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Strength Characteristic of Chenab Soil Stabilization with Bagasse Ash and Cementfor Road Work.

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ABSTRACT
In this paper an attempt has been made to improve the strength properties of Chenab river soil from Akhnoor area (Jammu&Kashmir, India) to be used as sub-gradeby using bagasse ash admixtures with cement. The CBR value of virgin Chenab soilis found to be 3.15 %. Other samples were remoulded by addition of additives in varying percentages of 7.5%, 15.0% and 22.5 % of bagasse ash with either 3 % or 6 % of cement content by dry weight of the soil at Optimum Moisture Content (OMC) and Maximum Dry Density (MDD). Different soil combinations were made by varying percentages of bagasse ash and cement to evaluate the California Bearing ratio (CBR) with different period of curing i.e. on the same day (immediately after bagasse ash and cement mix with soil) and after 7 or 28 days of curing. It is observed that addition of varying percentages of 7.5%, 15.0% and 22.5 % of bagasse ash along with either 3 % or 6 % of cement content by dry weight showed a remarkable improvement in the California bearing ratio (CBR) values.Further, it is found that addition of bagasse cement mix showed better results at an optimum dosage of 7.5 % Bagasse ash and 6 % cement after 28 days of curing.
Keywords: Sugar cane ash**,** Soil stabilizing material, Chenab river soil, Index properties, California Bearing Ratio (CBR).

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I. INTRODUCTION

Efficient road network is prime requirement for the progress of any developing country like India.Rural connectivity becomes a critical component in the socio-economic development of rural people by providing access to amenities like education, health, marketing etc. It has been established that investments in rural roads lifts rural people above the poverty line. The evidence also indicates that as the rural connectivity improves; the rural poverty levels come down and there result in overall improvement in country economy. So far the progress in this regard has been minimal. But now with the implementation of government schemes like ‘‘Pradhan Mantri Gram Sadak Yojana’’ (PMGSY),Golden Quadrilateral Project, North South East West Corridor Project, the road constructions scenario has taken a big leap forward.Some of these road projects especially Pradhan Mantri Gram Sadak Yojana (PMGSY), four lanning of Jammu-Srinagar highway, four lanning of Jammu-Poonch Highway and others roads projects of Government of India greatly help to boost the economy of State (Jammu and Kashmir).However, fund constraint, lacks of good quality construction materials in the nearby areas of the project considerably hampers the progress rate.One of the major costs involved in road construction is the transportation of materials.Tominimize this cost, the locally available materials should be used, particularly for soil. But if the soil available locally is not of good quality, it causes major problem. For this soil has to be stabilized suitably. Bagasse ash withcement stabilized sub-grade roads can provide a far better surface than conventional WBM roads due to the higher strength.

II. LITERATURE REVIEW

Modification and stabilization of sub grades by chemical stabilization is a well-established and time tested practice. **Ken Onyelowe (2012)**studied cements stabilized Akwuete Lateritic soil. The soil was stabilized using 4% and 6% cement with variations of bagasse ash ranging from 0%, 2%, 4%, 6%, 8%, and 10% by weight of the dry soil. The OMC, MDD, and CBR tests were carried out on the mixture of soil with cement and with bagasse ash as admixture. The test results show that there was tremendous improvement in the CBR with

Bagasse-cement mix as compared to the natural soil.**Chittaranjan, Vijay, Keerthi (2011)** studied the 'Agricultural wastes as soil stabilizers'. In this study Agricultural wastes such as sugar cane bagasse ash, rice husk ash and groundnut shell ash are used to stabilize the weak sub grade soil. The weak sub grade soil is treated with the above three wastes separately at 0%, 3%, 6%, 9%,12% and 15% and CBR tests were carried out for each per cent .The results of these tests showed improvement in CBR value with the increase in percentage of waste. **Gandhi (2012**) successfully worked on improving the existing poor and expansive sub grade soil using Bagasse ash at 0 %, 3%, 5%, 7% and 10% respectively. Bagasse ash effectively dries wet soils and provides an initial rapid strength gain, which is useful during construction in wet, unstable ground conditions.**Kiran (2013)**studied the various strength parameters like CBR, UCS by using 0%, 4%, 8% and 12% of bagasse ash with natural soil.It was observed that blend results of bagasse ash with natural soil increases the strength parameters to many times.**Kharade et al(2014)** worked on bagasse ash can be used as stabilizing material for expansive soils. Various experiments were conducted on black cotton soil with partial replacement by Bagasse Ash at 3%, 6%, 9% and 12% respectively. It was seen that due to addition of bagasse ash, CBR and Compressive strength increases almost by 40%.

