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Effect of Bagasse Ash and Waste Plastic on CBR Value of Subgrade

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Abstract—*In the present study locally available soil is stabilized using Sugarcane Bagasse Ash and Waste Plastic. A series of experimental investigation is carried out comprising of Proctor compaction Test and CBR test on un-stabilized soil sample with Bagasse Ash in varying percentage from 5% to 20% by weight of dry soil. An optimum dose of Bagasse Ash is observed as 15%. Further to Bagasse ash stabilized soil sample, waste plastic is added in 0.2%, 0.4% and 0.6% by weight of soil and Bagasse ash. From the result it is observed that addition of Bagasse ash improves the CBR value in both soaked and un-soaked condition. Addition of waste plastic further improves the CBR value.*

Keywords*: Bagasse Ash; Waste Plastic; CBR; Proctor Compaction Test.*

1. INTRODUCTION

In developing countries like India, the biggest problem to build a road is limited finances sources available. Use of local materials, including local soils, can considerably lower down the construction cost. If the stability of local soil is not adequate for supporting wheel loads, the properties are improved by soil stabilization techniques. There are many techniques for soil stabilization. It can be either mechanical or chemical stabilization. Higher CBR value results into reduced requirement of crust for particular design traffic, with this objective work an attempt has been made to investigate the potential use of Sugarcane Bagasse Ash and waste plastic as an additive for soil stabilization.

Massive amount of sugarcane bagasse ash waste is generated from the combustion of fibrous Residue of sugarcane. Its disposal is not only problematic but also hazardous to the nearby habitations. Also, plastic waste is generating day by day and its disposal is too problematic. High strength of soil in subgrade is recommended by IRC: 37-2012 code for design of flexible pavement IRC: 37-2012 recommend that the selected soil forming the Subgrade should have a minimum CBR of 8% for roads having traffic of 450 commercial vehicles per day (CVPD) or higher. Quite often, the soil is not suitable for Subgrade and the idea of replacing the whole soil is very uneconomical. In such a situation bagasse ash and plastic waste provide a better, eco-friendly and economical solution. It helps in improving various properties of subgrade soil such as its compaction characteristics and CBR value.

The aim of this research is to utilize the sugarcane Bagasse Ash and Plastic Waste to improve the CBR of subgrade soil, while avoiding the adverse health and environmental problems that can be induced due to the disposal of this material.

2. MATERIAL USED

2.1 Natural soil

The Natural soil sample was collected from the campus of NIT Kurukshetra Haryana. Wet sieve analysis of soil showed that 67.7% soil particle is passed from 75 micron sieve which is more than 50% of total soil particle, hence as per IS soil classification system IS(1498):1970 the soil has been classified as Silty Clay soil.

The index properties such as liquid limit, plastic limit, plasticity index and other important soil properties are as follow in table1

Table 1: Properties of Natural Soil

Sr. No.	Description of Properties	Obtained Results in Laboratory
1	Specific gravity	2.461
2	Liquid limit (%)	22.02
3	Plastic limit (%)	19.35
4	Plasticity Index (%)	2.67
5	Maximum dry density (g/cc)	1.92
6	Optimum moisture content (%)	11.69

2.2 Bagasse Ash

Sugarcane Bagasse Ash (SCBA) is obtained as a combustion by-product from boilers of sugar Industries. After crushing of sugarcane in sugar mills and extraction of juice from prepared

cane by milling, discarded fibrous residual matter of cane is called bagasse. Bagasse is very commonly used as fuel in boilers in the sugar mills for cogeneration process. After burning in the Cogeneration boiler, bagasse ash is collected in bag-house filter and is disposed locally, which causes severe environmental problems. Bagasse ash generation is also increasing significantly in India. Disposal of bagasse ash is a major problematic issue in the sugar industries.

