Facts and Relevance of Silty Soil

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Abstract - *Behaviour of fine grained soils is much more complex and variable compared to coarse grained soils. Very often fine grained soils exhibit unexpected properties or behaviour. Shrinkage limit is always less than plastic limit. However, the studies on the index properties of soils of various types have showed that this need not be true always. Shrinkage limit is considered to represent the limiting water content between semisolid & solid states of consistency of fine-grained soils, when the water content of the soil is reduced gradually. In some case shrinkage limit is higher than the plastic limit. If the quantity of the clay fraction in the silty soils is very low, such soils have relatively uniform or poor gradation that does not lead to denser packing and hence higher shrinkage limit results. Sample used is silty marine clay to study the percentage of silt at which shrinkage limit becomes more than plastic limit. Also study the effect of varying percentage of silt content on undrained shear strength value. Test results shows that shrinkage limit is higher than plastic limit when the silt content becomes 70% due to the denser packing. Compressive stress and undrained shear strength comes to decreases by the addition of silt content. This is due to the loss of plasticity of the sample by the addition of silt content.*

Key Words: Silt, Plastic limit, Shrinkage limit, Unconfined Compressive Strength

1. INTRODUCTION

Among the three Atterberg limits, probably the shrinkage limit has the least priority in the general field of soil mechanics. Conventionally, being one of the consistency limits, shrinkage limit is considered to represent the limiting water content between semisolid and solid states of consistency of fine grained soils, when the water content of the soil is reduced. At that point, the solid particles are in contact with each other and the water hold within is just sufficient to fill the void spaces in the soil mass. With a further decrease in the water content, practically negligible or no volume reduction of the soil mass takes place. The practical significance of the shrinkage limit shows the lowest void ratio that can be reached due to transpiration or evaporation from vegetation, below which no volume change takes place. Atterberg's studies on plasticity of clays showed that the shrinkage limit is always less than plastic limit. However studies on the index properties of soils of various types have indicated that it need not be true always.

Shrinkage limit is higher than plastic limit. If the quantity of the clay fraction in the silty soils is very low and such soils have relatively uniform or poor gradation that does not lead to denser packing and, hence, higher shrinkage limit results. This logic further indicates that the soil for which the shrinkage limit is more than the plastic limit will still be in the plastic stage when it is at the shrinkage limit water content. The shrinkage limit obtained for such soils does not represent the boundary between semi solid and solid states of consistency.

1.1 Objectives of the Project

The major objective of the study is to investigate whether shrinkage limit has any effect on soil plasticity. To investigate the optimum percentage of silt at which shrinkage limit exceeds plastic limit. The variation of unconfined compressive strength with increase in silt content has determined.

1.2 Scope of the Study

Regions like earth dams, soils undergo large volume changes when going through wet and dry conditions. In such situations shrinkage limit is useful. Present study attains importance with respect to design of backfill materials used for various applications. Also understand the change in undrained shear strength with the addition of silt content.

2. MATERIALS USED

Silty marine clay and silt from quarry dust are the major materials used in this study.

2.1 Silty Marine Clay

The soil used was silty marine clay and it contains 30% of silt. The clay is collected from Kochi. The soil was initially air dried in open atmosphere prior to the testing. Figure 1 shows the soil used in the particular study.

Fig. -1: Silty marine clay used

2.2 Silt

The silt was collected from quarry dust by dry sieving from 75 micron IS sieve. Figure 2 shows the silt used in the particular study and table-1 shows the basic properties of the sample.

Fig. -2: Silt from quarry dust

Table -1: Basic properties of silty sample

Properties of Silty Sample			
Specific gravity	2.67	Grain size distribution (a) Sand (%)	21.79
Liquid limit (%)	31	(b) Silt (%)	29.56
Plastic limit (%)	29.2	(c) Clay (%)	48.65
Shrinkage limit (%)	17.5	OMC (%)	1.6
Plasticity Index	1.79	Dry density (g/cc)	17.18

3. EXPERIMENTAL PROGRAMME

Investigation has been conducted to find the optimum percentage of silt at which shrinkage limit greater than plastic limit by varying the percentage of silt as 30%, 40%, 50%, 60%, 70% and 80%.

Plastic Limit (w_S) is defined as the minimum water content at which the sample will just crumble when rolled into threads of approximately 3mm diameter. Plastic limit is found out by preparing threads of 3mm diameter. Plastic limit analysis was done in accordance with IS: 2720 (Part 5) – 1985.

Shrinkage Limit is found out by preparing shrinkage pat and using mercury. A soil sample of 50gm of soil passing through 425 micron IS sieve is taken and mixed with distilled water to make a creamy paste. The water content (w_1) of the soil is kept greater than the liquid limit. The volume of the dry pat (V_d) is equal to the volume of the mercury displaced. Shrinkage limit analysis was done in accordance with IS: 2720 (Part 6) – 1972.

Unconfined Compression Test- Samples were prepared at dry density and moisture content obtained from standard proctor compaction test. Unconfined compression tests were done on these samples to obtain the unconfined compressive strength. The unconfined compression test was done in accordance with IS: 2720 (Part 10) – 1991.

4. RESULT AND DISCUSSION

4.1 Effect of Silt Content on Shrinkage Limit

By varying the percentage of silt content, the shrinkage limit is determined. The variations are 30%, 40%, 50%, 60%, 70% and 80% of silt content. Chart-1 shows the variation of percentage of silt content with the shrinkage limit of the soil.

