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AN EXPERIMENTAL STUDY OF EXPENSIVE SOIL STABILIZED WITH BANANA FIBRE AND MAGNESIUM CHLORIDE

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ABSTRACT: The black cotton soils undergo excessive volume changes, making their use in the construction of civil engineering projects very difficult. Swelling soil always create problems more for lightly loaded structures than moderately loaded structures. By consolidating under load and changing volumetrically along with seasonal moisture and unequal settlement. As a result, damage to foundation systems, structural elements and architectural features defeat the purpose for which the structures are erected. The properties of the black cotton soils can be altered in many ways viz. mechanical, thermal and chemical means. Therefore, soil stabilization techniques are necessary to ensure the good stability of soil so that it can successfully sustain the load of the superstructure especially in case of soil which is highly active; also, it saves a lot of time. Attempts to study about such unpredictable behavior through research on how to bring these problems under control form the backdrop for this project work. Therefore, a number of laboratory experiments are conducted to ascertain host of soil engineering properties of a naturally available expansive soil before and after stabilization. Pre-and post-stabilized results are compared to arrive at conclusion that can thwart expansive soil problems. Expansive soil reinforced with synthetic fibers is a modified method developed in recent years. Laboratory studies on soil reinforced with discrete fibers which are useful in restraining the shrinkage tendency of the soil. Test values. In the present work, an attempt has been made to study the compaction, Cyclic plate load tests, California Bearing Ratio(CBR) tests were conducted on black cotton soil mixing with different percentages of Banana fiber and Magnesium chloride with a view to determine the optimum percentage.

INTRODUCTION: Soil is either part of the foundation or one of the raw materials used in the construction process. Understanding the engineering properties of soil is crucial to obtain strength and economic permanence. Soil stabilization is the process of maximizing the suitability of soil for a given construction purpose. Soil variability and uncertainty of a natural soil deposit and its properties are common challenges in geotechnical engineering design. Foundations in expansive soils, popularly known as black cotton soils in this country, undergo alternate swelling and shrinkage upon wetting and drying due to seasonal moisture fluctuations Expansive soils are highly weak because of the large changes in volume due to fluctuations in the moisture

content. Expansive soils usually have undesirable engineering properties, such as low bearing capacity, coupled with low stability and excessive swelling. Soil has been used as a construction material from time immortal. Being poor in mechanical properties, it has been putting challenges to civil engineers to improve its properties depending upon the requirement which varies from site to site. The roads laid on BC soil bases develop undulations at the road surface due to loss of strength of the sub grade through softening during monsoon. Soaked laboratory CBR values of Black Cotton soils are generally found in the range of 2 to 4%. Due to very low CBR values on sub grade BC soil, excessive pavement thickness is required for designing for flexible pavement. Research &Development (R&D) efforts have been made for a long time to improve the strength characteristics of BC soil with new technologies During last 25 years, much work has been done on strength deformation behaviour of fly ash and fibre reinforced soil and it has been established beyond doubt that Expansive soils pose serious problems to structures constructed over them in terms of differential settlements, poor strength and high compressibility especially during rainy season. Several states in India have vast deposit of expansive soils. The current approach adopted to deal with such soils is to modify the properties with admixture like lime and gypsum to make them suitable for the construction of overlying structures.

To further improve the mechanical properties of these stabilized soils, a variety of materials are being used as reinforcement which are polymeric in composition, having long life, do not undergo biological degradation and liable to create environmental problem from its manufacture till the end use.

In the present work, an attempt has been made to study the compaction, CBR and unconfined compressive strength of expansive soil treated with banana fiber and Magnesium Chloride.

Characteristics of Expansive soils are inorganic clays of medium to high compressibility and form a major soil group in India. Expansive soil has a high percentage of clay, which is predominantly montmorillonite in structure and black or blackish grey in color. Because of its high swelling and shrinkage characteristics, the Expansive soil has been a challenge to geotechnical and highway engineers. The soil is very hard when dry, but loses its strength completely when in wet condition.

