



Enhancement of Expansive Soil with Addition of Wood Husk Ash and Silica Fume

Srija Juluru, Parthiban D, Manuel Joy, Aaron Obeth S, Shamlik Mohammed V

Abstract: Soil is the foundation material which supports loads from an overlying structure; it mainly consists of minerals, organic matter, liquids etc. In India the soil most present is Clay, using which the construction of sub grade is deemed problematic. as Clayey soils are expansive soils. The problem of using clayey soil for civil engineering constructions has been observed since early ages.. On the basis of type of soil, soil stabilization is undertaken and is a major technology in construction engineering. Soil strengthening refers to the process of enhancing physical, chemical and mechanical properties of soil to maintain its stability. In this investigation, an attempt has been made to improve the engineering properties of locally available clayey soil near Mahabalipuram by making a composite mix with silica fume and wood ash with equal composition in various proportions. Addition of such materials will increase the physical as well as chemical properties of the soil. study, experimental investigations are carried out to study the beneficial effects of stabilizing Clay soil using silica fume and wood ash with 3%, 5% and 7%. The tests were conducted in order to evaluate the improvement in strength characteristics of the sub graded soil. The parameters tested included the Atterberg limits, Modified Proctor Density, California bearing ratio (CBR). Results showed that the geotechnical parameters of clay soil improved substantially by the addition of wood husk ash and silica fume

Keywords : Expansive soil, Silica fume, Wood ash, Atterberg limits, CBR,

I. INTRODUCTION

Soil is an aggregation of weathered mineral particulates produced by weathering of rocks, moisture, and other organic and inorganic substances. Soil has been the first structural material for human species to work with. However the engineering properties of soil are largely dependent on soil type, its density and moisture content. Engineers are often met with challenge to mount a structure on a soil with unsuitable properties like clayey or sandy soils.

Revised Manuscript Received on December 30, 2019.

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This calls for enhancement of soil properties by addition of appropriate additives, which is also known as soil stabilization. The additives used to enhance the soil properties, are lately being sourced from by-products or industrial wastes which left alone, pose a threat to the environment.

ChhayaNegi [1], et.al conclude that by addition of silica fume

increases CBR value and then finally decrease the swelling characteristics. Abo-Hashema M et al[2] studied that by adding lime and silica fume to expansive soil results in improving the shear strength and decrease of atterberg limits. Dr. Adel et al[3] examined that by using in silica fume cracks development in compacted expansive sample diminishes to 75% with increase in compressive strength properties. Oormila.T.R et al [4] shows that by addition of GGBS of varying percentages (15% to 25%) and fly ash with percentage of enhancements(5% to 20%) gives 20% is optimum satisfying all engineering properties of soil .Rathan Raj R1 Et al[5] have shown a decrease in behaviour of swell index from 59% to 14%is mainly due to calcium oxide in rice husk

This paper, investigates the enhancement of clayey soil properties by addition of such industrial wastes namely silica fume and wood ash. Silica fume is generated during production of silicon metal or ferrosilicon alloys, which are used in electronics, and in production of steel and aluminum. Wood ash is produced after combustion of wood in an industrial power plant.

II. MATERIALS AND METHODOLOGY

A. Clay Soil

Clay is composed of natural occurring aluminum silicate minerals with organic matter and small quantities of metal oxides and quartz. Depending on mineral composition, the colour varies from white to red. Clay can trap or hold moisture within its structure in varying amounts, as per particle spacing. They exhibit plasticity, which varies with amount of moisture contained in the soil. It becomes, hard, tough, non-plastic and brittle on heating or drying. Clay soils laden with high moisture content are sticky and susceptible to compaction and water logging. Therefore construction undertaken on clayey soil is problematic, as the soil gets unstable with absorption of moisture from surroundings

B. Silica fume

Silica fume is a non-crystalline form of silicon dioxide or silica. Silica fume is an ultrafine particle material consisting of spherical particulates of average diameter of 150 nm.

Therefore they are an inevitable hazardous by-product in the electronic industry.



