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UTILIZATION OF SUGARCANE ASH & WASTE PAPER SLUDGE ASH IN STABILIZATION OF BLACK COTTON SOIL

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ABSTRACT

In the present scenario, urbanization and industrialization increases, generates huge quantity of waste which leads to landfill depletion, soil contamination and many hazardous effects. Hence the main aim of this study is to utilize this industrial waste for improving the soil property by soil stabilization technique. Sugarcane Ash is the by-product of Sugar Industry and Waste Paper Sludge comes out from Paper Industry. To prove effectiveness of this waste, various laboratory tests were carried out (viz. Atterberg's Limit, Compaction test, California bearing Ratio, Unconfined Compressive Strength) on different soil sample blended with different percentage of Sugarcane Ash and Waste Paper Sludge Ash. From the results it has been observed that both ashes not only improved the property of soil but also helps to reduce environmental issues.

Keywords: *Stabilization, Black Cotton Soil, Sugarcane Ash, Waste Paper Sludge Ash, CBR*

I. INTRODUCTION

Expansive soils are the example of weak soil, which causes deformation in bridges, buildings, highways etc. when it comes in contact with water and undergoes change in volume. In summer season, it shrinks due to evaporation of water from the voids and in rainy season it swells due to absorption of water in the voids. Therefore it is necessary to improve the properties of soil. To avoid this problem, soil can be stabilized by adding some stabilizer and helps to improve the property of soil. Sugarcane Ash is the by- product of sugar industry, rich in Silica content and Waste paper sludge produces from paper Industry which content about 20% CaO (Dharan,2016), causes disposal problem, air contamination etc. With the help of stabilization technique, strength property of soil improves. Soil with lime or bagasse ash helps to reduce the shrinkage and swelling property of soil hence reduces the plasticity of soil.. When SCBA alone is used then CBR value decreased because of low content of calcium element which limited the cementitious reaction. It was concluded that only SCBA cannot give better result as compare to its combination with lime (Barasa et al.,2013). The effect of bagasse ash and lime and their combination on the properties of the expansive soil gives better as compared to the addition of lime and bagasse ash separately (Wubshet & Tadesse, 2014). With increase in percentage of bagasse ash, moisture content increases but density decreases (Surjandari et al., 2017). Paper Sludge is the sludge which comes out from Paper Industry and after incinerated it convert into Ash. As the percentage of WPSA increases, density decreases but OMC increases. At 8% of WPSA, CBR and UCS value increases about 5 times and 2 times of untreated soil respectively. It also helps to reduce the cost of construction and to solve disposal problem (Dharan and Sharmila, 2016).

II. MATERIALS

Black Cotton Soil

The soil used in this study was collected from Alwasa village in Sanwer district at a depth of 1.5 m. as shown in Fig.2.1.The grain size analysis was done by Sedimentation analysis. Particle size distribution curve of soil was obtained as shown in Fig.2.2. Geotechnical Properties of Black Cotton Soil is tabulated in Table 2.1

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Fig.2.1 Black Cotton Soil

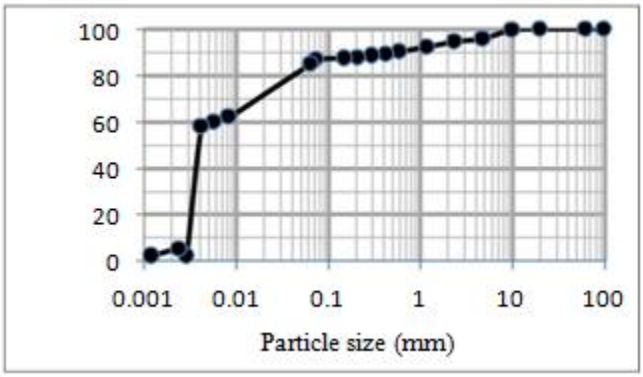

Fig.2.2 Particle size Distribution Curve of Black Cotton Soil

Table 2.1 Geotechnical Properties of Black cotton Soil

Properties	Value
I.S. Classification	CH
Specific gravity	2.59
Plasticity Index (%)	38.65
Free Swell Index (%)	63.36
Maximum dry density (gm/cc)	1.51
Optimum Moisture Content (%)	25.2
California Bearing Ratio (%), CBR (Unsoaked) CBR (Soaked)	4.06 3.45
Unconfined Compressive Strength, UCS (kg/cm^2)	0.658

Sugarcane Ash

Sugarcane ash is collected from Narmadanagar, Madhya Pradesh as shown in Fig.2.2. Specific gravity of SCA was found to be 2.43. Before using in test, it was oven dried at temperature of 105 to 110° C and sieved through 425 micron IS sieve. Chemical Composition of Sugarcane Ash is shown in Table 2.2.

