AN EXPERIMENTAL STUDY ON THE ATTERBERG LIMITS OF SOIL AROUND HUSSAIN SAGAR LAKE: PROSPECTIVE LOCATION FOR TALL STRUCTURES

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Abstract

Plastic behaviour of soil is an element of concern in civil engineering as it highly affects construction design. Soils with high plasticity index may result in sudden and unpredictable structural failures due to volumetric changes in soil by moisture infiltration through surface cracks. The Aim of this Research Paper is to find the Plasticity Index of the soil strata around Hussain Sagar Lake which is proposed for the construction of World's tallest building. Atterberg's limits for various samples collected at suitable intervals at the proposed site were calculated and then the plasticity index was found. It was found Imperative to modify the Plastic Characteristics of soil by using appropriate additives to make it suitable for the prestigious project, various additives were added to the collected soil samples and corresponding inferences were obtained regarding the soil suitability. This aspect has been further discussed in this Research Paper.

***Keyword**: Plasticity Index, Volumetric Changes, Additives.*

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1. INTRODUCTION

Atterberg Limits and Index properties have been in wide use for preliminary soil classification. They are found to correlate well with the engineering properties of soil as both the Atterberg's limits and engineering properties are found to be influenced by same set of factors such as clay minerals, the ions in the pore water, stress history of soil deposit etc. Hence the consistency limits and indices, though arbitrary and empirical, may be used for classifying fine grained soils for engineering purpose.

It is well known fact that natural structure of a clayey soil has a marked influence on its engineering behavior The Liquid limit and plastic limit indicate the plasticity of soil and both are dependent on amount and type of clay in the soil, while the plasticity index is seen to be dependent mainly on the amount of clay present in the soil, the study of plasticity index in combination with the liquid limit forms the basis for identifying both the type and nature of clay. The shrinkage limit is a useful parameter for the study of expansive and shrinkage behavior of clay soil.

There is a Relationship between Atterberg Limit and engineering properties of soil. An important indication of the compressibility of a soil can judged from the liquid limit of the soil. Greater the Liquid limit, greater the compressibility of soil. In fact, reliable correlations between the liquid limit and the compressibility parameter are in practical usage. For soils with the same value of liquid limit, the greater the plasticity index, the greater the dry strength, and toughness at plastic limit. But the permeability and the rate of volume change decrease while compressibility remains the same. Comparing soils with equal values of plasticity index it is seen that with increase in liquid limit, the dry strength and toughness decrease when the permeability and compressibility increase.

The term soil stabilization means improving the strength or bearing capacity or decreasing the settlements of a poor soil by using controlled compaction, proportioning and or the addition of suitable admixtures or stabilizers. In this study lime and fly, as stabilizers were used to understand the changes in plasticity characteristics of soil.

Lime's use is especially valuable when expansive clays are encountered. Expansive clays have been known to crack concrete slabs or to create rough joints as the slabs heaved and then settled during wet and dry cycles. Lime alleviates this problem first by reducing the soil's expansive properties and second by forming a moisture barrier which helps prevent water from reaching the underlying expansive subsoil.

The use of fly ash additive is attractive because fly ash is an industrial byproduct that is relatively inexpensive, compared with cement and lime. Expansive soils can be potentially stabilized effectively by cation exchange using flyash.

In this Paper, an attempt is made to critically evaluate the atterberg limits by carrying out experiments on the soil of the site proposed for the upcoming project of Skyscrapers in and around Hussain Sagar Lake, Specifically Sanjeevaiah Park. A brief study was also conducted to evaluate the improvements in the soil characteristics when stabilized with the stabilizers.

2. EXPERIMENTAL STUDY

An experimental study was conducted at Sanjeevaiah Park, the proposed site for the city's first skyscrapers in order to determine Atterberg's limits of the soil. As clayey soil is mostly found in Hyderabad testing of plasticity characteristics is very essential. It's a well known fact that Atterberg's limits for clayey soil have marked influence on engineering properties. Hence, it is essential to test the variations in Atterberg's limits at the proposed site.