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However it finds an excellent application as a pozzolanic component that can be added to concrete to enhance its strength. Application of silica fume in concrete improves strength significantly while lowering the permeability of the grouting. Addition of silica fume also prevents adverse chemical reactions in harsh environments. The composition is presented in Table 1

Table I :Physical properties of silica fume

S.no	Parameters	Test Value
1.	Silica as SiO ₂ ,% by mass	87
2.	Lime as CaO,% by mass	6.99
3	Magnesia as MgO,% by mass	3.68
	Total Sulphur Content as SO ₃ ,% by mass	0.39

C. Wood Husk Ash

The residue powder left after the combustion of wood, in a home fireplace or an industrial power plant is wood husk ash. It can be used for both gardening as a good source of potash and around the home. It is environmentally friendly and child safe Moisture and stain resistant.Very tough and durable

Soil samples were prepared by admixture of locally sourced soil with varying proportions of additives. Three different percentages of additives were used leading to three distinct samples, for each experiment. They are 3, 5 and 7% of additives addition. Atterberg limits, compaction test, CBR tests are the tests conducted on each sample

III. RESULTS AND DISCUSSIONS

A Proctor Compaction Test

To establish the relationship between MDD and OMC, Proctor’s compaction test was carried as per IS: 2720 [6] the tested values are tabulated in Table 1and Comparison in graph is shown in Fig 1 & 2.It is observed that there is decrease in MDD and increase in OMC values with increasing usage of replacement material wood husk and silica fume. However there appears a threshold value wherein the properties begin to deteriorate, with further addition of the replacement material. The low value of threshold can be attributed to presence of fibres in the wood husk. The fibres lead to additional binding in soil thus lowering the specific gravity of soil

Table 1: Variation of OMC% & MDD for different soil samples

Replacement of stabilized sample	Clayey soil		Clay soil +silica fume+ Wood Husk ash	
	MDD	OMC	MDD	OMC
0%	1.644	16.57	NIL	NIL
3%			1.71	17.32
5%			1.83	18.2
7%			1.79	18.82

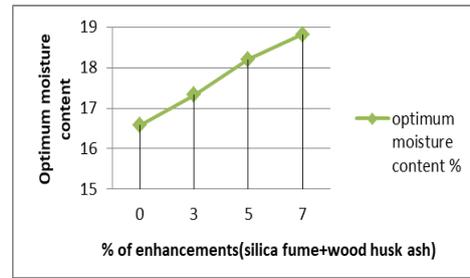


Fig:1 Effect of OMC with varying percentage of SF & WHA

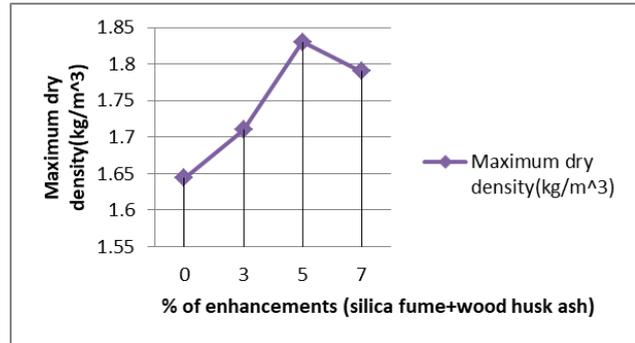


Fig:2 Effect of MDD with varying percentage of SF & WHA Atterberg Limits



Fig:3 Standard Proctor Test

B Atterberg limits

Plasticity of the soil is an important property that determines stability of slopes, embankments and other structures. It is essentially the ability of soil to be moulded when wet. Plasticity is due to the presence of clayey materials and water. The particles of soil are molecularly adhesive to water droplets trapped within the soil. Atterberg limit is used to determine the plasticity of soil. Fig 4 shows the variation of atterberg limits with various percentage of replacement material.

