Stabilization of Clay by using Wood ASH and Fly ASH

Gyaneshwar Singh Uchariya[1] Rohit Arya[2] Dr. M.k.Trivedi[3]
[1,2]Student [3]Professor
[1,2,3]Department of Civil Engineering
[1,2,3]Mits College Gwalior (M.P.)

Abstract— Soil is a peculiar material. Some waste material such as fly ash, wood ash, rice husk ash, pond ash may use to make the soil to be stable. Ash from biomass fuel contains a significant amount of CaO. Therefore, the substitution of burnt lime as a binder for silt and clay soil stabilization by wood ash and fly ash seem to be reasonable way of utilization. Addition of such material will increase the physical as well as chemical properties of the soil. Properties to be increased are CBR value, shear strength, liquid limit, compressive strength and bearing capacity. Plasticity was reduced 32% and CBR and strength increased 25 to 50% and 45 to 65% the result of investigation shall provide the basic successful implementation of wood ash and fly ash as a binder for clay soil stabilization in practice.

Key words: Soil Stabilization, Clays, Wood Ash, Fly Ash, Strength, Stiffness, Evaluation

I. INTRODUCTION

In recent years, the promotion of energy production from biomass Austria and European Union has led to a strong increase in the amount of combustion resides i.e. ashes, at present a large friction of wood ash produced are disposed of in landfills. Construction of road on soft soil problematic because soft soil typically has low shear strength and high compressibility. Laboratory testing of soil sample from to environment show that where as the soil from ordinary site where acidic (pH=6.0). the soil from the dumpsite were alkaline (Ph=8.6), these result implies that wood ash and fly ash behaves like lime which is used to reduce soil acidity.

Lime is also known to be used to improve the geotechnical property if clay soil in developing countries, however, lime is expensive, hence research in these countries. Continue to search for possible alternative. In this paper write present results of geotechnical laboratory tests on clay soil. Wood ash mixture and assesses the potential of fly ash stabilization of clay soil.

II. PREVIOUS WORK ON CHEMICAL AS SOIL MODIFIER

The stabilization of clay and silt soil by mixing burnt lime (if the moisture content of the soil is low, also hydrated lime can be used) with the soil is a prevent technology. When binders such a lime, cement and fly ash are blended with soil in the presence of water, a set of reaction occur that result in association of lime (CaO) in the binder and the formation of cementation and pozzalanics gels.

$$CaO+H2O = Ca(OH)2 \qquad (1)$$

$$Ca(OH)2 = Ca2+ + 2(OH)- \qquad (2)$$

$$Ca2+ + 2(OH) + SiO2 = CHS \qquad (3)$$

$$Ca2+ + 2(OH)- + Al2O3 = CASH \qquad (4)$$

These reaction are referred to simultaneous and pozzalanics reaction that result in the formation of simultaneous gels. These improved strength was found to be roughly CHS for short term strength and pozzalanics reaction product, CASH for long term strength gain.

Many work have reported on additives that could substitute lime as a soil modifier. Such material includes fly ash (Cokca 1999 indraratna), rice husk (Muntohar 1999, Muntohar and Hantoro), marble dust (Okagbue and Onyeobi 1999), and lime stone ash (Okagbue and Yakubu 2000). At most this works the author have reported a decreases in dry density, decrease in plasticity and increase strength of over all work ability of soil.

III. MATERIAL AND METHODS SOIL SAMPLE AND SAMPLE PREPARATION

Bulk samples of clay obtained from a dug pit at pound or lake and taken to the laboratory when they were air dried for 2 weeks or dried into oven machine before testing. Wood ash was obtained from baker industry and fly ash was obtained from thermal power plants. Both ashes was sieved through ISI sieve of 75µm to be obtained the friction needed for ash- clay reaction. +