As per IS 2720 Part V, experiments were conducted to determine Plasticity characteristics of soil.About 16 samples were collected from the site with an interval of 250 meters, (shown in Fig1) to understand the variations of plasticity characteristics of the soil.
The following tests were conducted on the soil sample with and without stabilizers.

1. Liquid limit Test
2. Plastic limit Test
3. Shrinkage limit Test

Liquid limit

The liquid limit of a soil is the moisture content, expressed as a percentage of the weight of the oven-dried soil, at the boundary between the liquid and plastic states of consistency. The moisture content at this boundary is arbitrarily defined as the water content at which two halves of a soil cake will flow together, for a distance of 12.7 mm along the bottom of a groove of standard dimensions separating the two halves, when the cup of a standard liquid limit apparatus is dropped 25 times from a height of 10 mm at the rate of two drops/second.(shown in fig 2)

Plastic limit

The plastic limit of a soil is the moisture content, expressed as a percentage of the weight of the oven-dry soil, at the boundary between the plastic and semisolid states of consistency. It is the moisture content at which a soil will just begin to crumble when rolled into a thread 3 mm in diameter using a ground glass plate or other acceptable surface

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Shrinkage limit

The shrinkage limit of the soil is the maximum water content at which the reduction in water content will not cause decrease in total volume of soil but the increase in moisture content will cause an increase in moisture content A shrinkage limit test gives a 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.

Plasticity Index

The plasticity index of a soil is the numerical difference between its liquid limit and its plastic limit, and is a dimensionless number. Both the liquid and plastic limits are moisture contents

The Atterberg's limits, so obtained from the various tests are presented in Table 1 and the variations of plasticity Index is given in Table 2.

From the above table, it was found that the soil has very high plasticity index , which makes the soil unstable to bear the structural loads. Hence, it's essential to reduce the plasticity index to improve the engineering properties of soil. Fig 3 illustrates the variations in Atterberg's limit and also indicates very high values of liquid limit. The variation in plasticity index of the soil is illustrated in Fig 4. A comparative study was conducted between the original soil properties and stabilized soil with lime and fly ash as additives

3. STABILIZATION OF SOIL

Lime is found to be quite effective in stabilizing clayey soil with plasticity index greater than 10. When lime is added to clayey soil, the clay particles tend to agglomerate into large sized particles (flocculation), imparting friability to the mixture.

Due to the aggregation of smaller particles into bigger ones, one of the early effects of adding lime is to make the grains coarser. Lime brings about a substantial reduction in plasticity. The liquid limit generally decreases and the plastic limit increases, thus causing a reduction in the Plasticity Index of the soil.

Fly ash can provide an array of divalent and trivalent cations (Ca^{2+}, Al^{3+}, Fe^{3+}etc) under ionized conditions that can promote flocculation of dispersed clay particles. Thus expansive soils can be potentially stabilized effectively by cation exchange using fly ash.

From fig. 4, the sample having maximum plasticity index was shown. Sample 8 has plasticity index of 34, which is quite high and hence stabilizers were added to the sample so study their effects on plasticity index. Lime was added in 4%, 6% and 8% by weight of soil to understand the decrease in plasticity characteristics of soil with varying percentage of lime. Fig 5 illustrates the variation in Atterberg's limits on addition of lime. Addition of lime resulted in drastic change in plasticity Index which is illustrated in Fig 6.

The percentage of fly ash added to the soil sample was higher than lime. Fly ash was added in 10%, 15% and 20 % by weight of soil to understand the changes in Atterberg's limit, which is illustrated in Fig.7. The variation in plasticity index of soil is understood from Fig 8.

From the above figures, it can be understood that with less dosage of lime more variation in plasticity index can be obtained. When soil was stabilized with fly ash, it requires comparatively high dosage to reduce the plasticity of soil which makes it uneconomical.

4. CONCLUSION

The Atterberg's limits were evaluated at the proposed site for the upcoming prestigious project, to understand the variations in plasticity characteristics of the soil. The soil found in at the site was highly plastic which indicates that it has less bearing capacity to support tall structures. To reduce plasticity index, stabilizers like lime and fly were added. Both lime and fly ash have brought changes in Atterberg's limits but the decrease in Plasticity Index was more with lime as stabilizer when compared with flyash. Hence stabilization with lime is better than fly ash.