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Fig.2.2 Sugarcane Ash

Fig.2.3 Waste Paper Sludge Ash

Waste paper sludge Ash

Paper sludge was collected from Bhawrasla in Indore district. Then it kept in muffle furnace at 650^{o} C for 2 hrs, it was convert into powdered form ash and sieved through 425 micron IS sieve before using in soil testing as shown in Fig.2.3. Specific gravity of WPSA was found to be 2.51. Chemical Composition of Waste Paper Sludge Ash was shown in Table 2.2

Table 2.2 Chemical Composition of Sugarcane Ash and Waste Paper Sludge Ash

Chemical Constituents	**Chemical Composition (%)**	
	SCA	**WPSA**
Silica (SiO2)	66.92	23.84
Iron (Fe2O3)	5.28	0.89
Calcuim (CaO)	3.39	62.35
Magnesium (Mg2O)	2.96	3.43
Sodium (Na2O)	0.63	0.54
Alumina (Al2O3)	2.86	5.87

III. METHOD

Preparation of sample

11 samples were prepared with different percentage of Sugarcane Ash (5%, 10%, 15%, 20%) and Waste Paper Sludge Ash (2%, 4%, 6%) and their optimum content blended with soil and various laboratory tests were performed listed as in Table 2.3.

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Table 2.3 Test Parameters & Relevant IS codes

S.NO.	PARAMETERS	IS CODE
1.	Specific Gravity	IS 2720 (Part-3) - 1980
2.	Free Swell Index	IS 2720 (Part-40) - 1977
3.	Atterberg's Limit	IS 2720 (Part-5) -1985
4.	Compaction Test	IS 2720 (Part-7) - 1980
5.	California Bearing Ratio	IS 2720 (Part-16) - 1987
6.	Unconfined Compressive strength	IS 2720 (Part-10) -1991

Experimental setup

i. Laboratory test (Specific gravity, Free swell index, Atterberg's limit, Compaction test, CBR value and UCS test) were conducted on BC soil sample to determine physical and geotechnical properties of soil.
ii. After this, BC soil was blended with Sugarcane ash (SCA) and Waste paper sludge ash (WPSA) in various percentages.
iii. Then all laboratory tests were conducted on the different soil sample blended with SCA and WPSA.
iv. Analyzed the result and find out the optimum percentage of stabilizer suitable for stabilization of black cotton soil.

IV. RESULTS AND DISCUSSION

Effects of Sugarcane Ash on Geotechnical Properties of soil

From the results shown in Table 4.1, addition of SCA helps to reduce swelling from 63.63% to 5.55%. Plasticity Index increases with increase in percentage of SCA. As expected due to lower specific gravity of SCA may be the reason of reduction in dry density in comparison to natural soil and OMC increases because density and moisture content are inversely proportional to each other (Hasan et al., 2016). Due to porous property of SCA, the soil absorbed more water which results increase in OMC (Mahapatra and Sahoo, 2017) as shown in Fig.2.4.
Similarly, unsoaked and soaked CBR value increases to 11.829% and 9.289% respectively as shown in Fig.2.5, UCS increases from 0.658 kg/cm^2 to 0.803 kg/cm^2 and beyond it starts decreasing as shown in Fig.2.6. It has been found that 15% of SCA is the optimum content.

Table 4.1 Effects of Sugarcane Ash on Geotechnical properties of soil

SCA (%)	FSI (%)	PI (%)	MDD (g/cc)	OMC (%)	CBR (%) (Unsoaked)	CBR (%) (Soaked)	UCS (kg/cm^2)
5	77.66	55.05	1.48	25.9	7.863	6.856	0.637
10	58.44	52.31	1.487	26.68	8.387	7.627	0.643
15	34.33	48.58	1.458	27.31	11.829	9.289	0.803
20	28.38	45.86	1.423	28.83	9.537	7.314	0.729
25	25.66	43.23	1.398	29.13	6.93	5.175	0.658

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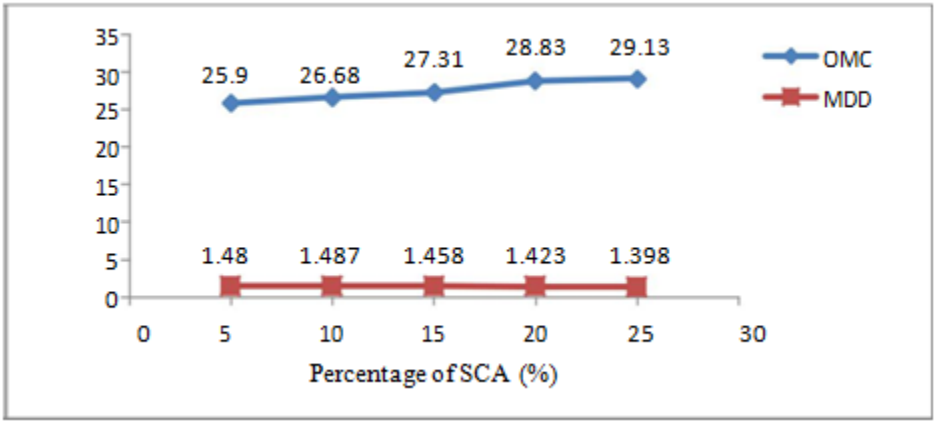