As per Bahurudeen et al. (2015), India is the second largest country in the world in Sugar production next to Brazil. India contributes approx. 18% of the total sugar production in the World as shown in figure 1

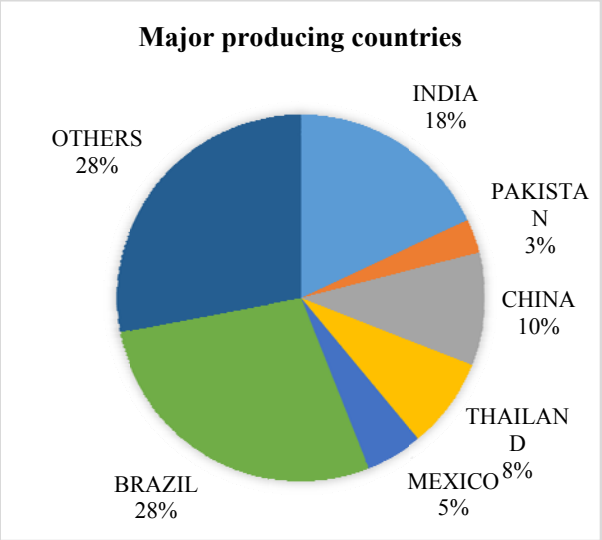

Figure 1. Contribution of sugar production of India in total world sugar production

As per Bahurudeen et al. (2015) a total of 44220 tons/day bagasse ash is produced in India. Uttar Pradesh is the leading producer of bagasse ash with 17160 tons/day. Maharashtra, Karnataka, Tamil Nadu and Andhra Pradesh are the other major producers of bagasse ash as shown in table 2. The high production of bagasse ash (SCBA) and less utilization causes ecological imbalance and environment hazards. Due to this there is an urgent need for its effective utilization in various sectors

Table 2: State Wise Bagasse Ash Generation

Sr. No.	STATE	SCBA %
1	Uttar Pradesh	39
2	Maharashtra	24
3	Karnataka	9
4	Tamil Nadu	7
5	Andhra Pradesh	5

2.3 Plastic Waste

According to Central Pollution Control Board (CPCB) of India, India generates 5.6 million tons of plastic waste annually. Total plastic waste, which is collected and recycled in the country, is estimated to be 9,205 tons per day (approximately 60% of total plastic waste) and 6,137 tons remain uncollected and littered which become environmental problems. A few organizations in India utilize the poly bags and plastic wastes in the form of chips and fiber in the construction of roads and these applications in India have been successfully use. Waste Plastic strips of varying percentage such as 0.2%, 0.4% and 0.6% are used of size 5mm x 10 mm. The reason behind selecting that particular size and plastic content is based on the literature reviews which showed the properties of natural soil change with addition of plastic strips content in varying proportion.

3. METHODOLOGY

In this study, various experiments have been done on selected soil and their mix proportion with Bagasse ash and plastic waste to understand the suitability of using them in the road construction.

The experimental have been carried out as per recommended in Indian Standard (IS) Codes. Laboratory investigation like Particle Size distribution, Atterberg limits, Specific gravity, Standard Proctor Test and California Bearing Ratio Tests were conducted to determine the properties of natural soil. Further again the Standard Proctor Test and California Bearing Ratio Test on soil mix with different percentage of Bagasse Ash and Plastic Waste is conducted.

4. RESULTS AND DISCUSSIONS

A series of Proctor test and California Bearing Ratio test have been done on un-stabilized soil to improve its properties and the following results have been drawn.

4.1 Specific Gravity Test

As per specification of IS: 2720 (Part 13/section 1) (1980) code for specific gravity test following results are drawn

Table 3: Specific Gravity of Materials

Sr. No.	Material	Specific Gravity
1	Natural Soil	2.461
2	Bagasse ash	1.36
3	Plastic waste	0.9

4.2 Compaction Test

Proctor test were conducted as per specification of IS: 2720 (Part 7) (1980) on parent soil with Bagasse ash and waste plastic to determine its maximum dry density and optimum moisture content.