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NOTATIONS:

1. WL=LIQUID LIMIT
2. WP=PLASTIC LIMIT
3. IP=PLASTICITY INDEX
4. IL=LIQUIDITY INDEX
5. SL=SHRINKAGE LIMIT

LIST OF FIGURE

Fig 1. Collection of soil sample

Fig.2 Determination of Atterberg's limits

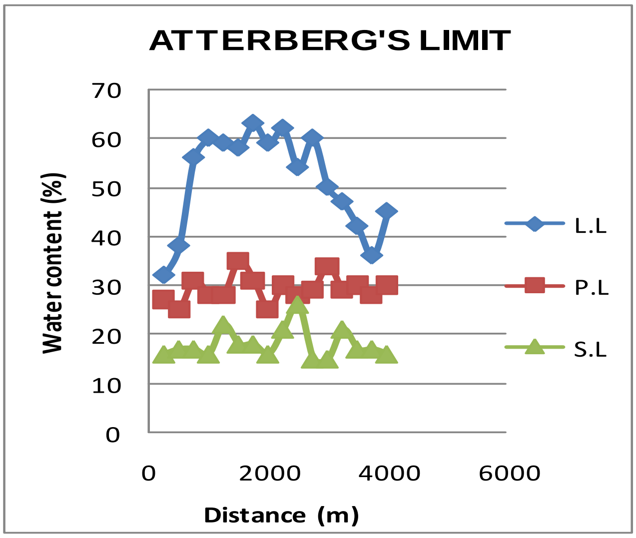

Fig 3.Atterberg's limits of orginal soil sample

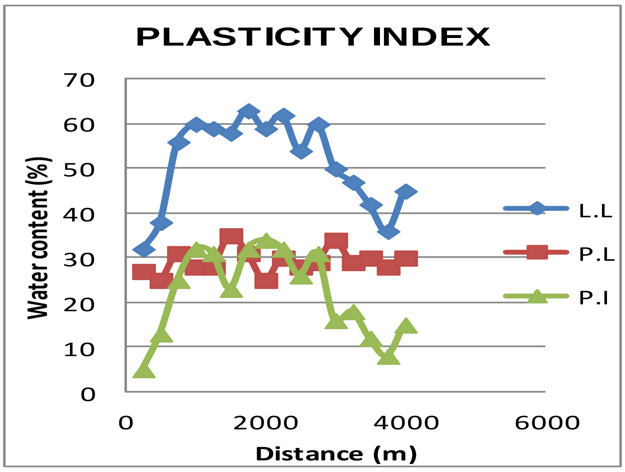

Fig 4. Plasticity index of orginal soil sample

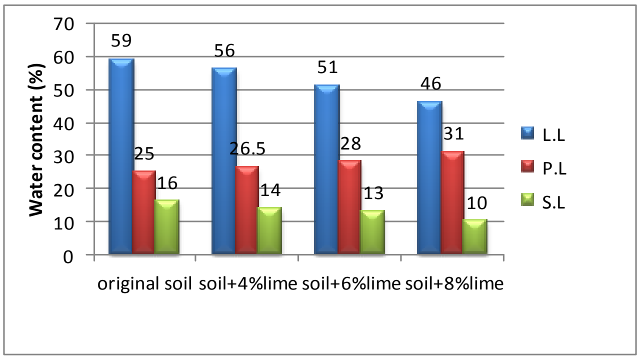

Fig 5. Variation in Atterberg's Limits with increase in dosage of lime

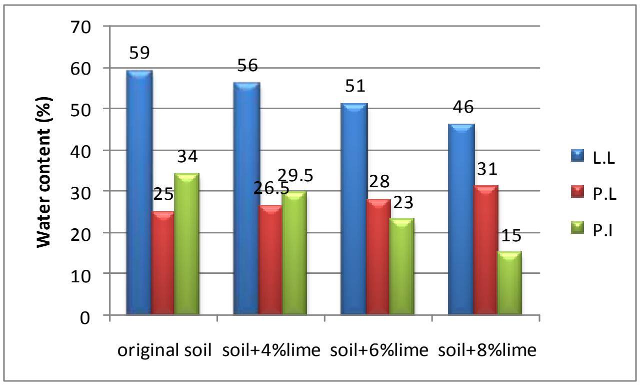

Fig 6. Variation of Plasticity Index with increase in dosage of lime

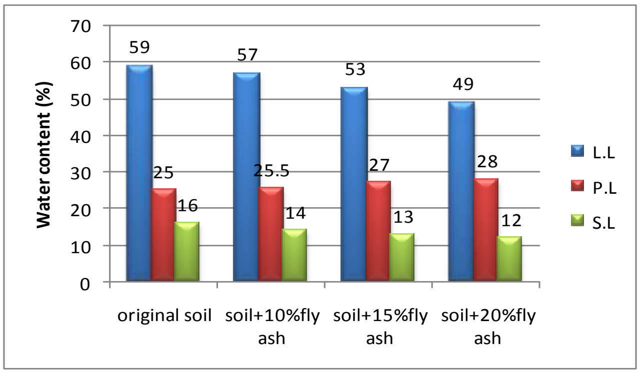

Fig 7. Variation in Atterberg's Limits with increase in dosage of fly ash

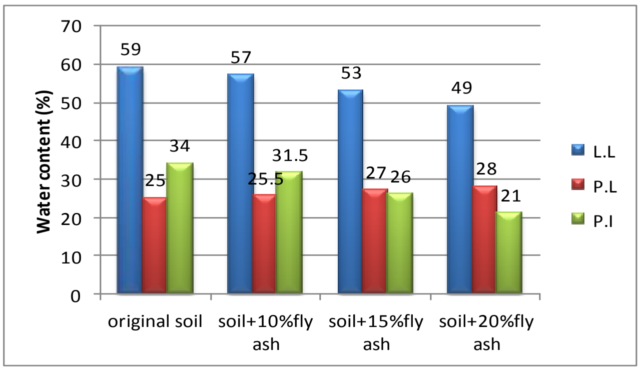

Fig 8. Variation of Plasticity Index with increase in dosage of fly ash