Element Oxide[a]	%	Element	Range (%)[b]	Ground Limestone
CaO	32.434	Ca	2.50-32.45	31.00
K_2O	0.30	K	0.10-12.00	0.12
Al_2O_3	1.38	Al	0.45-32.00	0.26
MgO	1.6	Mg	0.10-2.48	5.11
Fe_2O_3	5.15	Fe	0.20-2.10	0.29
P_2O_5	0.02	P	0.10-1.39	0.07
Na_{2O}	2.52	Na	0.00-0.54	0.08
SiO_2	53.14	N/A[C]	N/A[C]	------
		Mn	0.00-1.29	0.05
		Ni	0.02-0.77	0.01
		$CaCO_3$ eq.	33.00-93.00	100.00
pH	10.20		9.00-13.51	9.90

Table 1: Chemical Composition of wood ash & fly ash

[a]*This study*
[b]From literature (Risse and Harris 2000).
[c]N/A = not available.

IV. METHODOLOGY

The following test were carried out on the clay in its natural state and when mixed varying proportion (6,12,18,24) of wood ash & fly ash , particles sizes distribution, Atterberg limit, Proctor compaction test, specific gravity test, Unconfined compressive strength test and CBR value.

The mixing of fly ash and wood ash, soil and water was done manually in a sample tray. Proctor test were carried out CBR molds in order that CBR value could be determined at various moisture content and compaction. Strength value was obtained by unconfined compressive testing. CBR measurement taken at 7, 14, 21, and 28 days, respectively, to determine the development of strength with time specific gravity as well as the pH of the wood ash & fly ash was also determined.

V. RESULT AND DISCUSSION

pH, Specific gravity and lime composition of fly ash and wood ash.

The clay soil was measured by two method Eades and Grim. The pH of each fly & wood ash and soil was measured using the procedure describe in Eades and Grim. ASTM DS239 used a solid to distilled water ratio 1:4 and 2-h lag between mixing pH measurement. These two method used solid distilled water ratio 1:5 the fly ash and wood ash was also measured 1, 2, 6, 24, 48, and 96 hr. The specific gravity test on wood ash yield average value 10.2 and 2.2 respectively. The chemical composition test results in Table no.1. The result of ashes in alkaline and of low specific gravity when compared with natural soil grain. There is presence of alkali and alkali earth metals which inevitable yield a very alkaline solution. CaO_2 is a major constituent as in time.

VI. PARTICLE SIZE DISTRIBUTION

Ashes %	Combined silt and clay	Sand	Gravel
0	78	11	13
6	75	14	13
12	62	20	20
18	58	26	16

Table 2: Grain size distribution of clay at varying percentages of fly ash and wood ash

The clay soil used in investigation comprised 13% gravel, 11% sand, and 78% fines (silt and clay) the fines plotted in the medium plasticity range of the casagrande plasticity chart. When fly ash and wood ash was mixed with clay soil, there was a reaction in fine content and increase sand gravel content show in Table no.2. the addition of fly ash and wood ash to the clay supplied of Ca^{2+} by dissociation of the product Ca^{2+} and H_2O with wood ash. The resulting Ca^{2+} replaced the weaker metallic positive ions (Na^+, K^+, and Mg^{2+}) from exchange complex of clay. These reactions ultimately change the gradation of the clay.

VII. ATTERBERG LIMIT

The variation of liquid limit, plastic limit, and plasticity index, with varying percentages of wood ash and fly ash are shown in graphically. The results show that both the liquid limit and plastic limit increase with increasing percentage of wood ash and fly ash. These include cation exchange, flocculation of the clay, agglomeration, and pozzalanic reaction. According to test the first two test reaction take place rapidly and produce immediate change in plasticity and swelling properties of treated soil. CHS gel produced a reaction coats the clay clasts bending together and filling the pores. In this way, water absorption is reduces.

% of wood ash & fly ash	Liquid limit in %
0	52
6	57
12	60
18	62
24	59

Table 3: Liquid Limit Value for Clay Soil with Wood Ash and Fly Ash.

