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EXPERIMENT NO: 01

DETERMINE THE MOISTURE CONTANT OF SOIL BY OVEN DRY METHOD.

OBJECTIVE:

The objective of this experiment is to determine the quantity of water or moisture content in soil sample by the use of oven dry method

TESTING DETAILS:

1. In first step, clean and dry the containers and weigh them and note down the mass of each container (M1). Also note down the number of each container along with its weight.
2. Collect the soil sample from field. Remove the top layer of soil and collect the wet soil from bottom layers.
3. Fill the containers with required quantity of soil sample and weigh the each container and note down its mass (M2).
4. Place the containers in hot air oven, arrange temperature to 110o ± 5o C and allow them to dry for 24 hours.
5. After 24 hours turn off the oven and take out the containers using tongs.
6. Cool down the containers in desiccator for one hour.
7. After that weigh containers and note down the mass (m3) of each container.

ANALYSIS OF TEST RESULTS:

Mass of container, M_c = 112.3 grams

Mass of container and wet soil, M_{cws} = 305 grams

Mass of container and dry soil, M_{cs} = 296.6 grams

Mass of water, $M_w = M_{cws} - M_{cs}$

$= 305 - 296.6$

$=8.4$ grams

Mass of solid particles, M_s = MCS - MC

$= 296.6 – 112.3$

$= 184.3$ grams

Water content, $W = M_W/M_S \times 100$

$= 8.4/184.3 \times 100$

$= 4.55$ %

CONCLUSION:

From this experiment it is concluded that the determination of soil water content is to show gravimetric measurement of soil water content is based on removal of water from the sample. ... In each of

these methods the water and soil are separated and the amount of water removed is measured.

EXPERIMENT NO: 02

SPECIFIC GRAVITY OF SOIL BY PYCNOMETER

OBJECTIVE:

The objective of this experiment is to determine the specific gravity of soil by pycnometer.

TESTING DETAILS:

1. Wash, clean and dry the pycnometer and note down its mass (M1) along with brass cap and washer using weighing balance with an accuracy of 1.0 g.
2. Now place a sample of wet soil about 200 to 400 g in pycnometer and note down its mass (M2).
3. Then add water to the soil in the pycnometer to make it about half full.
4. Stir the soil using glass rod to remove air voids of the soil sample. If available connect the vacuum pump to the soil specimen to remove entrapped air.
5. Add some more water and after eliminating the entrapped air stop stirring and fix the brass cap. More water is added through hole in brass cap until the water is flush with the hole.
6. Now take the mass of pycnometer (M3).
7. Now empty and wash the pycnometer. Then fill it with only water and take its mass (M4).

ANALYSIS OF TEST DETAILS:

SOIL SAMPLE: 100 grams

EMPTY PYCNOMETER, W_1	450.9 g
PYCNOMETER AND SOIL, W_2	550.9 g
PYCNOMETER+WATER+SAND,W_3	1661.1 g
PYCNOMETER+WATER, W_4	1601.4 g

$$G_S = [W_2 - W_1] / [W_4 - W_1] - [W_3 - W_2]$$

$G_S =$ [550.9 – 450.9] / [1601.4 – 450.9] – [1661.1 – 550.9]

$G_S =$ 2.5

CONCLUSION:

From this experiment it is concluded that the specific gravity of soil particles will come within the range of 2.65 and 2.85. If the soils consist of porous and organic materials, a specific gravity value of less than 2 will be obtained. A specific gravity value greater than 3 will be shown by soils that have heavy substances.

EXPERIMENT NO: 03

GRAIN SIEVE ANALYSIS OF SOIL BY SIEVE

OBJECTIVE:

The objective of this experiment is to determine the particles size or particles distribution of the soil sample by different sieves.

The mechanical or sieve analysis is performed to determine the distribution of the coarser, larger-sized particles, and the hydrometer method is used to determine the distribution of the finer particles.

TESTING DETAILS:

1. Write down the weight of each sieve as well as the bottom pan to be used in the analysis.
2. Record the weight of the given dry soil sample.
3. Make sure that all the sieves are clean, and assemble them in the ascending order of sieve numbers (#4 sieves at top and #200 sieves at bottom). Place the pan below #200 sieves. Carefully pour the soil sample into the top sieve and place the cap over it.
4. Place the sieve stack in the mechanical shaker and shake for 10 minutes.
5. Remove the stack from the shaker and carefully weigh and record the weight of each sieve with its retained soil. In addition, remember to weigh and record the weight of the bottom pan with its retained fine soil.

ANALYSIS OF TEST RESULTS:

MASS OF SOIL SAMPLE: 1000 GRAMS

SIEVE NO	MASS RETAINED (G)	MASS RETIANED %	COMMULATIVE RETAINED %	PERCENTAGE PASSING
#4	179.8	17.98	17.98	82.02
#8	148.2	14.82	32.8	67.2
#16	120.9	12.09	44.89	55.11
#30	126.3	12.63	57.52	42.48
#50	94.3	9.43	66.95	33.05
#100	94.8	9.48	76.43	23.57
#200	176.9	17.69	94.12	5.88
Pan	54.1	5.41	99.53	0.47

CONCLUSION:

From this experiment it is concluded that by sieving soil particles we can observe different size of soil retained on different sieves which is known as gradation of soil.

