ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 6, Issue 6 , June 2019

Effects of Wood Ash and Calcium Chloride on the Clayey soil

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ABSTRACT: The clayey soil cause serious problem to infrastructure and various constructions, due to swelling when comes in contact with moisture. The strength and sub-grade characteristics of soil are very poor due to this property. In such cases, soil improvement is an alternative to improve the properties of soil. Hence construction on clayey soil becomes difficult so proper treatment of clayey soil is required, using different methods of stabilization bearing capacity of soil can be increased. Soil stabilization is the process of improving the physical, chemical and mechanical properties of soil to enhance its stability by using compaction and/or addition of suitable additives in proper proportions. Every year a large quantity of wood ash in thousand tons are generated and with the expansion in production, its volume is likely to be become twice in no time. . Developing countries like India required new infrastructure and renovate the existing structure so the production of wood wastes can be utilize for stabilization of weak soil, highway pavements etc. In this paper we describe the use of wood ash and calcium chloride for soil stabilization. Standard proctor test, unconfined compression strength and California bearing ratio test were carried out. Wood ash is added in percentage 4,8,12, 16 and calcium chloride in percentage in 1 ,3, 5,7 individually and then combination by varying Calcium chloride % 4, 6, and 8 along with fixed value of wood ash 12% in clayey soil. The different percentage was determined which showed considerable enhancement in the strength of treated soil as compared to untreated soil. Experiment results shows that with the addition of wood ash and calcium chloride the strength properties of soil is increased with use of economical materials and it also solves the problem of environment pollution.

KEY WORDS: Clayey soil, Wood ash, Calcium chloride, chemical stabilization, UCS, CBR test, Improved.

I.INTRODUCTION

It is very difficult to magnify the importance of soil in construction of structures and other prospect of civil engineering practices. The foundation of any building, road or any other construction project is an essential part for the transmission of its various load to the subsoil present beneath it. The quality of the soil present on the site has large impact on the structure and its design. Clayey soil has poor engineering properties and these properties are to be Improved to fulfil the requirement for proper foundation design. In the present study, experiment is carried out to investigate the influence of wood waste, wood ash and inorganic salt, calcium chloride on the properties of expansive nature of clayey soil. In this research we have determine the effectivity of soil stabilization using Wood ash and calcium chloride. When wood ash is added up to a certain percentage, the strength increases, after that it starts decreases. Wood ash is added in percentage 4,8,12, 16 and calcium chloride in percentage in 1 ,3, 5,7 individually and then combination of both wood ash and calcium chloride with clayey soil by keeping the value of wood ash fixed at 12% and varying $CaCl_2$.

II. LITERATURE REVIEW

Butt et al. (2016) used saw dust ash to improve soil characteristics performed California bearings ratio(CBR) compactions and unconfined compressive strengths test concluded that maximums dry density decreases and optimum moistures content increases as they percentage of ash increases up to certain limit, CBR value increases and UCS was increased up to certain percentage and reveals that SDA can be used in road construction in rural area and better alternative that using industrial waste.

ISSN: 2350-0328

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Patil et al. (2017) examines the geotechnical properties of black cotton soil and compare the result by adding the quarry dust to the same soil reveals that for consistency limit wood ash found to be useful while comparing the strength characteristics quarry dust had slightly larger value than wood ash.

Bade et al. (2017) investigated the index properties of black cotton soil using wood shaving ash concluded that plasticity index decreases as the percentage increases.

S.S. V Prasad, D.S.V Prasad, R. Dayakar, Basu, "Efficiency of $CaCl_2$ and vitrified Tiles Sludge on the strength characteristics of expansive soil." (IJARET), Vol. 2 issue 3. PP. 202-205, (July –Sept. 2015.)

Shon et al. (2016) reported that treatment of soil with calcium chloride increases the density and strength of the compacted soil. Further it increases the surface tension of the retained moisture within the soil matrix, thus increasing the suction pressure of the system. Thus in turn, increases the cohesive energy between the particles which result I greater strength.

Hilbrich and McDonald (2016) conducted unconfined compressive strength, triaxial compressive strength and suction tests using the calcium chloride and F class Fly ash. High strength was obtained by using the filter cake and class F fly ash. The highest unconfined compressive strength was obtained from specimens containing 1.7% $CaCl_2$ + 10% fly ash and it had higher and more stable strength. The higher suction value was obtained from the same mix design samples (1.7% $CaCl_2$ + 10% class F fly ash).

Zumrawi, M,M,E, and Khalid A. Eltayeb (2016), "Laboratory Investigation of expansive soil stabilized with $CaCl_2$".

Olawatosin (2013) studied the effect of ashes of hardwood and softwood on geotechnical properties of soil they revealed that California bearing ratio(CBR) of soil has increase significantly, OMC increases and MDD decreases.