Fig.2.4 Variation in MDD and OMC of soil with different percentage of SCA

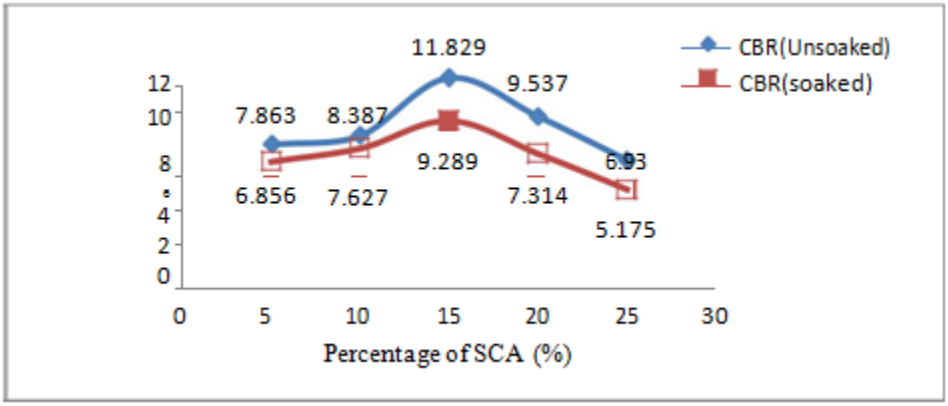

Fig.2.5 Variation in CBR Value of soil with different percentage of SCA

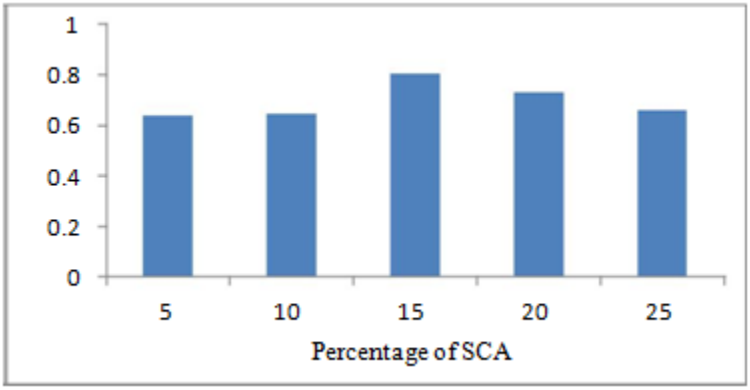

Fig.2.6 Variation in UCS of soil with different percentage of SCA

Effects of Waste Paper Sludge Ash on Geotechnical Properties of Soil

On addition of WPSA, Table 4.2 indicated that free swell index reduces from 79.89% to 52.52% at 6% WPSA and further addition starts increasing. On increasing percentage of WPSA, Plasticity Index reduced from 37.26% to 23.42%. MDD increases from 1.536 g/cc to 1.543 g/cc at 2% WPSA to % WPSA respectively and further addition start decreasing and OMC increases. Similarly at 6% WPSA, Unsoaked CBR, Soaked CBR and UCS value gives maximum value 11.923%, 8.42% and 0.768 kg/cm^2 respectively. Due to formation of calcium silicates after

reaction of Silica present in ash and soil, unsoaked CBR increases and then decreases when the excess of silica does not react with soil. Decrease in soaked CBR value is due to excess ash that was not take part in reaction, which occupies the space within sample and reducing strength of bond in soil ash mix (Yadav et al., 2017).

Table 4.2 Effect of Waste Paper Sludge Ash on Geotechnical properties of soil

WPSA (%)	FSI (%)	PI (%)	MDD (g/cc)	OMC (%)	CBR (%) (Unsoaked)	CBR (%) (Soaked)	UCS (kg/cm^2)
2	79.89	37.26	1.536	25.38	3.43	2.17	0.546
4	64.44	33.30	1.539	25.79	6.72	5.75	0.705
6	52.52	29.3	1.543	26.48	11.923	8.42	0.768
8	71.83	23.42	1.52	26.93	7.351	4.81	0.658

Effect of Optimum Content of SCA and WPSA in combination with Soil

On adding optimum percentage of both the waste SCA (15%) and WPSA (6%) with soil, properties of soil were more improve like MDD becomes 1.568g/cc and OMC was 34.35%. Similarly unsoaked CBR, soaked CBR and UCS were 13.804%, 10.35% and 0.921 kg/cm^2 respectively. Based on previous discussion, the increase in UCS may be related to the hydration and pozzolanic reaction between soil and SCA and WPSA forming a compound which helps to fill void space and the particles bind together improving the strength of mass (Hasan et al., 2016).