III. LABORATORY INVESTIGATION

MATERIAL AND METHODS

Soil

The soil which was used in this paper was obtained from river Chenab near Akhnoor, which is 35km away from the main city of Jammu, Jammu and Kashmir, India.The various properties of natural untreated Chenabriver soil are presented in Table 1,

Table 1: **Properties Of River Chenab In Natural State**

Colour of soil	Brown
Soil Type	Silty
Natural Moisture Content (%)	10.52
Bulk Density, g/cc	2.20
Specific Gravity	2.43
Liquid Limit, LL	24
Plastic Limit, PL	N.P
Plastic Index, PI	N.P
Liquidity Index	0.44
Consistency Limit	0.56
Compression Index based on liquid limit, CC	0.10
Maximum dry density (gm/cc)	1.90
Optimum moisture content (%)	14.42

Sugarcane Baggasse Ash (Scba)

Sugar cane is a major raw material for sugar production. The Bagasse is the fibrous waste produced after the extraction of the sugar juice from cane. This material usually poses a disposal problem in sugar factories. Bagasse ash has been shown to possess pozzolonic properties (**Medjo** and **Riskowski, 2004**; **Sujjavanidi and Duangehan. 2004**; **Osinubi and Stephen, 2005**). Various research works have been carried out on the improvement of geotechnical characteristics of soils using bagasse ash. Different researchers have studied the physical and chemical properties of sugar cane waste (Bagasse ash) **(R.Srinivasan 2010, Amu, O.O., Ogunniyi, S.A. and Oladeji, O.O.2011).**Chemically Bagasse ash consists of 70-78% 0f Silica. The high percentage of siliceous material in bagasse ash indicates that it has potential pozzolonic properties.

For this research purpose, Sugarcane straws were obtained from a sugarcane juice extractor locally available in Jammu city. The straws were spread out on the ground and air dried for 1 to 2 days to facilitate easy burning. After air drying, the sugarcane straws were burnt openly into ash and collected in polythene bags, stored under room temperature until used. The SCSA was sieved through IS sieve 600 micron to get the fine ash. It was ensured that the sugarcane straw ash remained covered before and after use to prevent moisture and contaminations from other materials. The chemical composition of bagasse ash as per the report of private lab SPECTRO TESTING PVT. LTD. JAMMU, J&K, INDIA is given in table 2.


Figure 1 Cut Sugarcane


Figure 2 Cut Sugar Cane Straw


Figure 3 Bagasse Ash

Table 2: **Chemical Composition Of Sugarcane Bagasse Ash(Scba)**

S.NO	CHEMICAL ELEMENT	PERCENTAGE BY MASS
1	Silica (SiO_2)	60.92
2	Alumina (Al_2O_3)	1.14
3	Iron oxide (Fe_2O_3)	2.83
4	Titanium Oxide (Tio_2)	0.41
5	Calcium Oxide (CaO)	3.10

6	Magnesium Oxide (MgO)	1.45
7	Sodium Oxide (Na_2O)	0.04
8	Potassium Oxide (K_2O)	7.52
9	Manganese Oxide (MnO)	0.04
10	Sulphate (SO_3)	1.43
11	Phosphorous (P_2O_5)	2.27
12	Chloride (Cl)	0.33
13	Loss on Ignition	18.40

Cement
Portland cement which is the most common type of cement in general use in this part of the country was used with bagasse ash as stabilizing agent in this paper

Water
Potable water was used for the preparation of the specimens at the various moisture contents.

IV. METHODOLOGY

In order to conduct the present study, various experiments such as Atterberg's limits, Standard Proctor Test and CBR test were conducted on parent soil samples and soil mixed with sugarcane bagasse ash (SCBA) at different percentage (7.5%, 15.0%, 22.5 %) and Cementat either 3% or 6%.The experiments were conducted as per Indian Standard Specifications.

Compaction Test

Table 3 shows the variation of optimum moisture content (OMC)and maximum dry density (MDD) with sugar cane bagasse ash stabilizer at 7.5%,15.0%,22.5% by weight and Cement either 3 % or 6% by weight of soil.Table indicates that MDD decreased while the OMC increase with increase in the sugar cane straw ash (SCSA) in all the samples. The decrease in the MDD from 1.55g/cc to1.02 g/cc at 3% cement and decreases from 1.43 g/cc to 0.97% at 6% cement content respectively. The increase in OMC with increase in sugar cane straw ash 23.38% to 43.23%at 3% cement and increase in OMC from 21.49 % to 50.46 at 6% cement contentrespectively implies that more water is needed in order to compact the soil-sugar cane bagasse ash mixtures. Fig. 4 shows the variation of dry density and water content at different percentage of Sugarcane bagasse ash (SCBA) and Cement whereasthe change in M.D.D and O.M.C with the varying Sugarcane bagasse ash (SCBA) and cement arepresented in Fig. 5 and 6.

