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Lateritic Soil Stabilization for Roadway using Bamboo Leaf Ash - A Natural Material

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Abstract

Soil stabilization is being done now- a-days to improve various physical properties like shear strength, bearing capacity, control shrink and swell properties, etc. It also helps in reducing permeability and reduction of pavement thickness. The study was basically carried out to determine the properties of Bamboo Leaf Ash stabilization on lateritic soil during construction of highways. Various tests were being conducted on 3 samples namely I, II and III to identify and classify along with the consistency limit. California Bearing Ratio Test (CBR), Triaxial Test and Compaction Test were also performed on the samples, both at the stabilized and unstabilized states by adding 2.5, 4.5, 6.5, 8.5 and 10.5% bamboo leaf ash (BLA) by weight of sample to the soils. It has been observed from the results that the strength of the prepared samples increased upon addition of this additive. Optimum moisture content reduced to 20.20, 19.60 and 9.32% at 10.5, 8.5, and 6.5% BLA samples of I, II and III respectively whereas maximum dry density increased to 1440, 1776 and 1946 kg/m3 at 10.5, 4.5 and 6.5% BLA additions in samples I, II and III respectively. It has been revealed from the study that the unsoaked samples of I and II increased from 5.44 to 39.21% and from 11.42 to 37.99% respectively. Moreover, the shear strength properties of the three samples increased from 182.31 to 200.00 KN/m2 and from 155.81 to 166.90 KN/m2 respectively. Hence, the properties of bamboo fly ash make it feasible to be used as an efficient stabilizing material.

Keywords: *Bamboo Leaf Ash, compaction, Triaxial Test, dry density, CBR, Plasticity Index.*

I. INTRODUCTION

The materials which are generally used for road construction have become scarce and also very costly day by day. It has become very necessary to come up with some alternatives which have the properties almost similar to the already available conventional materials. Industries have been producing tons of waste every year thereby degrading the environment. Intensified research in some of the by-products coming out from industries showed that they can be used along with some other materials for stabilizing the soil. Use of these materials will help in sustainable development and conservation of natural resources.

Laterite soil which mainly consists of aluminium and iron is formed by prolonged weathering of underlying parent rock. It is found in hot and wet tropical areas and is rusty-red in colour. From some recent studies, it has been seen that lateritic soil has the potential to be used as a construction material in highways. They have the ability to carry low to medium traffic loads. Lateritic soil generally has low bearing capacity and strength due to its high clay content. This study has focussed on use of bamboo leaf ash as an alternative material to enhance the properties of subgrade soil. Bamboo leaves are firstly dried, burnt and then heated in a furnace at some ambient temperature to produce

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Bamboo Leaf Ash. It consists of various pozzolanic properties.

Soil stabilization is accompanied using various additives like lime, rice husk ash, marble dust, fly ash, Portland cement, etc. Calcium hydroxide is mostly used as stabilizing material; calcium oxide is also effective but it is corrosive in nature and may cause damage to skin of a person. Proper testing is a pre-requisite for any stabilization process, in order to achieve the required engineering properties. This will provide us the correct information on the amount of additive and admixture rate that must be used while designing of highways. Bamboo Leaf Ash was characterized by Scanning Electron Microscope Techniques and chemical analysis powder X-ray diffraction.

II. OBJECTIVES OF THE STUDY:

1. To optimize the strength of the samples using environment friendly material (Bamboo Fly Ash).
2. To specify the various strength parameters.
3. To determine the Atterberg's limits, CBR (California Bearing Ratio) and MDD (Maximum Dry Density of the three samples.

Table 1: %Wt. composition of Ordinary Portland Cement (OPC) and Bamboo Leaf Ash

Source: https://www.researchgate.net/figure/Chemical-composition-of-OPC-PPC-and-PSC_tbl1_233506229

				Composition (%wt)							
	SiO_2	CaO	Al_2O_3	MgO	Fe_2O_3	Na_2O	SO_3	TiO_2	K_2O	Loss on ignition	IR
OPC	20.6	62.5	5.6	0.6	3.6	0.22	2.53	-	0.46	1.5	1.66
BLA	75.8	7.45	4.10	1.84	1.22	0.22	1.05	0.20	5.63	-	-

III. MATERIALS USED AND METHODOLOGY:

Materials: The soil samples have been collected from Assam and they are named as I, II and III. The samples are taken by digging the ground at a depth not less than 150 mm. They are kept in clean bags and sealed properly to avoid dampness. Types of soil, sample number, depth of sampling along with time at which samples are collected are marked on the packets so that it is easy to identify. Bamboo leaves are collected and they are being burned in a furnace within a temperature of 800˚C to 1000˚C. The ashes that are left behind after the bamboo leaves are being burnt are obtained and kept in a sealed bag to prevent moisture absorption.

