International Journal of Trend in Scientific Research and Development (IJTSRD)
International Open Access Journal
ISSN No: 2456 - 6470 | www.ijtsrd.com | Volume - 2 | Issue – 3

An Experimental Study on Shear Strength of Soil Sub Grade using Cement as Stabilizing Agent

Farkhanda Fayaz
Student, Al-Falah University,
Faridabad,Haryana, India

Mohd Shoeb Alam
Professor, Al-Falah University,
Faridabad, Haryana, India

ABSTRACT

Soil stabilization is the process of altering some soil properties by different methods, mechanical or chemical in order to produce an improved soil material which has all the desired engineering properties. Soils are generally stabilized to increase their strength and durability or to prevent erosion and dust formation in soils. The main aim is the creation of a soil material or system that will hold under the design use conditions and for the designed life of the engineering project. The properties of soil vary a great deal at different places or in certain cases even at one place; the success of soil stabilization depends on soil testing. Various methods are employed to stabilize soil and the method should be verified in the lab with the soil material before applying it on the field.The prime objective of soil stabilization is to improve the California Bearing Ratio of in-situ soils by 4 to 6 times. The other prime objective of soil stabilization is to improve on-site materials to create a solid and strong sub-base and base courses. In certain regions of the world, typically developing countries and now more frequently in developed countries, soil stabilization stabilization is to improve on-site materials to create a solid and strong sub-base and base courses. In certain regions of the world, typically developing countries and now more frequently in developed countries, soil stabilization is being used to construct the entire road.

In the past, soil stabilization was done by utilizing the binding properties of clay soils, cement-based products such as soil cement utilizing the "rammed earth" technique (compaction) and lime. Traditionally and widely accepted types of soil stabilization techniques use products such as bitumen emulsions which can be used as a binding agents for producing a road base. However, bitumen is not environmentally friendly and becomes brittle when it dries out. Portland cement has been used as an alternative to soil stabilization. However, this can often be expensive and is not a very good "green" alternative.

The prime objective of Soil Stabilization is to improve the California Bearing Ratio of in-situ soils by 4 to 6 times. The other prime objective of soil stabilization is to improve on-site materials to create a solid and strong sub-base and base courses. In certain regions of the world, typically developing countries and now more frequently in developed countries, soil stabilization is being used to construct the entire road. Originally, soil stabilization was done by utilizing the binding properties of clay soils, cement-based products such as soil cement, and/or utilizing the "rammed earth" technique (soil compaction) and lime. Some of the renewable technologies are: enzymes, surfactants, biopolymers, synthetic polymers, co-polymer based products, cross-linking styrene acrylic polymers, tree resins, ionic stabilizers, fiber reinforcement, calcium chloride, calcite, sodium chloride, magnesium chloride and more. Some of these new stabilizing techniques create hydrophobic surfaces and mass that prevent road failure from water penetration or heavy frosts by inhibiting the ingress of water into the treated layer.

Scope of Study

The scope is to improving the engineering properties of soils used for pavement base courses, sub base courses, and sub grades by the use of additives which are mixed into the soil to effect the desired improvement. These criteria are also applicable to roads and airfields having a stabilized surface layer. As we know Soil-cement highly-compacted mixture of soil, Portland cement, and water. As the cement reacts, or hydrates, the mixture gains strength and improves the engineering properties of the raw soil. Its improved strength and durability, combined with its low first cost and ease of construction, make soil-cement an outstanding value for use as a base and sub base material. Its improved strength and durability, combined with its low first cost and ease of construction, make soil-cement an outstanding value for use as a base and sub base material. The soil material in soil-cement can be almost any combination of sand, silt, clay, shell, gravel, or crushed stone. Soil-cement is often more economical to construct than granular bases through the use of soil material on or near the commercial paving site.

EXPERIMENTAL INVESTIGATIONS

Scope of work

The experimental work comprises in the following parts:

1. Determination of Water content by Oven-Dry Method.
2. To Determination the Specific gravity of soil by pycnometer method.
3. Determination of soil properties (Atterberg's limits)