III. MATERIAL AND METHODS

A. Clayey soil

The clayey soil used in this investigation were collected from Samba district of J&K from where basantar river flows (India). The soil was brought to lab in bags and soil was dried in oven for one day followed by pulverization. Soil was pulverized to pass the soil through 4.75mm size sieve and stored in such way that, there is very minor chances of absorption of moisture by soil. Sieve analysis tests were conducted on soil to find out the soil classification and according to the soil results soil can be classified as CI (intermediate compressible clayey soil). The Engineering properties of the soil are given in Table1.

Table 1 Properties of virgin soil

S No.	Properties	Results
1	Specific gravity	2.52
3	Liquid Limit (%)	45
4	Plastic Limit (%)	24
5	Plasticity index (%)	21
6	Free swell index	18 %
7	Classification of soil	CI
8	Maximum Dry Density (gm/cc)	1.762
9	Optimum Moisture Content (%)	15.89
10	UCS (kpa)	82.06
11	CBR value (%)	2.9

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B. CALCIUM CHLORIDE ($CaCl_2$):

Calcium chloride can be used for numerous purposes at different concentrations depending on its use. It is an important calcium salt that has many household and industrial applications. The chemical formula of calcium chloride is CaCl2 and its molar mass is 110.98g/mol. It is an iconic compound consisting of calcium cation (Ca^{2+}) and two chlorine anions (Cl^-). It is a inorganic salt that behaves as a typical ionic halide, being solid at room temperature and highly soluble in water because of its hygroscopic nature.

Table 2 Physical properties of Calcium Chloride

S No.	Properties	Value
1	Form	A white odorless granule or flake
2	Assay	94% - 97% by weight CaCl2
3	Density	2.15 g/ml
4	Ph	6.5 – 10
5	Melting point	782 ^{0}C
6	Boiling point	1600 ^{0}C
7	Loss on drying	10 %

C. Wood Ash

Wood ash is obtained by burning wood flour taken from local saw mill and brought to laboratory in bags oven dried for 24 hours and is sieved through 4.758 mm sieve, and kept in polythene bags and is used for research work. The geotechnical are presented in table .

Table 3 Chemical composition of wood ash(source-internet)

Sr. No.	Constituent	value (%)
1.	Silica (SiO_2)	28.50
2.	Alumina (Al_2O_3)	14.77
3.	Iron Oxide (Fe_2O_3)	3.44
4.	Calcium Oxide (CaO)	29.80
5.	Magnesium Oxide (MgO)	9.32
6.	Sodium oxide(Na_2 o)	3.59
7	Potassium oxide(k_2 o)	10.38
8	Specific gravity	1.65-1.70

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Tests Conducted

Following are the tests conducted in the lab

1. Consistency limits

i. Liquid limit by Casagrande's apparatus

ii. Plastic limit

2. Determination of MDD and the corresponding OMC by standard proctor test
3. UCS test
4. CBR test

Table 4- Comparison of OMC, MDD, UCS and CBR% of virgin soil , Soil: 8% wood ash, Soil: 12% wood ash and Soil: 16% wood ash

Property	Virgin Soil	Soil with 8% wood ash	% Increase/ decrease	Soil with 12% wood ash	% Increase/ decrease	Soil with 16% wood ash	% Increase/ decrease
OMC %	15.89	16.30	2.5 % increase	17.90	12.69 % increase	18.10	13.90 % increase
MDD(gm/cc)	1.762	1.68	4.65 % decrease	1.61	8.62% decrease	1.63	7.49% decrease
UCS(kpa)	82.6	116.18	40.65% increase	152.08	84.11% increase	140.80	70.46 % increase
CBR%(soaked) for 2.5mm Penetration	2.9	4.0	37.93% increase	4.3	48.27 % increase	3.8	31.03% increase

Table 5- Comparison of OMC, MDD, UCS and CBR% of virgin soil , Soil: 3% $CaCl_2$, Soil: 5% $CaCl_2$ and Soil: 7% $CaCl_2$

Property	Virgin Soil	Soil with 3% $CaCl_2$	% Increase/ decrease	Soil with 3% $CaCl_2$	% Increase/ decrease	Soil with 7% $CaCl_2$	% Increase/ decrease
OMC %	15.89	16.5	3.80 % increase	17	6.98 % increase	17.5	10.13 % increase
MDD(gm/cc)	1.762	1.686	4.31% decrease	1.66	5.78 % decrease	1.63	7.49 % decrease
UCS(kpa)	82.6	110.02	33.19 % increase	131.01	58.60 % increase	150.566	82.27% increase
CBR%(soaked) for 2.5mm Penetration	2.9	3.7	27 % increase	3.9	34.48 % increase	4.1	41.37% increase