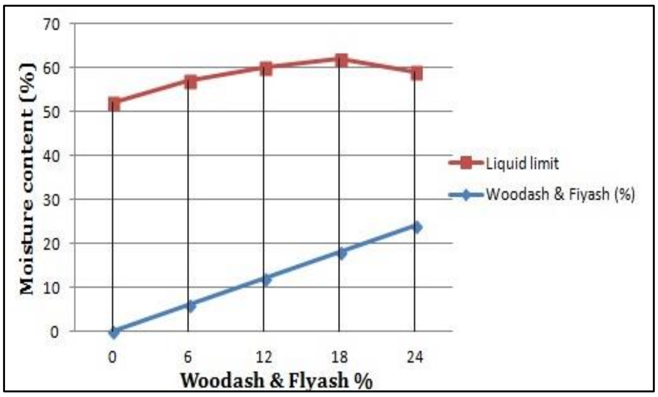

Fig. 1: Liquid Limit Curve Graph at Varying Percentages of Woods & Fly Ash

% of wood ash & fly ash	Plastic Limit %
0	22
6	24
12	25
18	27
24	23

Table 4: Plastic Limit Value for Clay Soil with Wood Ash and Fly Ash

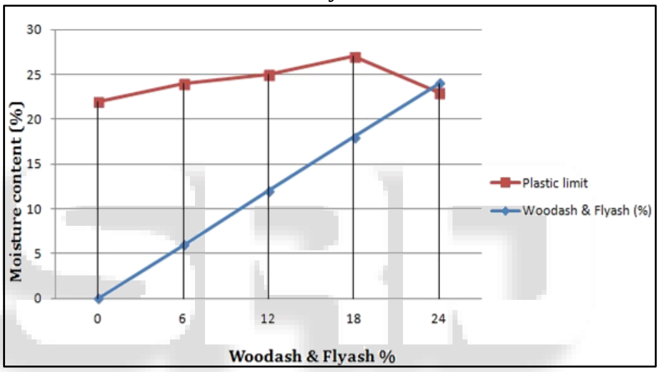

Fig. 2: Plastic limit at varying percentages of woodas & Fly Ash

A. *Proctor Compaction Test*

The addition of wood ash and fly ash to clay materials increase increases their optimum moisture content and reduced their maximum dry density for the same compactive effort.

Fig. 3: Proctor test on clay soil.

% of wood ash and fly ash	% of OMC
0	21
6	23
12	25
18	27
24	26

Table 5: OMC Value for Wood ash.

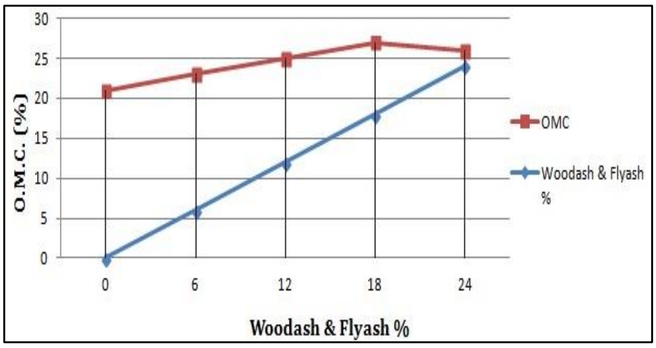

Fig. 4: Variation of O.M.C with varying percentage of woodash & Fly Ash

% of wood ash and fly ash	MDD (kg/m^3)
0	2.11
6	2.07
12	2.31
18	2.35
24	2.21

Table 6: Maximum Dry Density value for wood ash

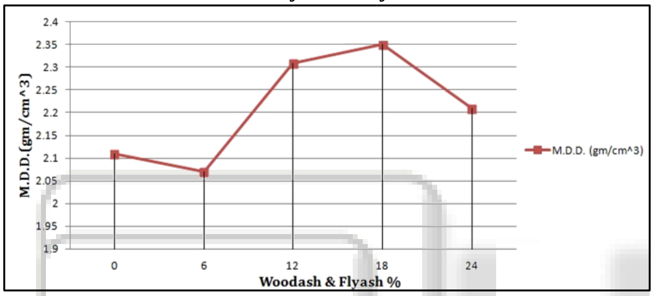

Fig. 5: Variation of M.D.D with varying percentage of woodash & Fly Ash

B. *Unconfined Compressive Strength (UCS)*

Unconfined compressive strength test were conducted on specimens prepared from the soil and soil –wood ash and fly ash mixture following ASTM D5102. Strength test was conducted on treated and untreated soaked samples compacted at maximum dry density and optimum moisture at ISI and modified compactive effort. The result is given graphically.