(i) Liquid limit by Casagrande's apparatus

1. Determination of Water content by Oven-Dry Method

Water content is defined as the ratio of the weight of water to the weight of solids in a given volume of soil. This ratio is usually expressed as percentage. And also soil moisture content may be expressed by weight as the ratio of the mass of water present in the soil to the dry weight of the soil sample, or by volume as ratio of volume of water to the total volume of the soil sample. To determine any of these ratios for a particular soil sample, the water mass must be determined by drying the soil to constant weight and measuring the soil sample mass after and before drying. The water content of soil is used throughout geotechnical engineering practice, both in the laboratory and in the field. Results are sometimes needed within a short time period and in locations where it is not practical to install an oven or to transport samples to an oven. This test method is used for these occasions. The results of this test have been used for field control of compacted embankments or other earth structures such as in the determination of water content for control of sod moisture and dry density within a specified range. The most accurate approach is that of oven-drying the soil sample and is adopted in the laboratory. This test is done to determine the moisture content in the soil by oven-drying method as per IS 2720 (part ii) 1973. The soil specimen should be representative of the soil mass. The quantity of the specimen taken would depend upon the gradation and the maximum size or the particles. For more than 90% of the particles passing through 425 microns IS sieve, the minimum quantity is 25g.

(ii) Observation and calculation:

Weight of dry soil = W3 –W1

Weight of wet soil =W2 – W1

Therefore, Water content (w) $=\frac{W2-W1}{W3-W1}$x 100

Table 3.1 -Observation table of moisture content:

S No.	Observation and calculation	1	2	3
1	Weight of empty container (W1) in grams	12	12	12
2	Weight of container + wet soil sample (W2) in grams	66	56	50
3	Weight of container + dry soil sample (W3) in grams	56	52	48
4	Weight of solids Ws= W3 - W1	44	40	36
5	Weight of water Ww=W2 – W3	10	4	2
6	Water content= $\frac{Ww}{Ws}$ x 100	22.73 %	10 %	5.55 %

Average water content =12.76%

2. Determination of Specific gravity by pycnometer method.

The specific gravity of a material is defined as the ratio of the mass of a unit volume of a material to the mass density of gas-free distilled water at a stated temperature.

Specific gravity of soil solids is written as **Gs=** $\frac{\rho s}{\rho w}$.

Where, ps = mass density or mass per unit volume of the soil solid.
ρw = mass per unit volume of water.

A material with a specific gravity greater than water is denser than water so it will not float in water. In soil mechanics, the specific gravity of soil solids is an important parameter and is a factor in many equations involving weight-volume relationships. Remember that the specific gravity of soil solids refers only to the solid phase of the three phase soil system, it does not include the water and air phases present in the void space. Unlike density, specific weight is not absolute. It depends upon the value of the gravitational acceleration, which varies with location. A significant influence upon the value of specific gravity is the temperature of the material. Pressure may also affect values, depending upon the bulk modulus of the material, but generally at moderate pressures, has a less significant effect than the other factors. For clayey and silty soils, the values of specific gravity range from 2.6 - 2.9.

(ii) Observations and calculations:

WI = weight of empty pycnometer.
W2 = weight of pycnometer + soil.
W3 =weight of pycnometer +soil+ water.
W4=weight of pycnometer +water.

:. Specific Gravity, G= $= \frac{(W2-W1)}{(W2-W1)-(W3-W4)}$

Specific gravity calculations:

(a) Sample 1 (soil), weight of sample=200gram

Test	grams
Mass of pycnometer, W1 (g)	658
Mass of pycnometer + dry soil, W2 (g)	858
Mass of pycnometer + soil + water, W3 (g)	1494
Mass of pycnometer + water, W4 (g)	1364
Specific gravity of soil, $G_s = \frac{(W_2 - W_1)}{(W_2 - W_1) - (W_3 - W_4)}$	2.85

Specific gravity calculation:

(b) Sample 2 (soil with cement)

Total Sample (200 gram) that is 180-gram soil +20 gram 0f cement (10% of cement)

Test	Grams
Mass of pycnometer, W1 (g)	658
Mass of pycnometer + dry soil + cement, W2 (g)	858
Mass of pycnometer + soil +cement+ water, W3 (g)	1466
Mass of pycnometer + water, W4 (g)	1348
Specific gravity of soil, $G_s = \frac{(W_2 - W_1)}{(W_2 - W_1) - (W_3 - W_4)}$	2.44