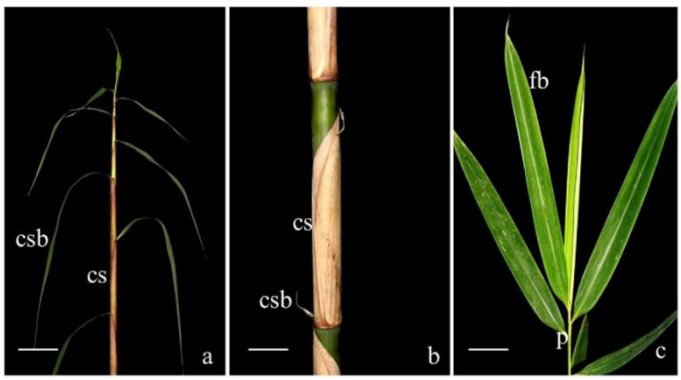

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Fig. 1: Bamboo leaf

Source:https://www.google.com/search?q=bamboo+leaf+images&rlz=1C1GCEA_enIN861IN861&source=lnms&tbm=isch&sa=X&ved=0ahUKEwjWuOz0x6fkAhUVSY8KHXNOCY4Q_AUIESgB&biw=1034&bih=616

Methods adopted:

- Various tests are performed on the soil samples determination of specific gravity, moisture content, consistency limits (also known as Atterberg's Limits) and particle size distribution.
- After that the three soil samples are mixed with Bamboo Fly Ash in different percentage of 2.5, 4.5, 6.5, 8.5 and 10.5.
- California Bearing Ratio Test, Compaction Test and UndrainedTriaxial Tests are done to determine the strength properties.

Thereafter, the stabilizing potential of Bamboo Fly Ash on the soil is being evaluated.

IV. ANALYSIS AND RESULTS

Primary Test: The result of the study is being shown below in tabulated form:

Table 2: Primary test of the three samples

Sample	Natural water content (%)	Liquid Limit (%)	Plastic Limit (%)	Specific gravity (%)	Plasticity index (%)	Soil type	AASTHO classification
I	22.12	62.22	32.85	1.76	28.21	Silty	A-2-7(2)
II	12.00	49.75	27.80	1.85	20.00	Silty	A-2-4(1)
III	21.15	45.00	24.32	2.19	19.68	Sandy	A-2-5(3)

1. It has been found from the study that liquid limit and plastic limit has been highest for sample I. Thus, sample I has the largest void ratio compared to others.
2. Specific gravity is highest for Sample II.
3. Plasticity index is found highest for Sample I.
4. The specific gravity for bamboo fly ash has been found to be 0.59.

It has been observed from the study that all the samples contain an appreciable amount of moisture which is a function of temperature, intensity, amount and duration of rainfall.

Moreover, the soils are being classified using AASTHO soil classification method and found that the samples which are used fall within the range of silty to sandy.

The percentage passing for the samples I, II and III are 3.76, 1.54 and 1.8 respectively.

Table 3: Permissible limits corresponding to plasticity

Liquid limit	Plasticity
< 35%	Low
35-50%	Medium
50-70%	High

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70-90%	Very High

There has been a change in liquid and plastic limit of all the three samples due to addition of bamboo leaf ash in different percentages. From the table, it has been observed that Sample I has high plasticity whereas Sample II and III have intermediate plasticity.

