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A STUDY ON THE EFFECT OF STABILIZATION OF EXPANSIVE SOIL AT LIQUID LIMIT USING COAL ASH

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Abstract: The foundations on expansive soils is one of the challenges faced by geotechnical engineers. The swell and shrinkage behaviour of expansive soil causes significant damage to structures. The most common methods used to control heave distress in expansive soils include stabilization and compaction. Utilization of industrial wastes as alternatives to commonly used stabilizing agents may contribute to control the expansive nature. In this study, coal ash which is the waste material obtained from cement industry is used as stabilizer with clay. The effect of addition coal ash with clay is studied. Soil samples with addition of stabilizers are cured at its liquid limit for a curing period upto 28 days. Samples are tested at various curing intervals such as 7, 14 and 28 days for its plasticity characteristics, permeability behavior and shear strength characteristics. It is observed from the results that there is appreciable improvement in plasticity characteristics, permeability behavior and shear strength characteristics.

Key words: Expansive soil, Soil stabilization, Consolidation, curing, shear strength.

I. INTRODUCTION

In the field of geotechnical engineering, it has long been known that swelling of expansive soils caused by moisture change results in severe damage to overlying structures. Expansive soils are mostly found in the arid and semi-arid regions and it covers very large area of the world. It covers nearly 20% of the land mass in india[1]. Expansive soils are known as shrink swell or swelling soils. The repeated cycles of swelling or shrinkage of soil cause deteriorations and distresses on the structures. Soil stabilization is a technique introduced with the main purpose to modify the soils capable of meeting the requirements of the specific engineering projects. The most common improvements achieved through stabilization include better soil gradation, reduction of plasticity index or swelling potential and increases strength and durability. Various stabilizers such as lime, cement and calcium chloride are used.

The over dependent on the utilization of industrially manufactured soil improving additives (cement, lime etc), have kept the cost of construction financially high. In order to make deficient soils useful and meet geotechnical engineering design requirements we should focus more on the use of potentially cost effective materials that are locally available from industrial and agricultural waste in order to improve the properties of expansive soils [2]. Generally, industrial waste causes many serious environmental problems. Utilization of industrial waste as a stabilizing agent is the best way to dispose it. A better understanding of compressibility characteristics will enhance the usage of industrial wastes in geotechnical engineering works in places where they are abundant and thereby making clays suitable for foundation purpose [3].

Coal ash is obtained in the kiln during the production of cement clinker in the cement manufacturing process. When combustion takes place in kiln, portion of the ash escapes through the chimney and part of the non-combustible residue fall by themselves into the bottom of the kiln. The ash settled at the bottom of the kiln by this process is known as coal ash which is having little cementitious value. Being a coarse ash it is an excellent substitute for soil used in filling, reclamation of low lying areas, construction of roads, embankments, dykes etc., It has 90% of coal ash and 10% of cement clinker.

The main objective of this experimental study is to improve the engineering properties of clay by using coal ash as stabilizer. Previous research indicates that the general behavior of bottom ash compares favourably with conventional granular materials, providing a promising solution to disposal problem and also an economic alternative to the use of conventional soils as construction materials [4]. The purpose of present study is to evaluate the effect of industrial wastes on the improvement of compressibility behavior of expansive soil.

Soil sample for the analysis is blended with the industrial wastes collected and allowed to cure at the liquid limit of the virgin sample for a period of 28 days. The cured samples are tested at various curing intervals for its plasticity characteristics, permeability behavior and shear strength characteristics.

II. EXPERIMENTAL STUDY

After trial and error procedure, it was found that 8% coal ash is the optimum content for stabilizing the clay soil. With this optimum content the plasticity, permeability and shear strength characteristics of treated soil with different curing periods are studied. The virgin soil is analysed for its various properties and the results obtained are given in Table-1.

Table-1 Properties of untreated Soil

S.no	Properties	Results
1.	Moisture Content	12.3%
2.	Specific Gravity	2.75
3.	Free Swell Index	65%
4.	Liquid limit	58%
5.	Plastic limit	23%
6.	Shrinkage limit	12%
7.	Plasticity index	35%
8.	Soil Classification	CH
9.	Coefficient of permeability	4.16×10^{-7} cm / sec

The liquid limit test for the stabilized sample is carried out by using soil cone penetrometer. The prepared sample is cured upto 28 days and tested for its liquid limit and permeability behaviour at various curing period. The results obtained are given in Table-2 and 3.

Table-2 variation of plasticity index

Optimum Dosage	Curing Period (Days)	Liquid Limit (%)	Plasticity Index (%)
CH+ 8% CA	7	44	21
	14	46	20
	28	45	19

Experimental result shows that the sample tends to medium plastic beyond 28 days curing. The variations of plasticity index are given in Figure-1.

