

An Experimental Study of Properties of Black Cotton Soil

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Abstract- The rapid growth of population, fast urbanization and more construction of various structures have resulted in reduction of good quality availability of land. There is no choice rather than to use weak soils around for construction activities. Such soil possesses poor shear strength and high shear and shrinkage. Black cotton soil is one of the major issues in India. Expansive soil is worldwide problematic soil that causes extensive damage to civil engineering structures. When exposed to variation in moisture content they undergo high swelling and shrinking making it more complicated for engineering point of view. Due to shrinking and swelling of soil crack appears on the ground that often leads to differential movement of structure resulting in severe damage to the foundations, buildings, roads, etc.

Keywords- (BCS) Black Cotton Soil, Shrinkage, Swelling, Specific gravity, Liquid and Plastic limit.

I. INTRODUCTION

From past decades there is always an effort to improve the properties of black cotton soil as it becomes challenging for the engineers everywhere in the world due to its high compressibility, swelling, and shrinkage and low shear strength.

Black cotton soil is found in extensive region of Deccan trap in India. It is also called as Regur soils are generally clayey, deep and impermeable. It is major soil deposit in India. When black cotton soil comes in contact with water it either swells or shrinks resulting in differential settlement of the structure. Due to high volumetric changes it is not suitable for construction. The unusual characteristics of the soil make it difficult to construct structures. In this soil there are volume changes, with change in moisture due to the presence of clay mineral i.e. Montmorillonite mineral. This mineral has three sheeted structure with expanding lattices.

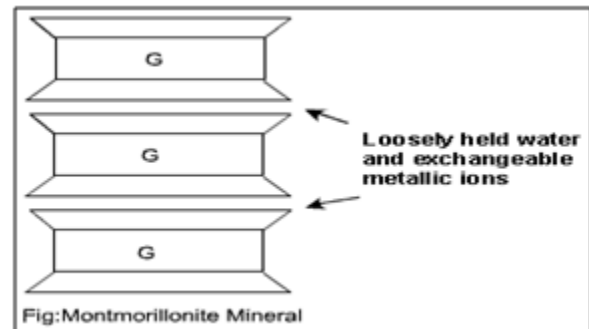


Fig.1 Montmorillonite mineral

II. METHODOLOGY

To study the properties of black cotton soil. The two samples of black cotton soil were collected from two different regions. Various laboratory tests were performed to determine the properties of soil like specific gravity, plastic limit, liquid limit, particle size distribution as per Indian Standard Codes mentioned below in the table.

Test Performed	IS Code
Grain size analysis	IS:2720(Part-4)-1985
Specific Gravity	IS:2720(Part-3)-1980
Atterberg's limit	IS:2720(Part-5)-1985
Classification and Identifications of soils for General Engineering purpose	IS:1498-1970

SPECIFIC GRAVITY:

The Pycnometer is used for determination of specific gravity of soil particles of both fine grained and coarse grained soils. The determination of specific gravity of soil will help in the calculation of void ratio, degree of saturation and other different soil properties.

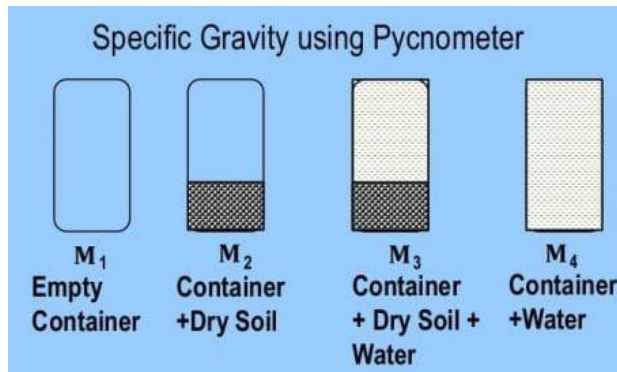


Fig.2 Specific Gravity using Pycnometer

LIQUID LIMIT:

The liquid limit of a soil is the water content at which the soil behaves practically like a liquid, but has small shear strength. It flows to close the groove in just 25 blows in Casagrande’s liquid limit device.

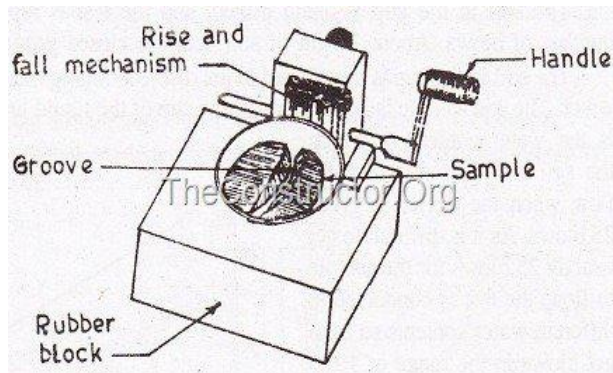


Fig.3 Casagrande’s Apparatus

Plastic limit:

It is the minimum water content at which soil just begin to crumble rolled into a thread approximately 3mm in diameter



Fig.4 Set for Plastic Limit Test

GRAIN SIZE ANALYSIS:

The soil is sieved through a set of sieves. The material retained on different sieves is determined. The percentage of material retained on any sieve is given by

$$P_n = \frac{M_n}{M} \times 100$$

Where M_n = mass of soil retained on sieve ‘n’ M= total mass of the sample.