% of wood ash and fly ash	UCS (N/cm^2)
0	23.21
6	24.6
12	53.29
18	60.82
24	54.92

Table 7: UCS value for wood ash

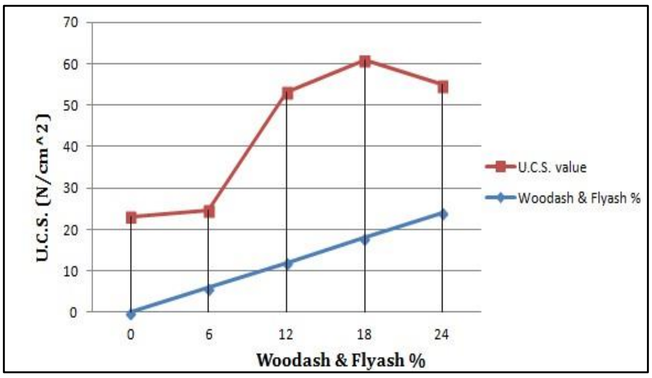

Fig. 6: Variation of U.C.S with varying percentage of woodash & Fly Ash

C. *California Bearing Ratio*

CBR test for soil sample. It can be seen that the CBR value increase as percentages of woodash to an optimum level. After mixing the wood ash the result of CBR value is favorable for soil stabilization. These results are shown in graphically.

% of wood ash and fly ash	CBR value@ 5mm
0	4.08
6	3.55
12	3.74
18	4.75
24	4.10

Table 8: CBR values at 5mm deflection.