3. Determination of soil properties (Atterberg's Limits)

LIQUID LIMIT TEST

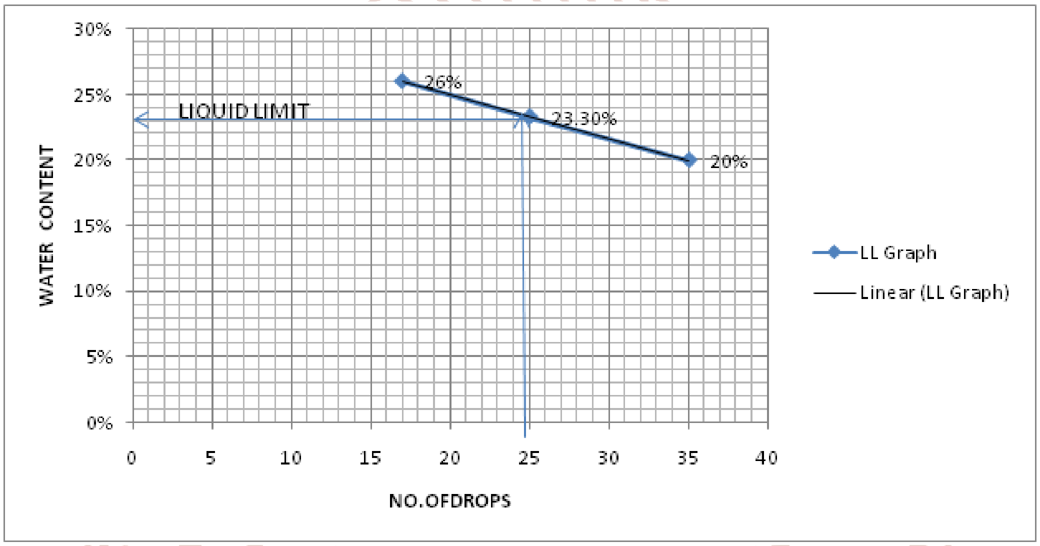
The Swedish soil scientist Albert Atterberg (1911) originally defined limit of consistency to classify fine-grained soil. This limit is based on water content of soil. If the water content of suspension soil is gradually reduced, the soil water mixture undergoes changes from a liquid state through a plastic state and finally into solid state. Transitions of soil from one state to another state according to increase and decrease in water content are termed as Atterberg Limits. So this test is also called Atterberg limit tests. Casagrande subsequently standardized the apparatus and the procedures to make the measurement more repeatable.

The liquid limit is the water content at which soil changes from liquid state to plastic state. At this stage all soil behaves practically like a liquid and posses certain small shear strength.

The flow close the groove in just 25 blows in Casagrande liquid limit device. As it is difficult to get exactly 25 blows in the test 3 to 4 tests are conducted, and the number of blows (N) required in each test determined. A semi-log plot is drawn between log N and the water content (W). The liquid limit is at water content corresponding to N=25.This test is done to determine the liquid limit of soil as per IS: 2720 (Part 5) — 1985.

Readings and Observation:
liquid limit of sample 1
(a)Liquid Limit sample 1 (soil)

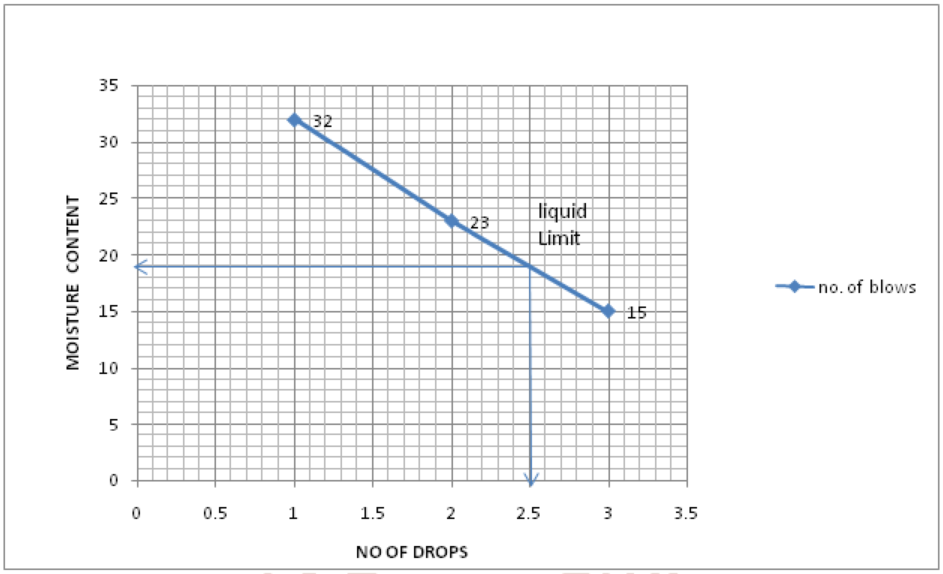
Sample Number	1	2	3
Container Number	A	B	C
Weight Of Container (W1) grams	10g	10g	10g
Weight Of Container + Wet Soil (W2) grams	34 g	42 g	30 g
Weight Of Container + Dry Soil(W3) grams	30 g	36g	26g
Weight Of Water (Ww)= (W2 – W1) grams	24g	32g	20g
Weight Of Dry Soil (Ws) =W3 – W1 grams	20 g	26g	16g
Moisture Content(w)	20%	23. 3%	26%
No of Blows	35	25	17