Table 4. Results of MDD and OMC for natural soil with Bagasse Ash only

Sr. No.	Mix Composition	MDD (g/cc)	OMC (%)
1	Natural soil	1.92	11.69
2	Natural Soil + 5%B.A.	1.81	14.03
3	Natural Soil +10%B.A.	1.75	14.24
4	Natural Soil +15%B.A.	1.68	16.72
5	Natural Soil +20%B.A.	1.52	18.17

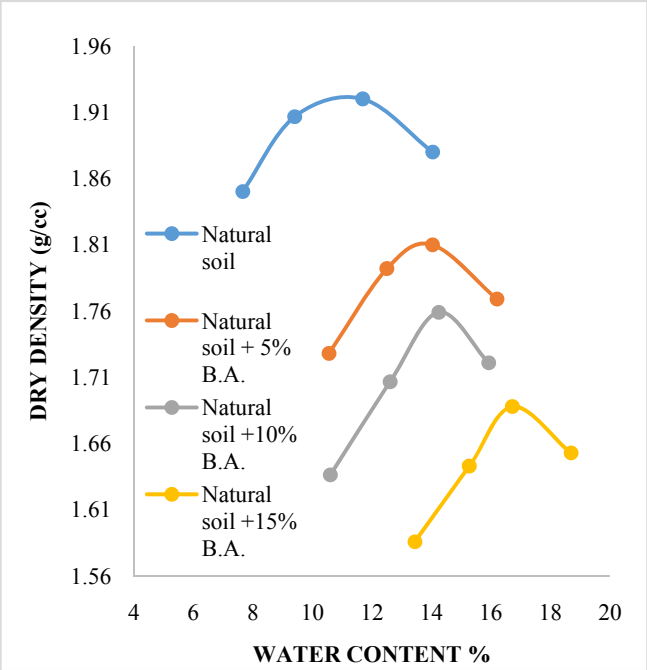

Figure 2. Results of MDD and OMC for natural soil with Bagasse Ash only

Table 5. Results of MDD and OMC for Natural Soil with Bagasse Ash and Waste Plastic

Sr. No.	Mix Composition	MDD (g/cc)	OMC (%)
1	Natural soil + 15% B.A. + 0.2% P.W.	1.653	16.33
2	Natural soil + 15% B.A. + 0.4% P.W.	1.62	16.07
3	Natural soil + 15% B.A. + 0.6% P.W.	1.589	15.87

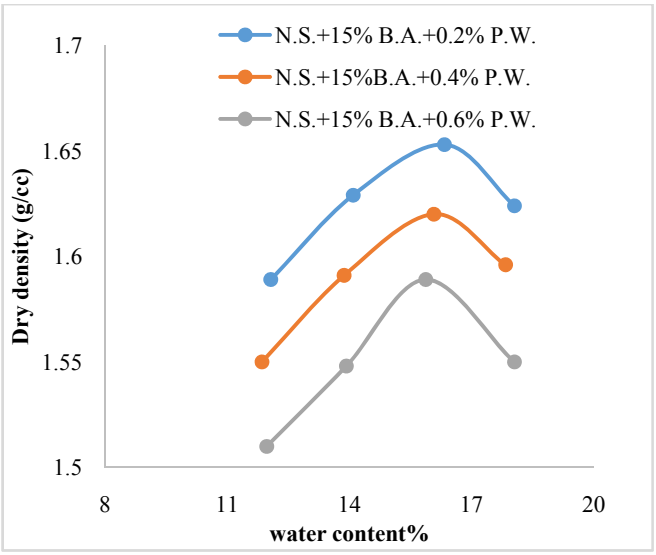

Figure 3. Results of MDD and OMC for natural soil with Bagasse Ash + Plastic waste

The addition of Bagasse Ash and plastic waste content in soil generally decrease the maximum dry density (MDD) whereas the optimum moisture content (OMC) increase with increase in the Bagasse Ash content only but when Plastic waste is further added in soil, the optimum moisture content decrease with increase in plastic content.