REVIEW OF LITERATURE:

Tripti Goyal1,Er. Rubel Sharma2,(2018)," studied on clayey soil stablised with fly ash and recron-3S. . The method used in the research is randomly distributed fibre reinforcement soil also termed as RDFS. The objective of the study is to be increase the strength of clayey soil using recron-3s fibre and fly ash. The research was focused on to improve the strength of soil and to obtain an optimum amount of soil-fly ashrecron-3s mix. The proportions used of fly ash were 10, 15, 20, 30, 40 and 50% and recron-3s was in 0.2, 0.4, 0.6, 0.8 and 1.0% in amount by weight. In this study number of proctor test, unconfined compressive strength test were performed. From Proctor test, it was determined that O.M.C increases and M.D.D

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decreases with increase in fly ash and recron3s.The fly ash was optimized at 15% and was used for further work. U.C.S value for virgin soil was 214.76 kN/m^2, by adding fly ash it was increased to 458.13 KN/m2 at 15% fly ash. On addition of recron-3s strength was increased and the maximum was at 0.8% i.e. 685.24 KN/m2 for 1-week curing and 791.05 KN/m2 for 2-week curing period. From the experimental results, it was concluded that recron-3s work as reinforcing the material and provides strength to the soil as well as fly ash worked as cementing material. The preeminent proportion obtained was 84.2% soil – 15% fly ash – 0.8% recron-3s fibre.

Navami Chandran B and Veena Vijayan L, (2017),"were study on two type of fiber bamboo fiber and banana fiber both are dried and cut in to equal length naturally occurring waste material for soil improvement by conducting compaction and CBR tests by adding different percentage of bamboo fiber and banana fiber are added to the soil and the optimum parentages found out. There was an increase in optimum moisture content with increase in percentage of bamboo fiber and banana fiber to the soil. The maximum dry density increases and Optimum moisture content decreases with increase in percentage of fiber. Addition of various percentages of fiber shows increased value for unconfined compression strength up to1% for bamboo fiber and 0.75% for banana fiber. The CBR value increases as amount of bamboo fiber increase up to 1% and banana fiber up to 0.5% then decreases on further addition. So 1% of bamboo fiber and 0.75% of banana fiber was taken as optimum percentage.

MATERIALS AND THEIR PROPERTIES

Expansive Soil

Natural black cotton soil was obtained from the agricultural fields of Duvva, West Godavari District, and Andhra Pradesh at a depth of 1 m below the ground level. The soil is dark grey to black in colour with light clay content. The obtained soil was air dried, pulverized manually and soil passing through 4.75 mm IS sieve was used. This soil is classified according to I.S classification as inorganic clay of high compressibility (CH).

BANANA FIBRE: It is a natural fibre obtained from banana plant. This fibre is obtained mainly from pseudo stem which acts as a strong fibre after dried properly. It is a fibre with appropriate stiffness and good mechanical properties.

Magnesium Chloride (MgCl2): Magnesium chloride is the name for the chemical compound with the formula $MgCl_2$ and its various hydrates $MgCl_2(H_2O)_x$. These salts are typical ionic halides, being highly soluble in water. The hydrated **magnesium chloride** can be extracted from brine or sea water.

RESULTS AND DISCUSSIONS:

Table 1 Particle size distribution of the expansive soil

S.No.	Property		Value
1	Grain Size Distribution		
	Gravel (%)		00.00
	Sand (%)		4.00
	Fines	Silt (%)	26.00
		Clay(%)	70.00

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Table 2 Properties of Untreated Expansive Soil

S.No	Laboratory Experimentation	Value
1	Specific gravity (G)	**2.58**
2	Free swell (%)	**130**
3	Atterberg limits Liquid limit (%) Plastic limit (%) Plasticity index (%)	 **72** **33** **39**
4	IS soil classification	***CH***
5	O.M.C. (%) M.D.D. (g/cc)	**26.85** **1.43**
6	C.B.R (%)	**1.152**
7	Cohesion (C), (Kg/cm^2) Angle of internal friction (0^0)	 **0.58** **2^0**

Table 3 OMC and MDD values of expansive soil treated with percentage variation of Banana fibre

S.No	Mix Proportion	OMC (%)	MDD (g/cc)
1	100% soil + 0 % BF	26.85	1.43
2	99.75% soil + 0.25% BF	29.2	1.41
3	99.5% soil + 0.5% BF	30.24	1.38
4	**99.25% soil + 0.75% BF**	**33.3**	**1.32**
5	99.0% soil + 1.0% BF	35.1	1.22

Table 4 CBR values of expansive soil treated with percentage variation of BF

S.No	Mix proportion	OMC (%)	Soaked CBR (%)
1	100 % soil	26.85	1.136
2	100 % soil + 0.25% BF BFBFBF	29.2	1.875
3	100 % soil + 0.5% BF	30.24	2.230
4	100 % soil + 0.75 % BF	33.3	2.755
5	**100 % soil + 1.0 % BF**	**35.1**	**3.16**

Table 5 Free Swell Index values of expansive soil treated with percentage variation of Banana Fibre.