Liquid Limit graph of sample 1(soil)

Liquid Limit sample 2 by adding 5% of Cement.
In this we add 5% of cement the total 120g sample (i.e. 108 g soil and 6 g cement):

Sample Number	1	2	3
Container Number	A	B	C
Weight Of Container (W1) grams	10	10	10
Weight Of Container + Wet Soil (W2) grams	35 g	42 g	33 g
Weight Of Container + Dry Soil(W3) grams	32 g	37 g	28 g
Weight Of Water (Ww)=W2 –W1 grams	25 g	32g	23 g
Weight Of Dry Soil (Ws)=W3 –W1 grams	22 g	27 g	18 g
Moisture Content (%)	14 %	18%	28%
No of Blows	32	23	15

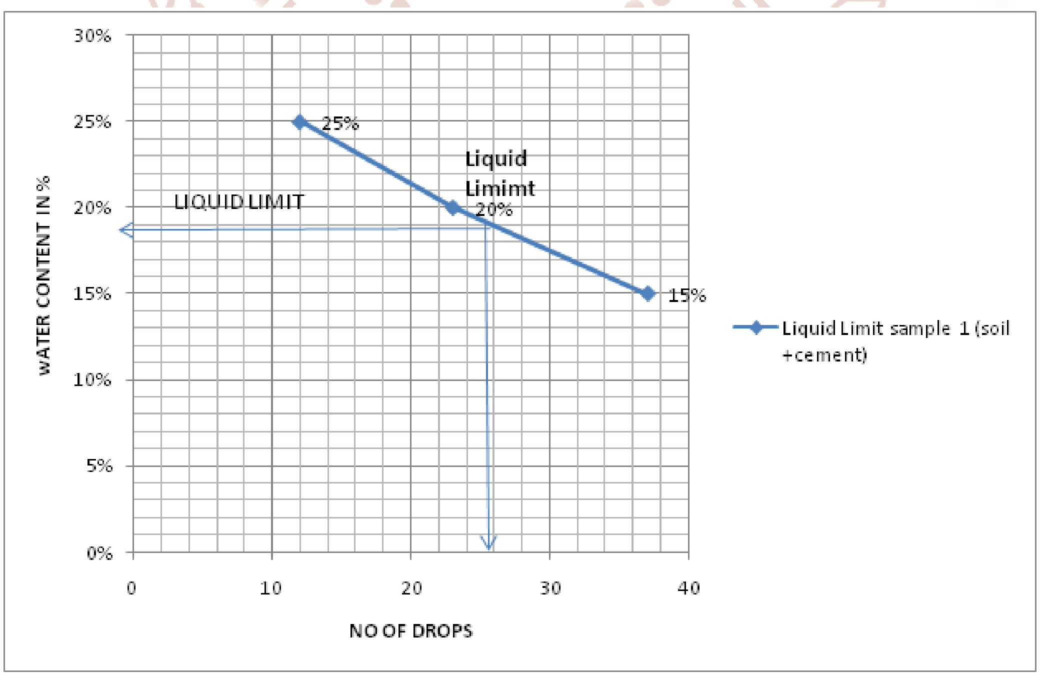


Liquid Limit graph of sample 2 By adding 5 % of cement.

Liquid Limit sample 3 by adding 10% of Cement to total volume.