III. RESULT

Specific Gravity:

It is the ratio of weight of given volume of solids to the weight of an equivalent volume of water. The test was carried out as per IS:2720(PART-3)-1980. Below the table shows the values of specific gravity of soil sample 1 & 2 respectively. As per IS:1498-1970 the recommended value for specific gravity for black cotton soil is 2.65-2.7. The observed value of specific gravity of soil sample 1 & 2 is 2.65 & 2.69 respectively, and hence the values of samples are within permissible limit.

Soil Sample number	1	2
Weight of bottle [W ₁]in gms	615	615
Weight of bottle +Dry soil [W ₂]in gms	916.5	912.6
Weight of bottle +Soil + Water [W ₃]	1712.23	1711.4
Weight of bottle + Water [W ₄]	1524.5	1524.4
Specific gravity	2.65	2.69

Liquid Limit:

It is that minimum water content at which soil has tendency to flow.

The liquid limit test was carried out as per IS: 1270(Part-5)-1985. The observed values are 43.5 & 42.98 for soil samples 1 & 2 respectively. As per IS: 1498-1970 the recommended value for black cotton soil of liquid limit is 35-50 and hence the values of samples are within permissible limit.

Soil sample-1

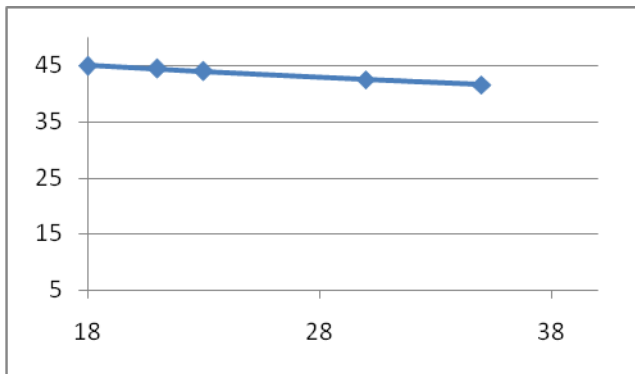


Figure 5: Liquid Limit of soil sample
The Liquid Limit obtained from graph=43.5

Soil sample-2

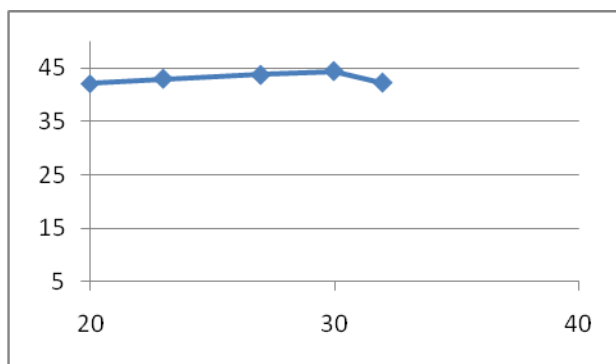


Figure 6: Liquid limit of soil sample-2
Liquid Limit obtained from graph=42.98

Plastic limit:

It is the minimum water content at which soil just begin to crumble rolled into a thread approximately 3mm in diameter.

The plastic limit test was carried out as per IS: 1270(Part-5)-1985. The observed values are 21.45 & 19.23 for soil samples 1 & 2 respectively. As per IS: 1498-1970 recommended value for plastic limit is less than 40.

Soil Sample no.	1	2
Plastic Limit	21.45	19.23

Grain size analysis:

The test is performed to determine the percentage of different grain sizes contained within the soil.

Sample	1	2
Sieve size	4.75	4.75
Retained (g)	64.15	63.97
Retained (%)	7.39	7.52
Cumulative Retained (%)	32.49	32.15
Cumulative finer (%)	60.39	67.85

IV. CONCLUSION

By observing the results of various tests on the soil, the following conclusions were made:

1. Specific gravity of the soil samples is 2.65 & 2.69 respectively.
2. Liquid limit of soil samples is 43.5 & 42.98.
3. Plastic limit is 21.45 & 19.23 of samples 1 & 2 respectively.
4. From the above results it can be concluded that the soil samples collected are Black Cotton Soil.

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