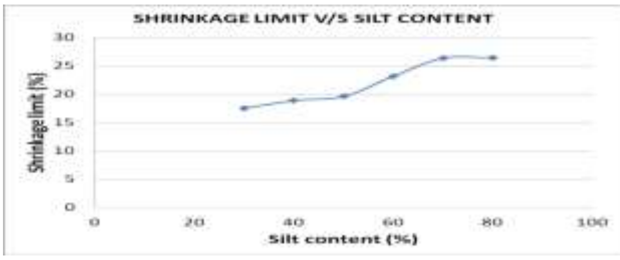

Chart-1: Shrinkage limit v/s silt content

From chart-1, it can be seen that as the percentage of silt content increases the shrinkage limit value also increases. Uniform or poor gradation does not lead to denser packing and hence higher shrinkage limit results by the addition of silt content.

4.2 Effect of Silt Content on Plastic Limit

By varying the percentage of silt content, the plastic limit is determined. The variations are 30%, 40%, 50%, 60%, 70% and 80% of silt content. Chart-2 shows the variation of percentage of silt content with the plastic limit of the soil.

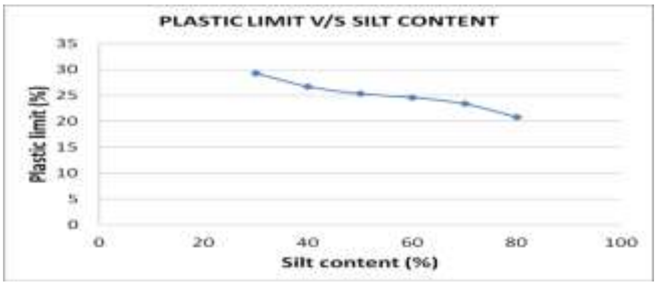

Chart-2: Plastic limit v/s silt content

From chart-2, it can be seen that as the percentage of silt content increases the plastic limit value decreases. This is due to the loss of plasticity of the sample by the addition of silt content.

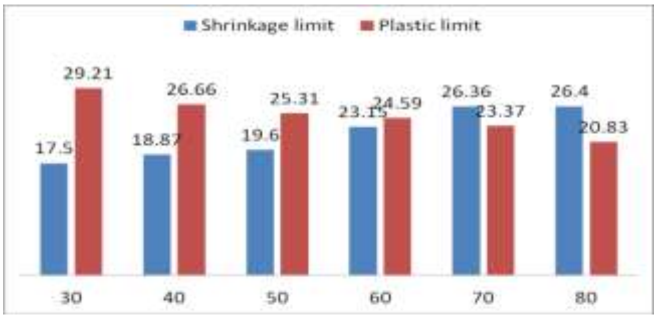

Chart-3: Bar chart between shrinkage limit and plastic limit

From chart-3, it is seen that after 70% of silt content shrinkage limit exceeds plastic limit. The amount of the clay fraction in the silty soils is very low and such soils have relatively uniform or poor gradation that does not lead to denser packing and hence higher shrinkage limit results.

4.3 Effect of Silt Content on Undrained Shear Strength

By varying the percentage of silt content, the undrained shear strength is determined. The variations are 30%, 40%, 50%, 60%, 70% and 80% of silt content. Chart-4 shows the variation of percentage of silt content with the undrained shear strength of the soil.

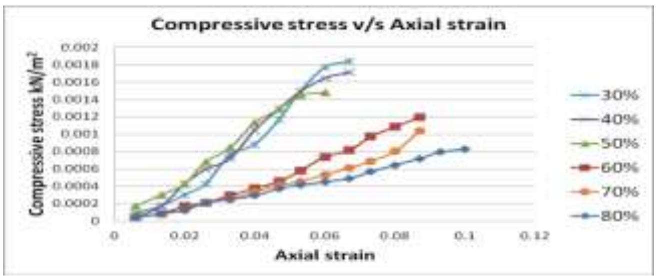

Chart-4: Compressive stress v/s axial strain

From chart-4, it can be seen that as the percentage of silt content increases the compressive stress decreases.This is due to the loss of plasticity of the sample by the addition of silt content.

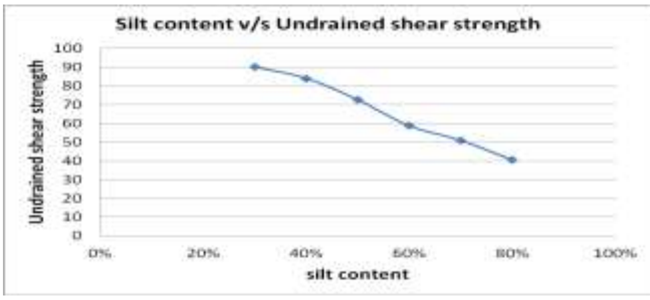

Chart-5: Silt content v/s undrained shear strength

From chart-5, it can be seen that as the percentage of silt content increases the undrained shear strength decreases. This is due to the loss of plasticity of the sample by the addition of silt content.

5. CONCLUSIONS

Shrinkage limit is higher than the plastic limit if the proportion of the clay fraction in the silty soils is very low. Such soils have relatively uniform or poor gradation that does not lead to denser packing and hence higher shrinkage limit results. Shrinkage limit is higher than plastic limit when the silt content becomes 70%. Shrinkage limit of sample is higher than plastic limit hence proving that shrinkage limit is not always a plasticity function. Plasticity of the sample decreases by the addition of silt content, hence compressive stress and undrained shear strength decrease.

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