Table 3: **Variation of M.D.D & O.M.C with Varying Percentage of SCBA and Cement**

S.NO	PERCENTAGE OF SCBA	PERCENTAGE OF CEMENT	OMC	MDD (g/cc)
1	7.50	3	23.38	1.55
2	15.00	3	31.38	1.22
3	22.50	3	43.23	1.02
4	7.50	6	21.49	1.43
5	15.00	6	42.95	1.07
6	22.50	6	50.46	0.97

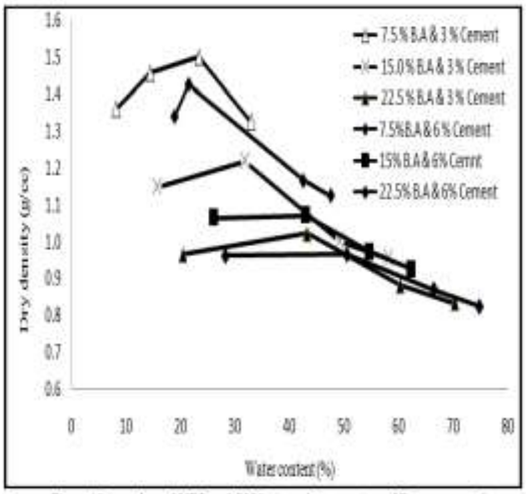

Figure 4Comparison of MDD and OMC at varying percentage of Baggase-cem mix.

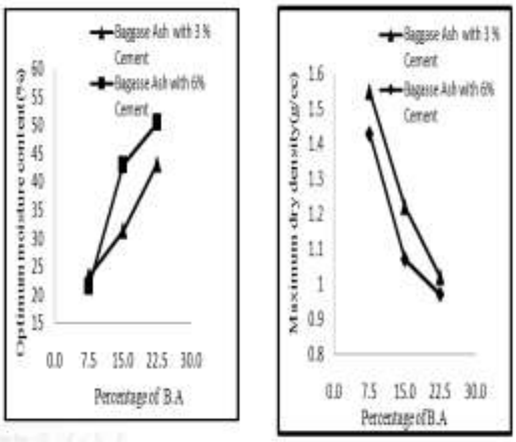

Figure 5 Figure

California Bearing Ratio (Cbr)

California bearing ratio tests were conducted on soil samples and on soil samples with7.5%, 15%, 22.5% Bagasse ash with either 3 or 6 % of Cement by dry weight of soil. The tests were carried out on samples prepared under unsoaked condition. The CBR values corresponding to various percentages of Bagasse ash Cement combinations are presented in Table 4. The variation in the CBR value with addition of Bagasse ash and cement under different proportions are shown in Fig.7 and Fig.8.

Table 4: Variation of CBR value with Varying Percentage of SCBA and Cement.

S.NO	PERCENTAGE OF B.A	PERCENTAGE OF CEMENT	DAYS OF CURING	CBR VALUE	PERCENTAGE CHANGE IN CBR VALUE
1	0.00	0.00	0.00	3.15	**0**
2	7.50	3.00	0.00	5.53	**75.55**
3	7.50	3.00	7.00	27.34	**767.93**
4	7.50	3.00	28.00	29.18	**826.35**
5	7.50	6.00	0.00	2.15	**(-) 31.74**
6	7.50	6.00	7.00	51.00	**1519.04**
7	7.50	6.00	28.00	81.56	**2489.20**
8	15.00	3.00	0.00	3.00	**(-) 4.76**
9	15.00	3.00	7.00	8.45	**168.25**
10	15.00	3.00	28.00	21.04	**567.93**
11	15.00	6.00	0.00	1.92	**(-) 39.04**
12	15.00	6.00	7.00	13.98	**343.81**
13	15.00	6.00	28.00	34.41	**992.38**
14	22.50	3.00	0.00	2.38	**(-) 24.44**
15	22.50	3.00	7.00	6.45	**104.76**
16	22.50	3.00	28.00	7.37	**133.97**
17	22.50	6.00	0.00	1.84	**(-) 41.58**
18	22.50	6.00	7.00	17.36	**451.11**
19	22.50	6.00	28.00	32.41	**928.89**

Figure 7

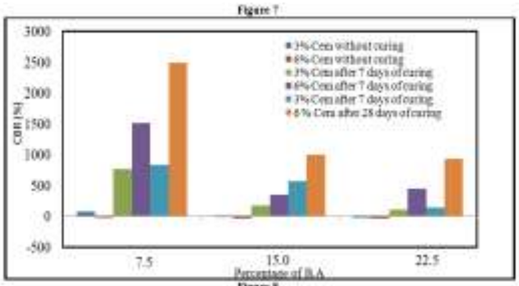

Figure 8

Design Of Flexible Pavement By Iit Pave

IIT Pave is the latest software developed by Tamil Nadu Highway department which is based on IRC 37-2012 is used for designing flexible pavement in my research work. The various parameters that are used in design of flexible pavement are shown in table 5 and the thickness of various roads