ISSN: 2350-0328

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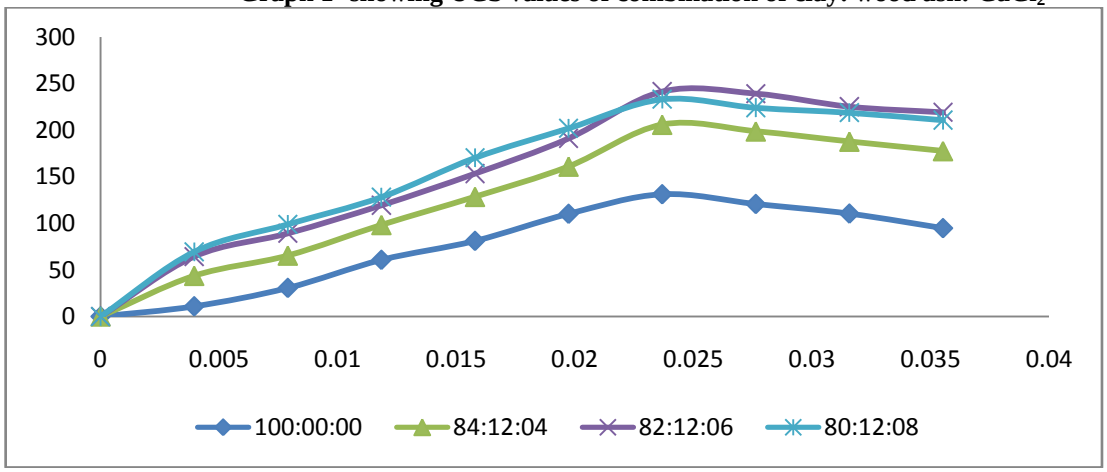
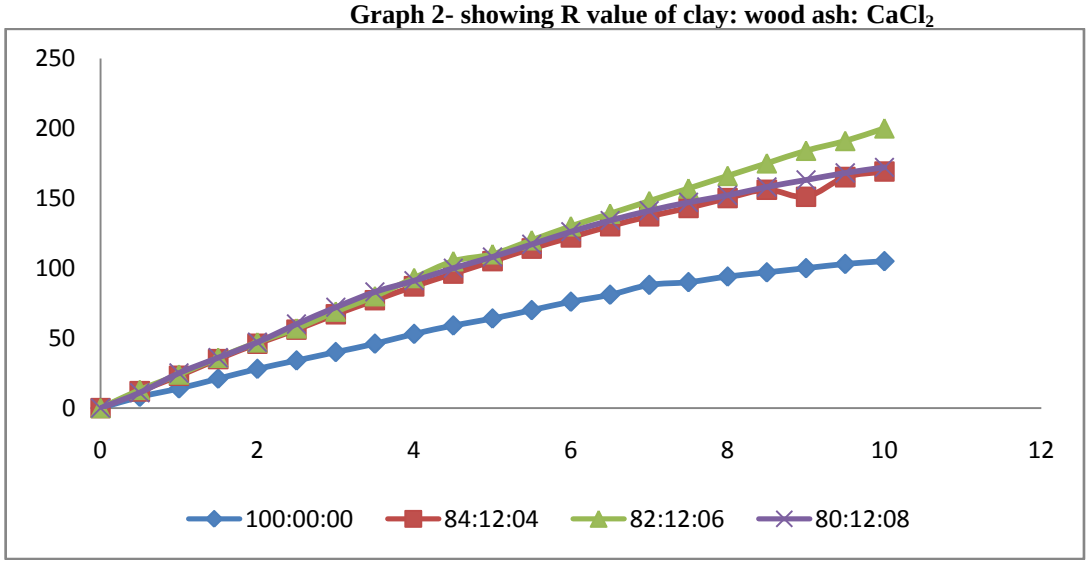
Table 6- Detail Test Results of soil: woodash: $CaCl_2$

CS: W.A :$CaCl_2$	OMC (%)	MDD (g/cc)	UCS (kpa)	CBR (%)
100:00:00	15.89	1.762	82.6	2.9
84:12:04	15.91	1.58	205.81	5.1
82:12:06	16.20	1.55	241.25	5.3
80:12:08	16.50	1.53	233.05	5.2

Graph 1- showing UCS values of combination of clay: wood ash: $CaCl_2$



Graph 2- showing R value of clay: wood ash: $CaCl_2$



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IV. CONCLUSION

A. With the addition of wood ash 12% and varying calcium chloride MDD of clayey soil decreases upto 3.83% with the increase in moisture content upto 4.43%.
B. The UCS value increases with an increase of $CaCl_2$ content along with a fixed quantity of wood ash 12%. The maximum value of UCS was found at 06% $CaCl_2$ and 12% wood ash. Further increase of $CaCl_2$ content in soil would decrease the UCS value.
C. Based on the CBR test results, the value of CBR increases from 2.9 to 5.3. further increase in calcium chloride % decreases CBRvalue.

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