Banana Fibre (%)	Free Swell Index (%)
0	130
0.25	116
0.5	104
0.75	94
1.0	88

Table 6 Liquid limit values of expansive soil treated with percentage variation of Banana fibre

S.No	Banana fibre (%)	Liquid limit (%)
1	0	72
2	0.25	70.26
3	0.5	67.75
4	0.75	65.51
5	1.0	63.31

Table 7 Plastic limit values of expansive soil treated with percentage variation of Banana fibre.

S.No	Banana Fibre (%)	Plastic limit (%)
1	0	33
2	0.25	34.26
3	0.5	35.12
4	0.75	35.96
5	1.0	36.35

Table 8 Plasticity index values of expansive soil treated with percentage variation of Banana fibre.

S.No	BF (%)	Plasticity Index (%)
1	0	39
2	0.25	36
3	0.5	32.73
4	0.75	29.75
5	1.0	27.0

Table 9 OMC and MDD values of BF treated expansive soil with percentage variation of $MgCl_2$.

Mix Proportion	OMC (%)	MDD (g/cc)
98.50% ES + 1.0% BF +0.50% $MgCl_2$	34.36	1.42
98.00% ES + 1.0% BF +1.00% $MgCl_2$	**30.48**	**1.55**
97.50% ES + 1.0% BF +1.50% $MgCl_2$	28.24	1.49

Table 10 CBR values of Banana fibre treated expansive soil with percentage variation of Magnesium chloride.

Mix Proportion	CBR value (%)
98.50% ES + 1.0% BF + 0.50% $MgCl_2$	5.76
98.0% ES + 1.0% BF + 1.00% $MgCl_2$	**7.01**
97.50% ES + 1.0% BF + 1.50% $MgCl_2$	6.01

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Table 11 Properties of Untreated Expansive soil and treated Expansive soil with optimum % of Banana Fibre and $MgCl_2$

S.No	Property	Expansive soil	99.0 ES +1.0% BF	98.0 ES+1.0% BF + 1.00% $MgCl_2$
1.	Atterberg limits			
	Liquid limit (%)	72	63.31	61.0
	Plastic limit (%)	33	36.35	41.26
	Plasticity index (%)	39	27.0	19.74
2.	Compaction properties			
	O.M.C (%)	26.85	35.1	30.48
	M.D.D (g/cc)	1.43	1.22	1.55
3.	Specific Gravity (G)	2.58	2.72	2.789
4.	IS Classification	CH	CH	CH
5.	Soaked C.B.R (%)	1.136	3.16	7.01
6.	Free swell (%)	130	88	48
7.	Cohesion (C) (Kg/cm^2)	0.58	0.94	0.98
8.	Angle of internal friction (ø)	2°	4°2'	5°08'

CONCLUSIONS

1. From the laboratory studies, it was observed that the Free Swell Index of the expansive clay has been **decreased** with the addition of 1% BF when compared with the untreated expansive soil.
2. It was also observed that the Free Swell Index of the expansive clay has been further **decreased** with addition of Magnesium Chloride to the BF treated expansive soil.
3. From the laboratory studies, it was observed that the liquid limit of the expansive soil has been **decreased** with the addition of 1% BF when compared with the untreated expansive soil.
4. It was also observed that the liquid limit of the expansive soil has been **decreased** with the addition of Magnesium Chloride to the 1% BF treated expansive soil.
5. From the laboratory studies, it was observed that the plastic limit of the expansive clay has been **increased** with the addition of 1% BF when compared with the untreated expansive soil.
6. It was also observed that the plastic limit of the expansive clay has been further **increased** with the addition of Magnesium Chloride to the 1% BF treated expansive soil.
7. It was observed that the CBR value **increased** on addition of 1% BF and further improvement was observed that 116.4% increased when treated with optimum values of Magnesium Chloride when compared with untreated expansive soil.
8. It was observed from the laboratory results that the shear strength parameters of expansive soil are **improved** with the addition of Banana Fibre along with optimum percentages of Magnesium Chloride.
9. It was concluded from the laboratory investigation that the CBR values of expansive soil treated with 1% BF + 1% Magnesium Chloride exhibits better results.
10. It was observed from the laboratory Static Plate Load Test results, that the ultimate load carrying capacity of the 1% BF treated expansive soil foundation bed has been **improved** by 82% when compared with the untreated expansive soil foundation bed.

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