Table5: Shows design parameter of flexible pavement of different soil samples

S.No	Design Considerations	Soil Sample A	Soil Sample B	Soil Sample C
1	Name of the work	Design of flexible pavement	Design of flexible pavement	Design of flexible pavement
2	Carriage way width	Single lane	Single lane	Single lane
3	Classification of road	State Highway	State Highway	State Highway
4	Design Life (years)	15	15	15
5	Initial traffic (A) in both direction (CVD)	1400	1400	1400
6	Traffic growth rate (%)	5	5	5
7	Year of traffic census	2014	2014	2014
8	Terrain	Plain	Plain	Plain
9	Current year	2015	2015	2015
10	Construction Period	1	1	1
11	CBR value of soil	3.15	51.00	81.56
12	Whether sub grade to be replace with borrow material	No	No	No
13	CBR of select sub grade (borrow material)	Nil	Nil	Nil
14	Whether Stage construction is involved	Yes	Yes	Yes
15	If yes, life of bituminous layer	5 years	5 years	5 years
16	Grade of Bituminous for wearing and binder course	VG 30	VG 30	VG 30
17	Initial traffic after the completion of construction = 1400x(1+5%)^(2014-2014+1)x1	1470CVD	1544 CVD	1544 CVD
18	Whether axle survey conducted?	No	No	No
19	Vehicle damage factor used for traffic design	3.5	4.5	4.5
20	Lane distribution factor	1	1	1
21	Design Traffic = 365*((1+r)^n1)*A*D*F)/r			
	(a) For 15 years	40.52 Msa	54.72 Msa	54.72 Msa
	(b) For 5 years	10.38 Msa	14.01 Msa	14.01 Msa
22	Percentage of air voids(Va) to be adopted in DBM	4.5	4.5	4.5

Table 6: Shows the thickness of different layers of flexible pavement

S.No	Pavement Composition	Sample 1 (CBR@ 3.15%)	Sample 2 (CBR@ 51%)	Sample 3 (CBR@ 81.56%)
1	Wearing Surface (BC) in mm	50	30	20
2	Bituminous base (DBM) in mm	100	40	40
3	Granular base (WMM) in mm	300	100	100
4	Granular sub base(GSB) in mm	400	150	100

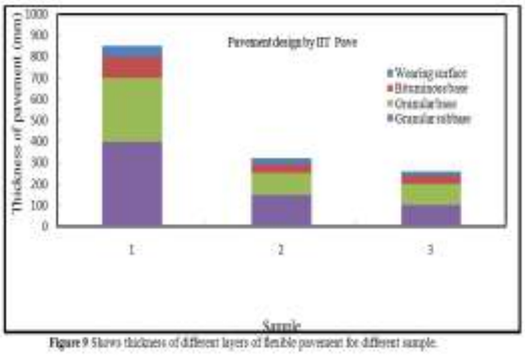

Figure 9 Shows thickness of different layers of flexible pavement for different sample.

V. CONCLUSION

Based on above results and discussion, following conclusions are drawn from this study:

1. From the chemical composition test report clearly shows that bagasse ash is composed of 61 % of silica and hence it can be conclude that bagasse ash possesses some binding properties. Thus, it can be used as one of the stabilizing material in various engineering project where there is abundant of bagasse available.

2. It is clear that OMC values at 6 % cement has greater values as compared to its counterpart of 3 % at same proportion of bagasse ash. It means more water is required to form homogenous mixture of bagasse-cement mix.
3. CBR value is increasing with the addition of bagasse ash and cement with passage of time. The maximum increase in CBR value was observed as 2490 % at 7.5% Bagasse ash and 6 % cement after 28 days of curing at OMC and MDD.
4. From the table 4, it is clear that CBR value at fixed proportion of bagasse-cement mix increases tremendously with the increasing days of curing. For example the CBR value at 7.5 % bagasse ash and 3 % cement are 5.53, 27.34 and 29.18 after 0, 7, 28 days of curing respectively.
5. From the table 6, it is clear that the thickness of granular sub base decreases to one-fourth if we follow the design consideration of sample 3 as compared to sample 1.
6. From table 6 and figure 29, it is observed that the design thickness of flexible pavement for ChenabRiver at natural condition is about 850 mm where for improvised Chenab soil, the thickness of pavement reduces to about 320 and 260 mm for sample A and sample B respectively. This shows remarkable reduction in cost for the construction of flexible pavement with s similar design parameters.

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