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Shrinkage Characteristics of Fine Graded Soils with the Addition of Cement

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ABSTRACT: Natural soils are formed by weathering of rocks and decomposition of organic matter. Shrinkage limit is the moisture content after which further loss of moisture does not cause a decrease in the volume of soil. Shrinkage limit is lowest water content at which a soil can still be completely saturated. It is observed that shrinkage and swelling of soils is mostly done on clay and soils containing it have shrinkage- swell curves that are qualitatively different in shape. But in this paper experiments are performed on fine graded soils (sand, rock dust, and bentonite) to determine the shrink parameters of different fine graded soils. The main objective of this work is to find out shrinkage parameters of different soils with their different proportion mix of cement to give a soil reference shrinkage curves. To obtain indication of change in volume of different soil samples. The methodology is based on detail accounting for contributions of the different proportions of soil mix and to the soil volume and water content during shrinkage. Using shrinkage apparatus, moisture content of sample is determined and volumetric analysis is evaluated by shrinkage limit apparatus. To enhance and reduce cracking behavior in the buildings shrinkage limit is performed for different fine soils. Hereby there is no change in moisture can occur before any appreciable volume changes.

KEYWORDS: shrinkage, moisture content, cracking.

I. INTRODUCTION

Soils are formed by process of weathering of parent rock. Due to different types of physical (i.e., temperature, radiation, and humidity), chemical (i.e., oxidation, hydration, carbonation, solution, leaching, and hydrolysis) and due to human intervention (i.e., conduit leakages disposal of industrial Hazardous wastes).The rupture and cracking resistance is a field measure of the ability of the soil to withstand an applied stress or pressure as applied using the thumb and forefinger. Soil consistency is defined as the relative ease with which a soil can be deformed use the terms of soft, firm, or hard. Consistency largely depends on soil minerals and the water content. The shrinkage curve is an important relationship of the soil. The shrinkage curve is usually plotted as void ratio versus water content.

This shrinkage results in cracking in some soils mainly in fine- grained soils (clayey soils).The presence of cracking in clay soils can significantly alter its hydrological, physico-chemical and thermal properties. This problem has been a stumbling block in numerous disciplines such as geotechnical, geo-environmental, agricultural and transportation engineering. Despite soil cracking has been a major issue in a wide range of applications moisture barriers, landfill liners, embankment cores, excavations and stability of slopes.

NEED AND SCOPE

As the soil loses moisture, either in its natural environment, or by artificial means in laboratory it changes from liquid state to plastic state to semi-solid state and then to solid state. The volume is also reduced by the decrease in water content. But, at a particular limit the moisture reduction causes no further volume change. A shrinkage limit test gives a

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quantitative indication of how much moisture can change before any significant volume change and to also indication of change in volume. The shrinkage limit is useful in areas where soils undergo large volume changes when going through wet and dry cycles (e.g. earth dams)

II. LITERATURE REVIEW

E.C. Leong, M.Wijaya(2014):

The soil shrinkage curve is used to relate the volume of soil as it dries with water content. The shape of shrinkage curve depends on the soil type and soil fabric. A shrinkage curve can consists of two to four phases. It is difficult to represent all types of shrinkage curves with a single continuous equation which uses explicit parameters. The shrinkage curve is an important relationship of the soil. The shrinkage curve is usually plotted as void ratio versus water content. A shrinkage curve can be considered as an n-linear segment curve. In this paper, a universal equation for all types of shrinkage curve has been developed. The universal shrinkage curve equation uses explicit parameters which can be determined easily from the experimental data.

V.Y. Chertkov(2008):

Clay and soil containing it have shrinkage curves that are qualitatively different in shape. The objective of this work is to qualitatively show with maximum simplicity, how a clay shrinkage curve turns into a soil shrinkage curve. Because of the crack volume the measured shrinkage curve is not the single-valued feature of a soil. The physical understanding of the transformation of the clay shrinkage curve to the soil shrinkage curve and of the new features of the intra-aggregate structure underlying this transformation, are essential for numerous applications; first of all, for the:

- Physical modeling of soil shrinkage,
- Water retention, hydraulic conductivity,
- Water flow and solute transport.

From the literature review it is observed that shrinkage and swelling of soils is mostly done on clay and soils containing it have shrinkage- swell curves that are qualitatively different in shape. But in this paper experiments are performed on fine graded soils. to determine the shrink parameters of different fine graded soils. The main objective of this work is to find out shrinkage parameters of different soils with their different proportion mix and to give a soil reference shrinkage curves. To obtain indication of change in volume of different soil samples. The methodology is based on detail accounting for contributions of the different proportions of soil mix and to the soil volume and water content during shrinkage. Using shrinkage apparatus, moisture content of sample is determined and volumetric analysis is evaluated by shrinkage limit apparatus. To enhance and reduce cracking behavior in the buildings shrinkage limit is performed for different fine soils. Hereby there is no change in moisture can occur before any appreciable volume changes.