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Table.1 Variations in Atterberg's limits for soil sample

S.NO	DESCRIPTION OF SOIL	W_L	W_P	S_L
1.	SAMPLE 1	32	27	16
2.	SAMPLE 2	38	25	17
3.	SAMPLE 3	56	31	17
4.	SAMPLE 4	60	28	16
5.	SAMPLE 5	59	28	22
6.	SAMPLE 6	58	35	18
7.	SAMPLE 7	63	31	18
8.	SAMPLE 8	59	25	16
9.	SAMPLE 9	62	30	21
10.	SAMPLE 10	54	28	26
11.	SAMPLE 11	60	29	15
12.	SAMPLE 12	50	34	15
13.	SAMPLE 13	47	29	21
14.	SAMPLE 14	42	30	17
15.	SAMPLE 15	36	28	17
16.	SAMPLE 16	45	30	16

Table.2 Variations in Plasticity Index for soil sample

S.NO	DESCRIPTION OF SOIL	W_L	W_P	I_P
1.	SAMPLE 1	32	27	5
2.	SAMPLE 2	38	25	13
3.	SAMPLE 3	56	31	25
4.	SAMPLE 4	60	28	32
5.	SAMPLE 5	59	28	31
6.	SAMPLE 6	58	35	23
7.	SAMPLE 7	63	31	32
8.	SAMPLE 8	59	25	34
9.	SAMPLE 9	62	30	32
10.	SAMPLE 10	54	28	26
11.	SAMPLE 11	60	29	31
12.	SAMPLE 12	50	34	16
13.	SAMPLE 13	47	29	18
14.	SAMPLE 14	42	30	12
15.	SAMPLE 15	36	28	8
16.	SAMPLE 16	45	30	15