4.3 California Bearing Ratio

California Bearing Ratio (CBR) test were conducted as per specification provide by IS: 2720 (Part 16) (1987). A series of CBR test were conducted on soil mix with different proportion (5%, 10%, 15% and 20%) of Bagasse ash and further with Bagasse ash stabilized soil sample with waste Plastic at 0.2%, 0.4% and 0.6% respectively.

Table 6- Results of CBR test for Natural Soil Stabilized with Bagasse Ash only

Sr. No.	Mix composition	CBR Value %	
		Un-Soaked	Soaked
1	Natural soil	7.59	3.50
2	Natural soil+5% B.A.	9.85	5.62
3	Natural soil+10% B.A.	11.82	6.56
4	Natural soil+15% B.A.	12.70	7.01
5	Natural soil+20% B.A.	6.93	5.54

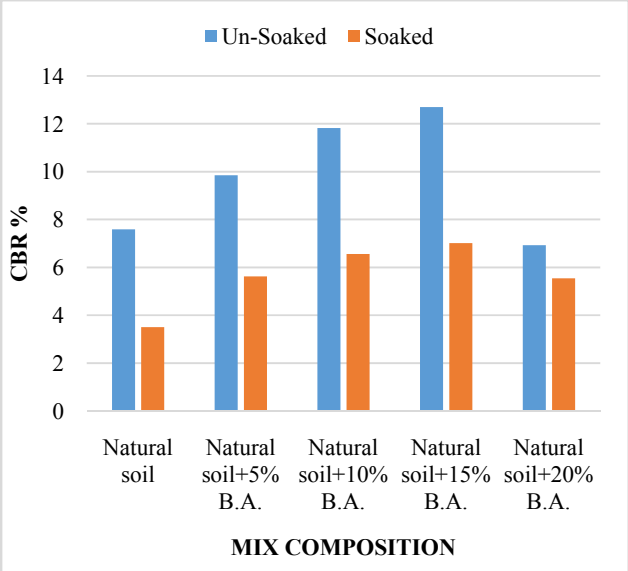

Figure 4. Results of CBR test for Natural Soil Stabilized with Bagasse Ash only

Table 7- Results of CBR test for Natural Soil Stabilized with Bagasse Ash and Plastic Waste

Sr. No.	Mix composition	CBR Value (%)	
		Un-Soaked	Soaked
1	Natural soil+15% B.A.+ 0.2% P.W.	15.11	8.17
2	Natural soil+15% B.A.+ 0.4% P.W	18.75	10.43
3	Natural soil+15% B.A.+ 0.6% P.W	12.40	7.59

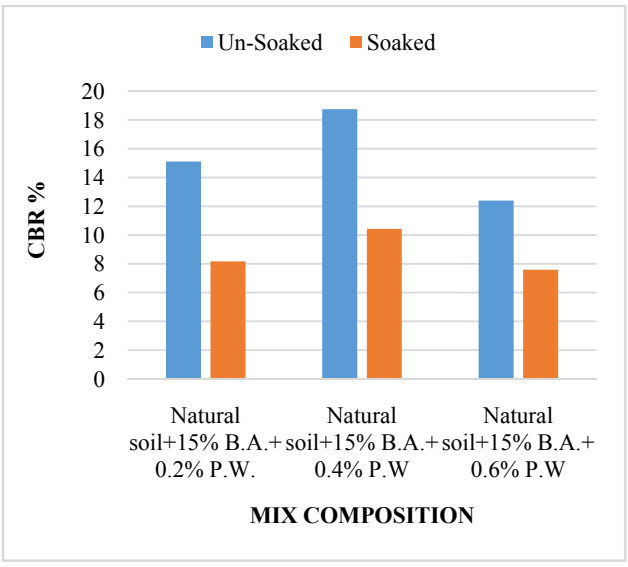

Figure 5. Results of CBR test for Natural Soil Stabilized with Bagasse Ash and Plastic Waste

The CBR value increase with the increase of Bagasse Ash and Waste Plastic percentage. The maximum CBR value of 10.43% is found to occur for combination of 15% Bagasse Ash and 0.4% waste plastic contents under soaked condition and the maximum CBR value is found to 18.75% for 15% Bagasse ash and 0.4%Waste Plastic combination under un-soaked condition. The CBR value is found to increase appreciably with addition of Bagasse ash and Plastic waste.