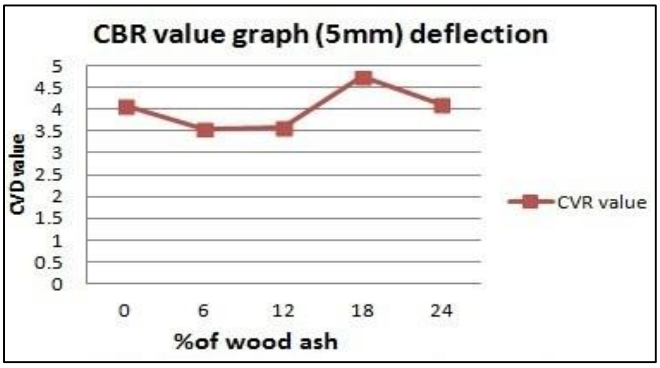

Fig. 7: CBR Value Curve for Wood Ash

% of wood ash and fly ash	CBR value@ 10mm
0	6.28
6	4.9
12	5.12
18	7.82
24	7.29

Table 9: CBR values at10mm deflection

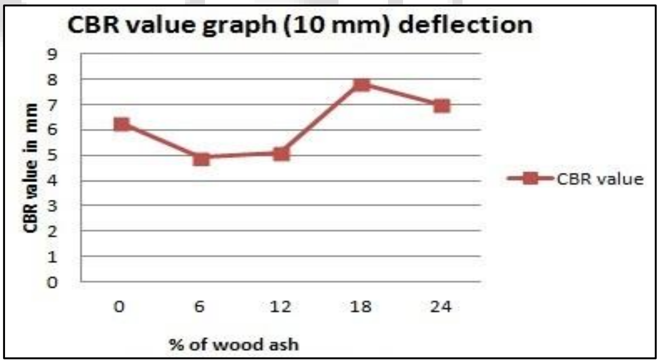

Table 9: CBR values at10mm deflection

VIII. CONCLUSION

This study has evaluated the extent to which lime contented in wood ash and fly ash can improved the physical, as well as the mechanical property of clay. The results from this research can have significant implementation for making use of marginal the onsite material possible and this lowering construction costs. Following can be concluded from this experimental research. Highest strength increased is developed after 7-14 days of curing at 20-30% of wood ash and fly ash – clay mixture. It is believed that "wood ash" produced by the optimal (12%) ashes contents is quickly used up with in first 2 weeks of curing the imply of these results that ashes although containing lime as a chemical component could be used soil modifier for construction purpose.

After using the wood ash material clay soil was stabilized and it's used in construction work purpose. Wood ash mixing in soil, soil property was increased like as liquid limit, plastic limit, compressive strength, and CBR value. After shown these test result clay soil was stabilized by using wood ash.

ACKNOWLEDGEMENT

Author would like to thanks to Dr. manoj kumar trivedi Professor of civil engg. Department and Mr. sahu sir soil lab. Incharge MITS college Gwalior (M.P) for his valuable assistance and suggestions during the thesis work.

REFERENCES

[1] Celestine O. Okagbue "Stabilization of Clay Using Wood ash" Journals of Materials in Civil Engineering © ASCE/Jaunary2007.
[2] Indraratna, B., Nutalaya, P., and Kuganethira, N. (1991). "Stabilization of a dispersive soil by blending with fly ash."Q. J. Eng., Geol., 24, 275-290.
[3] Indraratna, B., Balasubramanian, A. S., and Khan, M. J. (1995). "Effect of fly ash with lime and cement on the behaviour of a soft clay. " Q. J. Eng. Geol., 28, 131-132.
[4] Okagbue, c. o. and Yakubu, J. A. (2000). "Limestone ash waste as asubstitute for lime in soil improvement for engineering construction." Bull. Eng. Geol. Environ., 58(2) 107-113.
[5] Risse, M.,and Harris, G. (2000) "Soil acidity and lime training schedule." ‹www.hubscap.clemson.edu/blpit/best woodash.html›.
[6] Erdem O. Tastan., Tuncer B. Edil., "Stabilization of Organic Soils with Fly Ash." Journal of Geotechnical and Geoenvironmental Engineering © ASCE/ SEPTEMBER 2011/819.
[7] Federal Highway Administration (2003). "Fly ash facts for highway engineers." Technical Rep. FHWA-IF-03019, 4th Ed., Washington, DC.
[8] Ferguson, G. (1993). "Use of self-ashes as a soil stabilization agent." Fly ash for soil improvement (GSP 36), ASCE, New Yory.
[9] Keshawarz, M. S., and Dutta, U. (1993). "Stabilization of south Texas soils with fly ash." Fiy ash for soil improvement (GSP 36), ASCE, New York, 30-40.
[10] Karthik. S., Ashok Kumar. E., "Soil Stabilization By Using Fly Ash."IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE).PP 20-26
[11] Staffan Jacobson.,"Addition of Stabilization Wood Ashes to Swedish Coniferous Stands on Mineral Soils – Effects on Stem Growth and Needle Nutrient Concentrations"
[12] Clarholm, M. 1994. Granulated wood ash as a 'N-free' fertilizer to a forest soil – effects on P availability. Forest Ecology and Management 66; 127-136.
[13] Eriksson, H. M. 1988. Short- term effects of granulated wood ash on forest soil chemistry in SW and NE Sweden. Scandinavian Journal of Forest Research, Suppl.2;43-55.
[14] Larsson, P.E. & Westling, O. 1998.Leaching of wood ash and lime products ; Laboratory study. Scandinavian Journal of Forest Research, Suppl. 2; 17-22.
[15] Thompson, M. R. (1968)."Lime-treated soils for pavements construction." J .Highw. Div., 94(2), 42-53.
[16] British Standard institute (BSI). (1975)."Methods of testing soils for civil engineering purposes."BS 1377.