V. CONCLUSIONS

1. Addition of waste (SCA and WPSA) in black cotton soil improved the property of black cotton soil.
2. At optimum content of SCA and WPSA, dry density of soil increased and then decreased after further addition of ash.
3. With increase in percentage of SCA, Free Swell Index decreased because SCA is non-plastic material and in case of WPSA up to 6%, FSI decreased and then increased
4. Addition of optimum content of SCA with WPSA had given maximum soaked, unsoaked CBR value and UCS.
5. The optimum percentage of SCA & WPSA was found to be 15% and 6% respectively.
6. On addition of optimum content of SCA with WPSA, unsoaked CBR value improved about 3.4 times, soaked CBR value about 2 times and UCS about 1.4 times more as compared to the natural soil.

VI. SCOPE

1. To use some other regionally available waste material as a stabilizer like Rice Husk Ash, Coconut Coir Fibre etc. to enhance the properties of soil.
2. To evaluate the effect of SCA and WPSA on Permeability, Swelling pressure, and other shear test.
3. To compare the thickness of pavement of stabilized and unstabilized soil.
4. To use waste material in other aspect like, liner material in landfill, filler material in pavement etc

REFERENCES

1. *Barasa, P.K., Too., Jonah, K., and Mulei, S.M.(2013).“Stabilization of Expansive clay using Lime and Sugarcane Bagasse Ash.” International Journal of Science and Research, 4(4), 2112-2117.*
2. *Dharan, R.B. (2016). “Effect of Waste Paper sludge ash on Engineering behaviour of Black cotton Soils.” International Journal of Earth Science and Engineering, 9(3), 188-191.*
3. *Dharan,R.B., and Sharmila,R.M.S. (2016).“Study on Engineering behaviour of Black Cotton Soil treated with Waste Paper Sludge Ash”. 18th International Conference on Engineering Innovations and Solutions (ICEIS), 95-98.*

4. *Hasan, H., Dang, L., Khabbaz, H., Fatahi, B., and Terzaghi,S. (2016).“Remediation of Expansive soils using Agricultural waste Bagasse Ash.” Proceedings, 3rd International Conference on Transportation Geotechnics (ICTG), Australia, Vol. 143, 1368-1375.*
5. *IS 2720. (Part-3) 1980. Methods of tests for Soil - Determination of specific gravity, Bureau of Indian Standards, New Delhi, India.*
6. *IS 2720. (Part-5) 1985. Methods of tests for Soil - Determination of liquid limit and plastic limit, Bureau of Indian Standards, New Delhi, India.*
7. *IS 2720. (Part-6) 1980. Methods of tests for Soil - Determination of shrinkage limit soil, Bureau of Indian Standards, New Delhi, India.*
8. *IS 2720. (Part-7) 1980. Methods of tests for Soil - Determination of Water Content-Dry Density Relation Using Light Compaction, Bureau of Indian Standards, New Delhi, India.*
9. *IS 2720. (Part-10) 1991. Methods of tests for Soil - Determination of Unconfined Compressive strength of soil, Bureau of Indian Standards, New Delhi, India.*
10. *IS 2720. (Part-16) 1987. Methods of tests for Soil - Determination of California Bearing Ratio of soil, Bureau of Indian Standards, New Delhi, India.*
11. *IS 2720. (Part-40) 1977. Methods of tests for Soil - Determination of Free Swell Index of soil, Bureau of Indian Standards, New Delhi, India.*
12. *Mahapatra.S.R., and Sahoo.R.R. (2017). “Strength behaviour of Soil Stabilized with Flyash and Sugarcane Bagasse Ash”. Research Journal of Engineering Sciences, 6 (9), 1-5.*
13. *Surjandari,N.S., Djarwanti,N., and Ukoi,N.U. (2017). “Enhancing the Engineering properties of Expansive soil using Bagasse Ash”. International Conference on Science and Applied Science, Vol. 909, 1-7.*
14. *Wubshet, M., and Tadesse, S. (2014).“Stabilization of Expansive soil using Bagasse Ash and Lime.” Journal of European Economic Association, 32, 21-26.*
15. *Yadav, A. K., Kumar, G., Kishor, R., and Suman, S.K.(2017).“ Stabilization of Alluvial soil for Subgrade using Rice Husk Ash, Sugarcane Bagasse ash and Cow dung Ash for Rural Roads.”International Journal of Pavement Research and Technology, 10(3), 254-261*