In this we add 10% of cement the total 120g sample (i.e. 108 g soil and 12 g cement):

Sample Number	1	2	3
Container Number	A	B	C
Weight Of Container (W1) grams	10	10	10
Weight Of Container + Wet Soil (W2) grams	33 g	28 g	25 g
Weight Of Container + Dry Soil(W3) grams	30 g	25 g	22 g
Weight Of Water (Ww)=W2 –W1 grams	23 g	18 g	15 g
Weight Of Dry Soil (Ws)=W3 –W1 grams	20 g	15 g	12 g
Moisture Content (%)	15 %	20%	25%
No of Blows	37	23	12

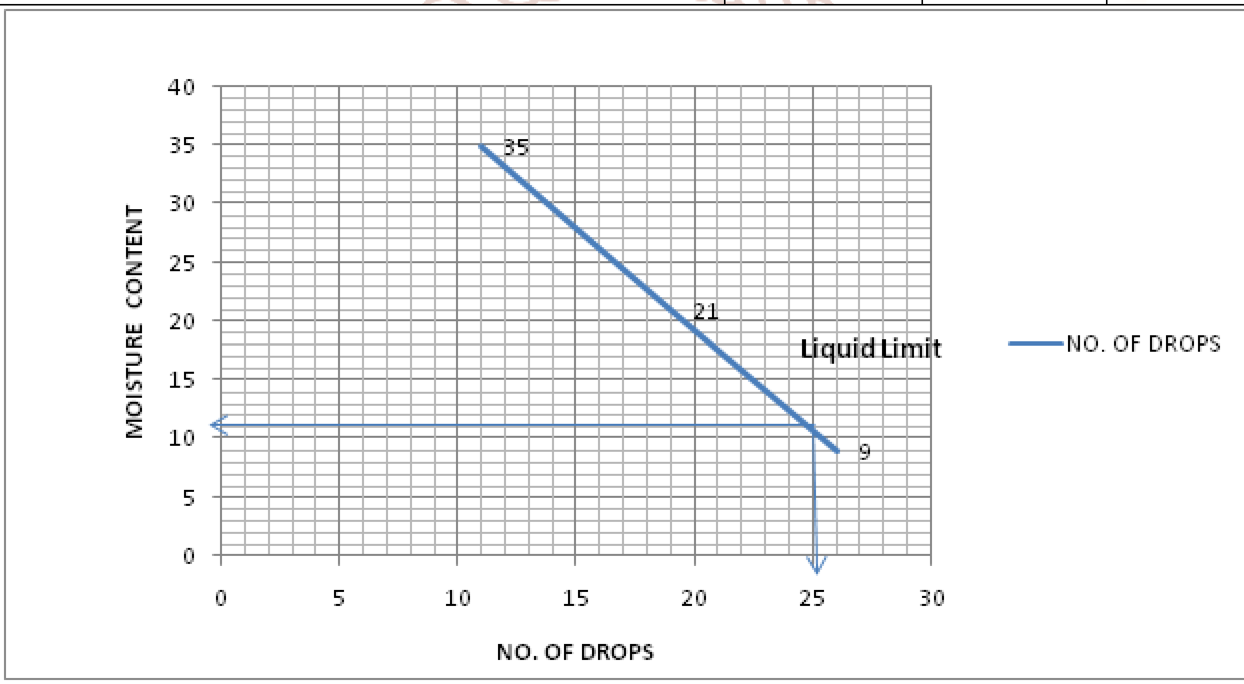


Liquid Limit graph of sample 3 By adding 10 % of cement.

Liquid Limit sample 4 by adding 15 % of Cement.

In this we add 15% of cement the total 120g sample (i.e. 108 g soil and 18 g cement):

Sample Number	1	2	3
Container Number	A	B	C
Weight Of Container (W1) grams	10	10	10
Weight Of Container + Wet Soil (W2) grams	30 g	29 g	31 g
Weight Of Container + Dry Soil(W3) grams	28 g	26 g	27 g
Weight Of Water (Ww)=W2 –W1 grams	20 g	19 g	21 g
Weight Of Dry Soil (Ws)=W3 –W1 grams	18 g	16 g	17 g
Moisture Content (%)	11 %	19%	26%
No of Blows	35	21	13



Liquid Limit graph of sample 4 By adding 15 % of cement.

CONCLUSION

On the basis of present experimental study, the following conclusions are drawn:

1. Based on the water content by oven-dry method, we found out that sample-1 has the highest 22.73% and the sample 3 has lowest 5.55% water content among all the three samples respectively. The moisture content of a soil has a direct effect on its strength and stability. Therefore, sample 3 with the lowest water content will be more stiff and stable and possesses higher strength comparing to the other samples.
2. Based on the liquid limit test by casagrand's apparatus, we found that the soil sample-1 has highest liquid limit as 23% than other three samples. By adding 5%, 10 and 15% of cement to the soil its water content decreases because drying rate increased with increasing in cement content, therefore decrease in water content increases its strength. (Fig 3.4) shows the decrement in Liquid limit at varying cement content.