It is observed that the plasticity of soil keeps decreasing with increase in use of replacement material. However at low per cent the soil exhibits good plasticity. It decreases steeply after 5% of replacement material. This variation needs to borne when using the material in practical applications. The lowering of liquid limit can be attributed to coating of larger clay particles with very fine silica fume particles

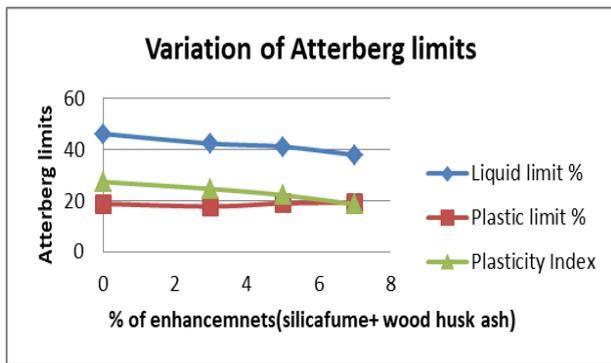


Fig:4 Liquid limit,plastic limit behaviour of clay soil by supplements of SF&WHA

C California Bearing Ratio

To check the shear strength, bearing capacity of the soil CBR value is used. For calculating CBR value generally two tests are to be done In this test, soaked sample is used, which gives the revamped CBR values. The graph from Fig 5 shows that at low energy levels bearing ratio is very less and therefore less water is available for controlling the hydration process. Thus, it is evident that When the percentage of stabilized sample increases, CBR value increases and decreases at certain optimum value. 5% enhancement of stabilized sample more relevant results is tabulated on Table 3

Table:3 Results of CBR % for soaked and unsoaked soil samples

Percentage of enhancement	Clay soil+WHA+SC(Soaked) CBR%		Claysoil+WHA+SC (unsoaked) CBR%	
	2.5mm	5mm	2.5mm	5mm
0%	3.85	3.37	5.18	4.79
3%	4.54	3.91	6.32	5.77
5%	6.88	6.43	8.44	7.98
7%	5.71	5.17	7.19	6.83

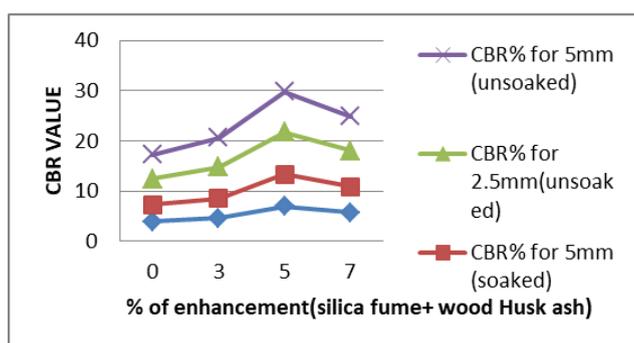


Fig 5: Effect on CBR value

IV. CONCLUSIONS

The study was conducted to examine the impact of addition of wood husk and silica fume ash to soil, through experimental investigation of soil properties. The soil investigated was sourced locally near Mahabalipuram, which is clayey in nature. The properties studied were plasticity index, MDD, OMC, and CBR clearly described in the paper. Optimum values of these properties spell the utility of soil for use in base, sub base material for a variety of infrastructure,

embankments and dams. These properties were studied at varying proportion of the additives, and the observations are noted as follows:

1. Atterberg limits for plasticity index were conducted. The tests showed that the plasticity keeps decreases with percentage increases of substitute materials. The decrease in steepness is steep after 5% addition, till when plasticity index is higher than 22. This shows that the swelling in clayey soil reduces with addition of the substitute material.
2. For determination OMC and MDD of the soil, Standard proctor test was conducted..The properties were observed to improve with increase in additives.This may be due to reduction of coarser clay material resulting in higher free surface area in soil which requires more moisture for compaction and then dry density decreases
3. CBR value is utilized broadly by many engineers and researchers in design of sub base material for building construction. This value is used as index parameter to determine the bearing capacity and shear strength of the soil. It is observed that CBR values increase with addition percentage of substitutive materials upto 5% and then deteriorates. This is due to increase in OMC after the said percentage. The peak increase in CBR is around 40 to 50% higher than the base strength.
4. The above observations conclude the fact that by adding of wood husk and silica fume to clayey soil, improves its properties considerably, till a certain percentage of addition. Thus the optimum percentage of addition in the soil investigated is found to be around 3 to 5%.

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