The present article tries to examine the effect of adding cement to clay on its shrinkage properties and to compare it with normal clay. A considerable number of expansion experiments were carried out on mixed samples with different weight percentages. The results suggested the significant effect of modification of clay soils in Golestan Province by adding cement on their shrinkage properties, such that increased percentage of additives increases the shrinkage limit

III. EXPERIMENTAL PROGRAM

Materials

Five different types of soils were taken mainly Black cotton, Silt, Sand, Rock dust and bentonite from in and around Hyderabad.

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Black cotton Black Cotton Soil was used in this study obtained from ANGRAU site Hyderabad. The Top soil was removed at a depth of 10 cm and then the soil was collected as disturbed soil sample excavated with trowels and then the soil is packed into bags and soon gets that bag to laboratory to avoid loss of moisture content. The soil Sample was air dried and pulverizing with a steel hammer to obtain the particle should be passing the sieve size of 4.75mm.

Silt was from obtained from the JNTU campus Sulthanpur Medak.

Sand was obtained from the construction site within the campus of VNR VJIET.

Experimentation

Basic Index tests:

Specific gravity

The Specific gravity (G) of the soil has been determined by exploited some density bottle and pycnometer as per the guidelines provided by [28]. The average value has been taken from the three trials was obtained and the results for different soils are shown in the table.

Wet sieve analysis and hydrometer test

According to IS: 2720 (part 4)-1985 the wet sieve analysis and hydrometer tests are conducted to determine the particle size of the soils

Liquid limit and plastic limit

According to the IS: 2720 (part V) - 1985 the liquid limit (LL) and plastic limit (PL) are conducted.

Standard Proctor test

According to IS: 2720 (part VII) - 1985 the standard proctor test conducted to determine the Optimum Moisture Content (OMC) and Maximum Dry density (MDD) of the soil.

Experimentation Procedure

The purpose of the present research was to examine the stabilizing effect of cement on the shrinkage properties of soils. First, the effect of cement on the plastic properties of the soil was examined by using soil samples with plasticity of 20, 30, and 35 and by adding different percentages of cement (1, 3, 5, 9, and 13 weight percentage). The effects were then compared.

The effect of adding cement on soil properties

Cement is widely used for soil stabilization, especially in the construction of roads and embankments. Cement can be used for stabilizing sandy and clay soils, particularly in regions with high levels of groundwater. Most fine-grained soils can be stabilized by cement except organic soils. The amount of cement required for soil stabilization depends on soil plasticity. Soils with higher fine-grained percentage or more plastic soils (higher plastic range) require a greater amount of cement for stabilization. For field compaction, the correct amount of cement can be mixed with soil. The mixing can be in situ or in a mixing plant and then be transferred to the site. Then, a proper amount of water is added to the mixture and it is compacted until it is of the weight of interest. Cement slurry (water-cement ratio of 0.5 to 50) can be injected in weak soils that form the infrastructure of buildings or other structures. Cement injection leads to reduced permeability and increased resistance and bearing capacity of soils.

IV. RESULTS AND DISCUSSIONS

The soils are collected in and around the Hyderabad city. These soils have been analysed for various physical and mechanical properties and the properties are as listed in the **Table 4.1 Index Properties of soils.**

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Properties	Soil samples		
	Black cotton	Silt	Sand
Specific Gravity	2.63	2.68	2.69
Gravel%	0	0	2
Sand %	5	6	98
Silt%	41	78	0
Clay%	56	14	0
Liquid limit (%)	42	24.2	0
Plastic limit (%)	18	19	0
OMC (%)	16	14	6
MDD (g/cm ³)	1.67	1.8	1.72

Table 4.1. Index Properties of soils

The effect of cement on the plastic and shrinkage properties of the soil:

The figures below show the results of liquid limit, plastic limit, and shrinkage limit experiments on soil samples with different plasticity, stabilized with different percentages of cement.

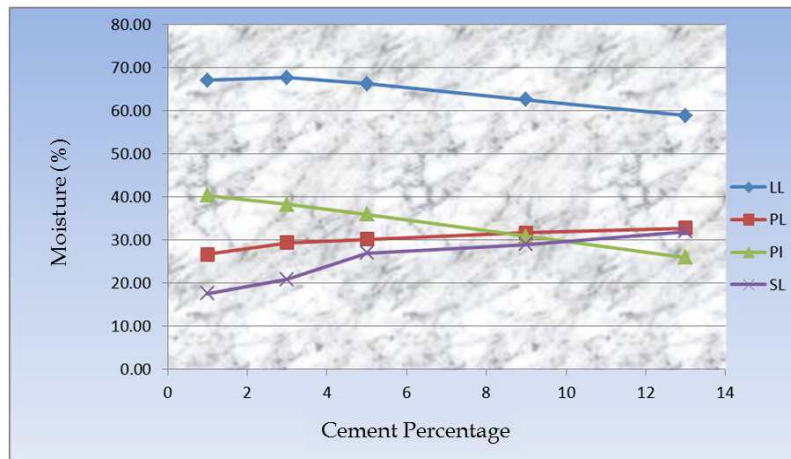


Table 4.2. The effect of adding different percentages of cement on the plastic and shrinkage properties of the black cotton soil.