EXPERIMENT NO: 04

DETERMINE THE LIQUID LIMIT OF SOIL

OBJECTIVE:

This test is done to determine the liquid limit of soil. The liquid limit of fine-grained soil is the water content at which soil behaves practically like a liquid, but has small shear strength.

TESTING DETAILS:

1. Place a portion of the paste in the cup of the liquid limit device.
2. Level the mix so as to have a maximum depth of 1cm.
3. Draw the grooving tool through the sample along the symmetrical axis of the cup, holding the tool perpendicular to the cup.
4. For normal fine grained soil: The Casagrande's tool is used to cut a groove 2mm wide at the bottom, 11mm wide at the top and 8mm deep.
5. For sandy soil: The ASTM tool is used to cut a groove 2mm wide at the bottom, 13.6mm wide at the top and 10mm deep.
6. After the soil pat has been cut by a proper grooving tool, the handle is rotated at the rate of about 2 revolutions per second and the no. of blows counted, till the two parts of the soil sample come into contact for about 10mm length.
7. Take about 10g of soil near the closed groove and determine its water content

8. The soil of the cup is transferred to the dish containing the soil paste and mixed thoroughly after adding a little more water. Repeat the test. Obtain at least 3 readings in the range of 15 to 35 blows.

ANALYSIS OF TEST RESULTS:

DETERMINATION NO	1	2	3
NO OF BLOWS	38	28	26
CONTAINER NO	T1	T2	T3
WEIGHT OF CONTAINER	112.3 g	11.7 g	65.9 g
WEIGHT OF CONTAINER AND WET SOIL	166.8 g	94.4 g	150.9 g
WEIGHT OF CONTAINER AND DRY SOIL	159.2 g	81.2 g	136.9 g
MASS OF WATER	7.6 g	13.2 g	14 g
MASS OF SOLID PARTICLES	46.2 g	69.5 g	71 g
MOISTURE CONTANT	16.2 %	18.99 %	19.71 %

CONCLUSION:

From this experiment it is concluded that the test is performed by increasing the water content. Soil with low water content would yield more blows and soil with high water content would yield less blows.

EXPERIMENT NO: 05

DETERMINE THE PLASTIC LIMIT OF SOIL

OBJECTIVE:

The objective of this experiment is to determine the plastic limit whereas plastic limit is define as The plastic limit of a soil is the moisture content at which soil begins to behave as a plastic material. At this water content (plastic limit), the soil will crumble when rolled into threads of 3.2mm (1/8in) in diameter.

TESTING DETAILS:

1. From the 20g sample select a 1.5 to 2 g specimen for testing.
2. Roll the test specimen between the palm and fingers on the ground glass plate to from a thread of uniform diameter.
3. Continue rolling the thread until it reaches a uniform diameter of 3.2mm or 1/8 in.
4. When the thread becomes a diameter of 1/8 in. reform it into a ball.
5. Knead the soil for a few minutes to reduce its water content slightly.
6. Repeat steps 2 to 5 until the thread crumbles when it reaches a uniform diameter of 1/8 in.
7. When the soil reaches the point where it will crumble, and when the thread is a uniform diameter of 1/8", it is at its plastic limit. Determine the water content of the soil.

ANALYSIS OF TEST DETAILS:

WEIGHT OF CONTAINER	11.3 g
WEIGHT OF CONTAINER AND WET SOIL	12.4 g
WEIGHT OF CONTAINER AND DRY SOIL	12.1 g
MASS OF WATER	0.3 g
MASS OF SOLID PARTICLES	0.8 g
MOISTURE CONTANT	37.5 %

CONCLUSION:

From this experiment it is concluded that the water content for this soil sample is 37.5% in order to achieved the plastic index, If the water sample does not break when it gain the size of rod it means that the water content is more and vice versa.

EXPERIMENT NO: 06

DETERMINE THE SHRINKAGE LIMIT OF SOIL

OBJECTIVE:

The objective of this experiment is to determine the shrinkage limit of soil.

TESTING DETAILS:

1. Take a soil sample passing through sieve#40 and add some amount of water in it to form a thick uniform paste.
2. Take the shrinkage dish, weigh it, and put some of the soil mixture in it by spatula, fill it and again weigh it.
3. Place the shrinkage dish in the oven for 24hours at 110-115C.
4. Find the volume of the shrinkage dish using mercury this will be equal to the volume of the saturated soil sample.
5. Take mercury in container and weigh it, put dry soil in it the mercury is displaced.
6. Collect carefully the displace mercury and weigh it with great accuracy.
7. The volume of dry soil is then determined by dividing the weight by the unit weight of mercury.

