules.

By adding 6% plastic granules combined with 9% wood ash, the Maximum Dry Density value rises from 1.60 g/cc to 1.85 g/cc; however, if the proportion of plastic granules is increased further, the value of MDD falls.

By comparing the two situations, it can be seen that adding plastic granules at a percentage of 8% + 9% Wood ash boosted the soil's UCS value from 0.051N/mm2 to 0.081N/mm2, which indicates that the combination's qualities are superior to those of the soil + wood ash combination.

CBR value increased by 2.22% to 7.49%. For stabilised subgrade, the pavement's thickness was reduced from 835mm to 650mm. Thus, 185mm of thickness are saved. Wood ash and plastic granules are used to add soil, which lowers the cost of building. The addition of more wood ash and plastic granules—up to 9% and 6%, respectively—significantly improves all engineering properties. This means that the plastic and wood ash granules can be used successfully. This subject can also be used to learn about and apply to many types of civil engineering infrastructure.

SCOPE OF FUTURE WORK

The combination of soil and wood ash + plastic granules can studied in depth and can be applied to many civil engineering works. A thorough investigation can be carried out to find out the minera logical change using SEM and XRD analysis.

The study can be carried out for different curing periods and can be checked for longterm durability.

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