The effect of cement percentages is more on liquid limit of the soil is at 60-70% whereas plasticity index of the soil is 40 and below while increasing the cement content in the soil. At 9% of cement the values of plastic limit, plasticity index and shrinkage limit of the soil are approximately near values. The least values are seen in the shrinkage limit is 10% and more on increasing cement percentage.

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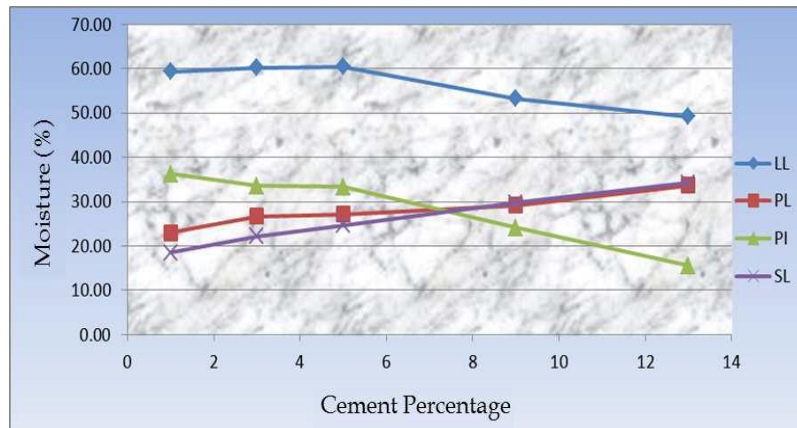


Table 4.3. The effect of adding different percentages of cement on the plastic and shrinkage properties of the sandy soil.

The graph indicates that the liquid limit values are higher than other values the range is between 50-60%. The plasticity index value is at 35 but on adding the percentages of cement the value decreases on increasing cement percentage. The plastic limit of the soil increases with increasing cement percentage and the shrinkage limit values also increasing with increase in cement percentage. At 9% of cement plastic limit and shrinkage limit values are equal.

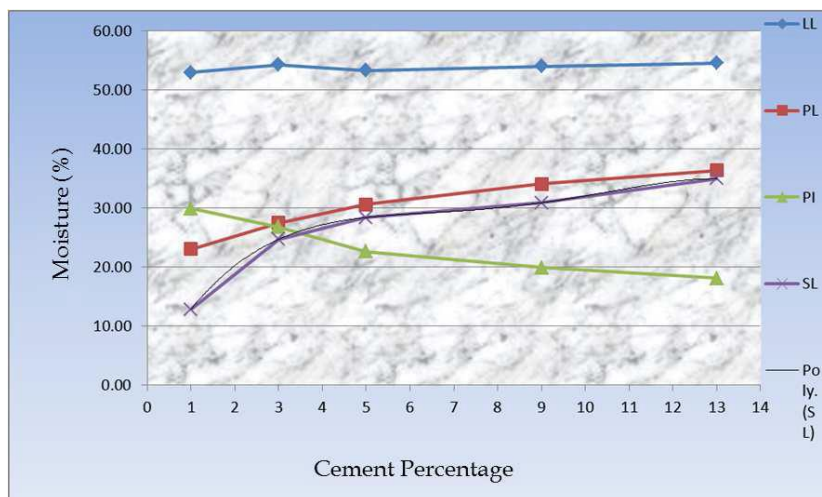


Table 4.4. The effect of adding different percentages of cement on the plastic and shrinkage properties of the silt soil.

The graph indicates the soil having liquid limit values more than 50%. Plasticity index at 30% but decreasing on increasing cement content it is observed that plastic limit and shrinkage limit values are increasing with increase in cement percentage.

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V.CONCLUSIONS

- A. Adding cement up to 5 percent of the weight of sample soils increases their liquid limit (LL), and increased cement percentage will reduce the LL of the samples.
- B. Adding cement to the sample soils is followed by increased plastic limit (PL) and the percentage of optimum moisture.
- C. Adding cement to the studied samples will increase shrinkage limit (SL) and this increase is almost linear for samples ascending in samples with 3% cement addition.
- D. Adding cement to the studied soil samples reduces the PI of the clay soils in the region.
- E. Finally, the optimum percentage of cement added to the studied problematic soils is 10% of total weight for soils with up to 35 PI and 13% of total weight for soils with 40 PI. It can thus be concluded that adding cement to the Problematic soils of Golestan Province improves the shrinkage limit and reduces the longitudinal and transverse cracks in these soils due to shrinkage.

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