Table 4: Stabilization of BLA on Consistency Limits

Samples	Percentage Stabilization of BLA	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
I	2.5%	60.10	31.89	27.21
	4.5%	52.20	24.88	26.32
	6.5%	54.54	25.35	28.19
	8.5%	54.50	17.20	38.30
	10.5%	61.00	39.48	20.52
II	2.5%	49.80	27.80	21.22
	4.5%	44.60	31.36	14.26
	6.5%	45.20	38.04	10.16
	8.5%	47.60	32.83	15.77
	10.5%	48.04	25.47	20.57
III	2.5%	44.10	24.32	18.78
	4.5%	64.40	62.32	5.08
	6.5%	61.00	57.22	5.88
	8.5%	41.00	14.89	24.21
	10.5%	53.46	34.79	18.23

The minimum plasticity has been occurred at 10.5, 6.5 and 4.5% respectively in the samples A, II and III and it has been known that lesser the plasticity index, more stable the soil with increased workability. Thus it can be concluded that optimum stabilization mixes are 10.5, 6.5 and 4.5% BLA in the samples I, II and III.

Table 5: CBR results of the samples

Samples	Percentage of Stabilization	Unsoaked CBR
I	2.5% BLA	6.44
	4.5% BLA	14.84
	6.5% BLA	18.62
	8.5% BLA	39.21
	10.5%BLA	25.22
II	2.5% BLA	12.42
	4.5%BLA	14.1
	6.5%BLA	19.26
	8.5%BLA	37.99
	10.5%BLA	22.44

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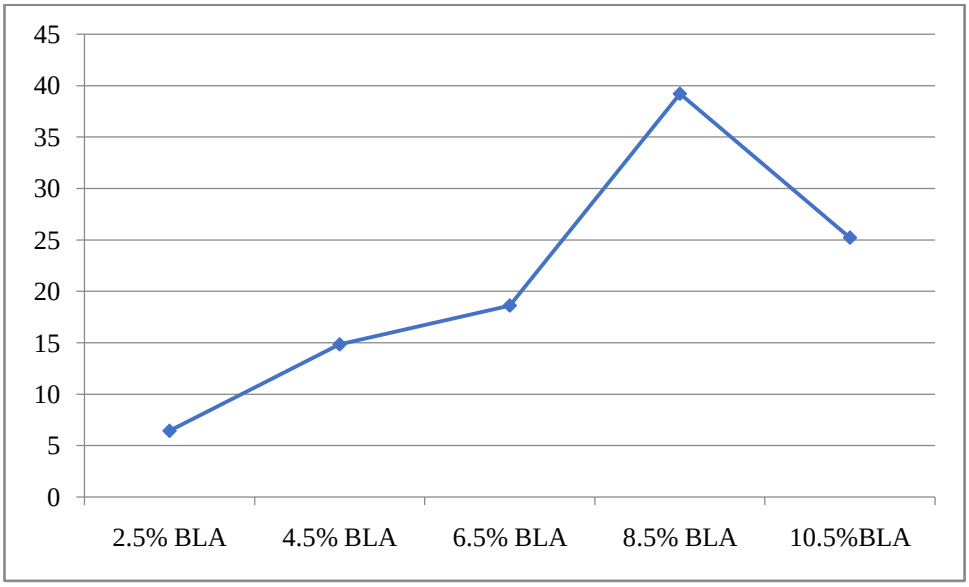

Fig.2: Graphical representation of CBR results of the sample I.