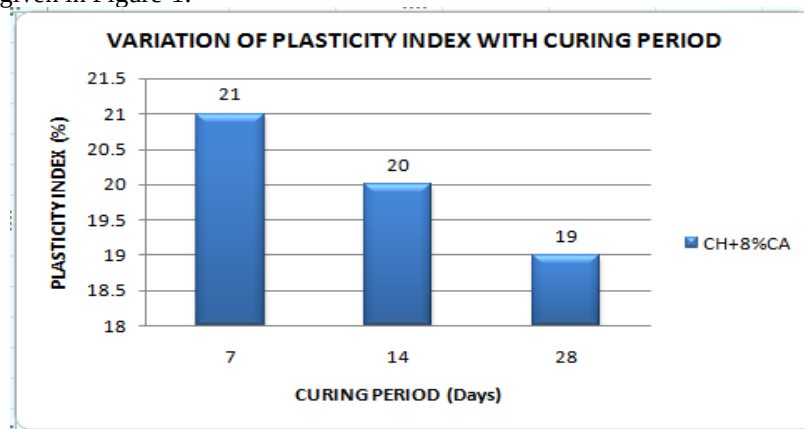


Figure-1 Variation of plasticity index

The results established by the permeability test conducted on the soil sample cured upto 28 days are given in Table-3.

Table 3 Co efficient of Permeability

S.no	Optimum Dosage	Co efficient of Permeability (cm / sec)
1	CH + 8% CA	1.45×10^{-4}

This value illustrates that co efficient of permeability is increased than that of the virgin sample. The vane shear test is performed on treated sample and the shear strength at different curing intervals is determined. The results obtained are given in Table-4. The effect of stabilizers on shear strength for various curing period is shown in Figure-2. The addition of stabilizers has improved the shear strength of virgin sample.

Table-4 Shear strength at various curing period

S.no	Optimum Dosage	Curing Period (Days)	Shear Strength (Kg/cm ²)
1	CH+8% CA	7	0.0795
		14	0.0944
		28	0.1094

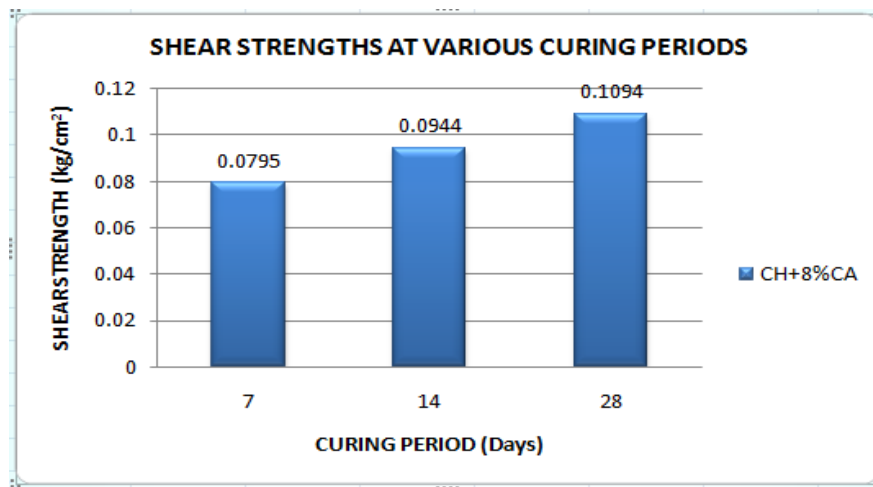


Figure-2 Variation of shear strength

III. RESULT AND DISCUSSION

Plasticity index

It is observed that the addition of stabilizing agents have improved the soil properties .The plasticity index of the soil got reduced with increase in curing period. This is may be due to the replacement of the soil particles by the stabilizing agents with consequent reduction in clay content. The plasticity of soil decreases as the amount of clay fraction decreases.

Permeability Test

The Permeability of the soil sample got increased, due to the fact that stabilizing compounds aggregate the particles, as result of which large floccules are formed, and this almost amounts to effective particle growth.

Shear strength

Due to the increased pozzolanic reaction that changes the soil matrix, the formation of pozzolanic products within the pore spaces got increased. Due to this physico-chemical changes within the soil structure, the shear strength of the treated sample is increased gradually.

IV. CONCLUSION

1. It has been observed that with the increase in curing period the plasticity index of the sample is decreased appreciably. Due to this the nature of the virgin soil has changed from highly plastic to medium plastic. It can be expected that the plasticity index may also further reduced in future when the curing period is extended.
2. The co efficient of permeability has been increased significantly. It results in substantially reduced overall compression.
3. The shear strength characteristics of the treated sample in increased considerably.
4. These findings shows that CH treated with coal ash will be suitable for re-claiming low lying marginal land for foundation works and for fills in embankment works.

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