5. CONCLUSION

Following conclusion can be drawn out of from this paper:-

1. From the proctor test it is observed that with increase in percentage of Bagasse ash MDD is decrease from 1.92 g/cc to 1.52 g/cc and OMC increase from 11.69% to 18.17% but when plastic waste added, OMC decrease from 16.33% to 15.87% and MDD also decrease from 1.653g/cc to 1.589 g/cc.
2. The soaked and un-soaked CBR value of the soil with bagasse ash and plastic waste is found to be increasing and when a peak point is achieved then it starts decreasing. Therefore, an optimum CBR is obtained when soil is mixed with 15% bagasse ash and 0.4% plastic waste.
3. Inclusion of the plastic waste strips of 5mm x 10mm at 0.4% played a significant role in increasing the CBR value of soil.

REFERENCE

[1] Agus Setyo Muntohar, Anita Widianti, Edi Hartono, Wilis Diana (2013) Engineering Properties Of Silty Soil Stabilized With Lime and Rice Husk Ash and Reinforced with Waste Plastic Fiber**.** *Journal of Materials in Civil Engineering, vol 25 no.9, September1, 2013 (ASCE), ISSN 0899-1561/2013/9-1260-1270.*

[2] A.Bahurudeen, K.S Vaisakh, Manu Santhanam (2015). Availability of Sugarcane Bagasse Ash and Potential for Use as a Supplementary Cementitious Material in Concrete. *Indian Concrete Journal 89(6) ·July 2015.*

[3] Anjani Kumar Yadav, Kumar Gaurav, Roop Kishor, S.K. Suman (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(2017), 254–261

[4] A.K. Choudhary, J.N. Jha, K.S. Gill (2010). A Study on CBR Behavior of Waste Plastic Strip Reinforced Soil. *Emirates Journal for Engineering Research, 15 (1), 51-57 (2010)*

[5] G.L. Sivakumar, Babu, M.E. Raja Jaladurgam (2014).Strength and Deformation Characteristics of Fly Ash Mixed with Randomly Distributed Plastic Waste .*Journal Of Materials in CivilEngineering,ASCE,ISSN08991561/04014093(7)*

[6] Liet Chi Dang, Behzad Fatahil, Hadi Khabbaz (2016).Behavior of Expansive Soils Stabilized with Hydrated Lime and Bagasse Fibers. *Advances in Transportation Geotechnics, International Conference on Transportation Geotechnics (ICTG 2016)*

[7] Mercy Joseph P, Haneef FM, Jacob MT, Krishnan R, Rajan S (2014). Effect of Plastic Granules on the Properties of Soil. *International Journal for Engineering Research, 4(4):160–164 (2014)*

[8] Saket Dixit (2017)**.** Effect of Waste Plastic on the Strength Characteristics of the Subgrade for the Flexible Pavement. *Global Research and Development Journal for Engineering, Volume 2, Issue 11, October 2017*

[9] *S.* Peddaiah. A. Burman, S. Sreedeep (2018). Experimental Study on Effect of Waste Plastic Bottle Strips in Soil Improvement. *Geotechnical and Geological Engineering October 2018, volume 36, ISSUE 5, pp 2907-2920*

[10] Thomas Rukenya, Karatai, James Wambua Kaluli, Charles Kabubo, George Thiong (2017*).* Soil Stabilization Using Rice Husk Ash and Natural Lime as an Alternative to Cutting and Filling in Road Construction*. Journal of Construction Engineering and Management ASCE, ISSN- 0733-9364.*