ANALYSIS OF TEST RESULTS:

Density of mercury = 13.6 mg/m^3

Weight of shrinkage dish	19.5 g
Weight of container + wet sample	55.2 g
Weight of wet sample	35.7 g
Weight of container + mercury	266.9 g
Weight of displace mercury	219 g
Weight of dry sample	28.8 g
Moisture content	24.82 %
Volume of wet sample	18.19
Volume of dry sample	16.10 g/m^3
Shrinkage limit	0.1757

Shrinkage limit

$(WS) = [W - (V-Vo) \times \int_w / W_o] \times 100$

=0.1757

EXPERIMENT NO: 07

DETERMINE THE LIQUID LIMIT BY DIGITAL CONE-PENETROMETER

OBJECTIVE:

The objective of this experiment is to determine the liquid limit by using digital cone-penetrometer. The liquid limit of fine-grained soil is the water content at which soil behaves practically like a liquid, but has small shear strength.

TESTING DETAILS:

1. About 150 gm. of air dried soil from thoroughly mixed portion of material passing 425 micron IS sieve is obtained.
2. Distilled water is mixed to the soil thus obtained in a mixing disc to form a uniform paste.
3. Then the wet soil paste is transferred to the cylindrical cup of cone penetrometer apparatus, ensuring that no air is trapped in this process.
4. Finally the wet soil is levelled up to the top of the cup and placed on the base of the cone penetrometer apparatus.
5. The penetrometer is so adjusted that the cone point just touches the surface of the soil paste in the cup and the initial ready is to be taken.
6. The vertical clamp is then released allowing the cone to penetrate into soil paste under its own weight for 5 seconds. After 5 seconds the penetration of the cone is noted to the nearest millimetre.

7. The test is repeated at least to have four sets of values of penetration in the range of 14 to 28 mm.
8. The exact moisture content of each trial is determined

ANALYSIS OS TEST RESULTS:

DETERMINATION NO	1	2	3
NO OF BLOWS	38	28	26
CONTAINER NO	T1	T2	T3
WEIGHT OF CONTAINER	112.3 g	11.7 g	65.9 g
WEIGHT OF CONTAINER AND WET SOIL	166.8 g	94.4 g	150.9 g
WEIGHT OF CONTAINER AND DRY SOIL	159.2 g	81.2 g	136.9 g
MASS OF WATER	7.6 g	13.2 g	14 g
MASS OF SOLID PARTICLES	46.2 g	69.5 g	71 g
MOISTURE CONTANT	16.2 %	18.99 %	19.71 %

CONCLUSION:

From this experiment it is concluded that the sample with high water content will penetrate more as compare to sample with low water content and this test is easy to perform and is less time consuming as compare to liquid limit by casagrande apparatus

EXPERIMENT NO: 08

FREE SWELL INDEX

OBJECTIVE:

The objective of this experiment is to determine the free swell index of soil. Free swell or differential free swell is the increase in volume of soil without any external constraint when subjected to submergence in water.

TESTING DETAILS:

1. Take two specimens of 20g each of pulverised soil passing through 425µm IS Sieve and oven-dry.
2. Pour each soil specimen into a graduated glass cylinder of 100ml capacity.
3. Pour distilled water in one and kerosene oil in the other cylinder up to 100ml mark.
4. Remove entrapped air by gently shaking or stirring with a glass rod.
5. Allow the suspension to attain the state of equilibrium (for not less than 24hours).
6. Final volume of soil in each of the cylinder should be read out.

ANALYSIS OF TEST RESULTS:

Free swell index = $[V_d - V_k] / V_k \times 100\%$

V_d = volume of soil specimen read from the graduated cylinder containing distilled water.

V_k = volume of soil specimen read from the graduated cylinder containing kerosene.

$V_d = 22$

$V_k = 21$

Free swell index = [22-21] / 21 x 100%

= 4.76%

Free Swell Index	Degree of expansiveness	LL	PL	SL
<20	Low	0.50	0-35%	>17%
20-35	Moderate	40-60%	25-50%	8-18%
35-50	High	50-75%	35-65%	6-12%
>50	Very high	>60%	>45%	<10%

CONCLUSION:

From this experiment it is concluded that the degree of expansiveness is low as the results obtained is lower than 20 so the liquid limit, plastic limit and shrinkage limit for this type of soil is 0.50, 0-35%, greater than 17 % respectively.

Quiz

Write a note different software which are used in Geotechnical Engineering

Ans The famous softwares used in the field of Geotechnical Engineering are mentioned below.

GEOS :-

It can be used for Excavation design, Shallow foundation and deep foundation design, Stability analysis, Settlement analysis and for various other field tests.

GEO STUDIO :-

The GeoStudio Suite includes eight products which can be used for analysing Slope stability, ground water seepage, Stress deformations and various other geotechnical problems.

PLAXIS :-

It is used for 2-Dimensional and 3-Dimensional geotechnical analysis of deformation and stability of soil structures, as well as ground water and heat flow, in geo-engineering applications such as excavation foundations, embankments and tunnels.

FLAC3D :-

It is used in advanced geotechnical analysis of soil, rock, and structural support in three dimensions. FLAC3D is used in analysis, testing, and design by geotechnical, civil and mining engineers.

Some other simple softwares are:

SEEP2D, STABL, SVFLUX, SVslope, UTEXAS. These are simple programmes and are not much versatile as compared to the above mentioned softwares.