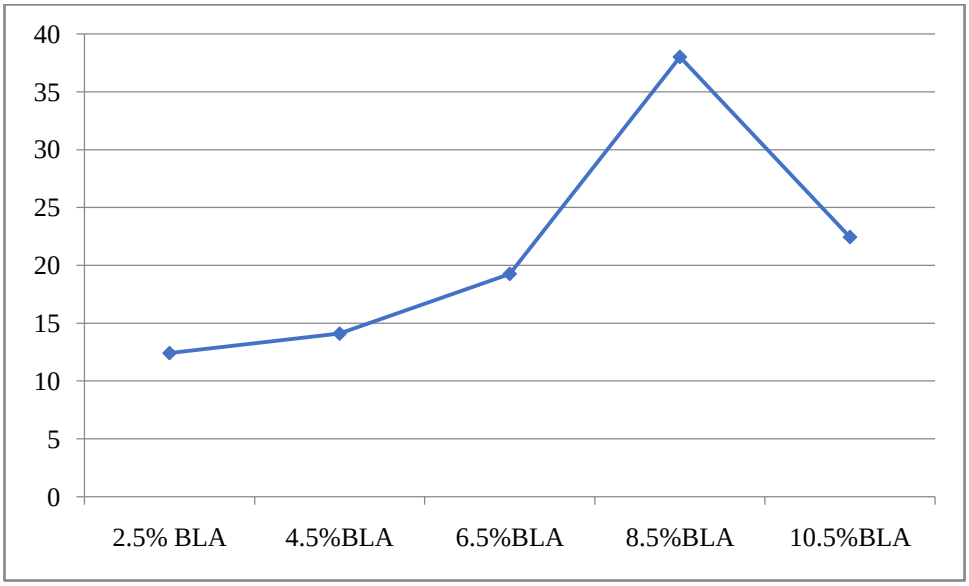

Fig. 3: Graphical representation of CBR results of sample II.

The results showed that the CBR (California Bearing Ratio) values increased upon addition of bamboo fly ash on samples I and II.

V. STRENGTH TESTS:

From the results, it has been found that the best natural moisture content of samples I, II and III are 24.00, 22.60 and 26.30%, and the maximum dry density (MDD) is 1320, 1526 and 1674 kg/m3. An increase in BLA percentages was usually caused by a corresponding reduction in the OAL of the samples. MDD values in the natural states increased to 1440, 1776 and 1946 in samples I, II and III respectively. The lower the OMC, the interoperability and increase in dry density is an improvement indicator. Thus, the stabilization of BLA showed a general improvement in the soil samples.

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Table 6: Stress properties of the samples

Sample	% Stabilization	Cohesion(KN/m^2)	Int. friction angle	Normal stress(KN/m^2)	Shear Stress (KN/m^2)
I	2.5% BLA	99.90	16.2	305.33	187.31
	4.5% BLA	104.50	18.2	317.22	200.11
	6.5% BLA	92.10	3.88	244.5	136.35
	8.5% BLA	129.30	2.89	206.66	114.66
	10.5% BLA	70.70	14.2	178.53	117.03
II	2.5% BLA	125.60	5.3	292.02	154.81
	4.5% BLA	134.11	10.12	310.11	165.9
	6.5% BLA	104.12	19.22	150.82	154.05
	8.5% BLA	65.80	17.1	196.43	121.34
	10.5% BLA	56.42	13.4	174.12	94.46

VI. CONCLUSION:

Therefore, it can be concluded that the BLA improved the qualities of soil samples, significantly reducing the plasticity indices. The optimum moisture content was decreased whereas maximum dry density increased from the natural states. Thus Bamboo Leaf Ash being environmental friendly has the ability to stabilize the soil to a great extent and can used for construction of highways

REFERENCES

[1] B. M. Das, 1990, Soil Mechanics, 3rd ed. California: Brooks/Cole publishers.

[2] B. M. Das, 2000, Fundamental of Geotechnical Engineering, 4th Edition, New York: Thomson Learning.

[3] C. F. Garber and M. F. Hoel, 2000, Traffic and Highway Engineering, 2nd ed. London: Brooks/Cole Publishing Company, pp. 481-492, 927-930.

[4] C. Liu and J. Evett, 2003, Soils and Foundation, 6th ed. USA: Prentice Hall.

[5] G. B. Ashworth and R. T. Overgaard,1976, Highway planning methods in Highway and Traffic Engineering in Developing Countries, B, Thagesen, Ed. London: Chapman and Hall, London.

[6] K. P. Thagesen, 1989, Foundation Engineering, 2nd Ed. New York: Wiley.

[7] Khan, S. A., 2005, Stabilization of Soil Using Bamboo Industry Waste, 32:18-19 July, Coimbra, Portugal, pp. 357-362.

[8] O. G. Ingles and J. B. Metcalf, 1992, "Soil Stabilization Principles and Practice", Boston: Butterworth Publishers.

[9] R. Whitlow, 1995, Basic Soil Mechanics. 3rd Edition, Edinburgh Gate: Addison Wesley Longman Limited.

[10] T. W. Lambe and V. R. Whiteman, 1979," Soil Mechanics", SI Version. New York: John Wiley and Sons.