Ex. No: 1
Date:

DETERMINATION OF SPECIFIC GRAVITY OF SOIL

(IS : 2720 (Part 3/Sec 1) – 1980)

AIM

To determine the specific gravity of soil solids using pycnometer.

THEORY AND APPLICATION

Specific gravity of soil solids is the ratio of weight, in air of a given volume; of dry soil solids to the weight of equal volume of water at 4ºC.Specific gravity of soil grains gives the property of the formation of soil mass and is independent of particle size. Specific gravity of soil grains is used in calculating void ratio, porosity and degree of saturation, by knowing moisture content and density. The value of specific gravity helps in identifying and classifying the soil type.

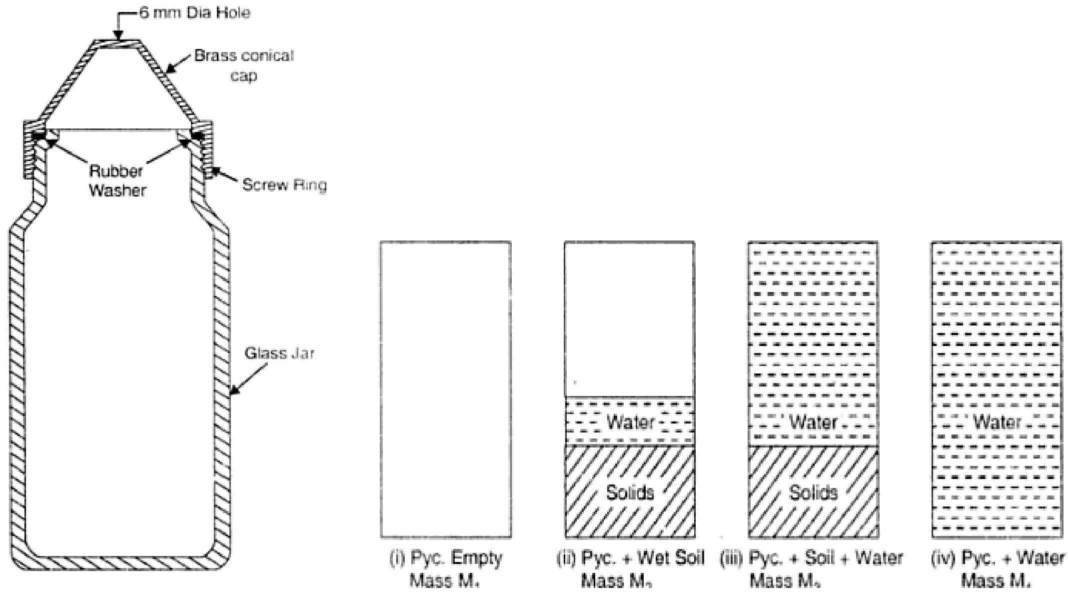
APPARATUS

1. Pycnometer
2. 450 mm sieve
3. Weighing balance
4. Oven
5. Glass rod
6. Distilled water

PROCEDURE

1. Dry the pycnometer and weigh it with its cap. (W_1)
2. Take about 200gm of oven dried soil passing through 4.75mm sieve into the pycnometer and weigh again (W_2).
3. Add sufficient de-aired water to cover the soil and screw on the cap.
4. Shake the pycnometer well and remove entrapped air if any.
5. After the air has been removed, fill the pycnometer with water completely.
6. Thoroughly dry the pycnometer from outside and weigh it (W_3).
7. Clean the pycnometer by washing thoroughly.

8. Fill the cleaned pycnometer completely with water up to its top with cap screw on.
9. Weigh the pycnometer after drying it on the outside thoroughly (W_4).
10. Repeat the procedure for three samples and obtain the average value of specific gravity.



OBSERVATIONS AND CALCULATIONS

Determine the specific gravity of soil grains (G) using the following equation

$$G = \frac{(W_2 - W_1)}{(W2 - W_1) - (W_3 - W_4)}$$

Where

W_1 = Empty weight of pycnometer.

W_2 = Weight of pycnometer + oven dry soil

W_3 = Weight of pycnometer + oven dry soil+ water

W_4 = Weight of pycnometer + water

OBSERVATION FOR SPECIFIC GRAVITY DETERMINATION

Sample Number	W_1 in gms	W_2 in gms	W_3 in gms	W_4 in gms	Specific Gravity G
1					
2					
3					

RESULT

Average specific gravity of soil solids G =

Ex. No: 2
Date:

DETERMINATION OF MOISTURE CONTENT OF SOIL BY OVEN DRYING METHOD

(IS : 2720 (Part 2) – 1973)

AIM

To determine the natural moisture content of the given soil sample.

THEORY AND APPLICATION

The natural water content also called the natural moisture content is the ratio of the weight of water to the weight of the solids in a given mass of soil. This ratio is usually expressed as percentage. In almost all soil tests natural moisture content of the soil is to be determined. The knowledge of the natural moisture content is essential in all studies of soil mechanics. To sight a few, natural moisture content is used in determining the bearing capacity and settlement. The natural moisture content will give an idea of the state of soil in the field.

APPARATUS

1. Non-corrodible air-tight container.
2. Electric oven, maintain the temperature between 1050 C to 1100 C.
3. Desicator.
4. Balance of sufficient sensitivity.

PROCEDURE

1) Clean the container with lid, dry it and weigh it (W1).
2) Take a specimen of the sample in the container and weigh with lid (W2).
3) Keep the container in the oven with lid removed. Dry the specimen to constant weight maintaining the temperature between 105^0 C to 110^0 C for a period of 16 to 24 hours.
4) Record the final constant weight (W3) of the container with dried soil sample. Peat and other organic soils are to be dried at lower temperature (say 60^0) possibly for a longer period.

OBSERVATIONS AND CALCULATIONS

Sl No.	Sample No.	1	2	3
1	Weight of container with lid W_1 gm			
2	Weight of container with lid +wet soil W_2 gm			
3	Weight of container with lid +dry soil W_3 gm			
4	Water/Moisture content $w = [(W_2-W_3)/(W_3-W_1)]x100$			

RESULT

Average natural moisture content of soil w =

Ex. No:3
Date:

DETERMINATION OF GRAIN SIZE DISTRIBUTION BY SIEVE ANALYSIS

(IS : 2720 (Part 4) – 1985)

AIM

To determine the percentages of particle sizes present in the given soil sample.

THEORY AND APPLICATION

Grain size analysis is used in the engineering classification of soils. Particularly coarse grained soils. Part of suitability criteria of soils for road, airfield, levee, dam and other embankment construction is based on the grain size analysis. Information obtained from the grain size analysis can be used to predict soil water movement. Soils are broadly classified as coarse grained soils and fine grained soils. Further classification of coarse grained soils depends mainly on grain size distribution and the fine grained soils are further classified based on their plasticity properties. The grain size distribution of coarse grained soil is studied by conducting sieve analysis.

APPARATUS

1. A set of Sieves 4.75 mm, 2.36 mm ,1.18 mm ,0.60mm, 0.30 mm 0.15 mm 0.075mm including lid and pan
2. Tray
3. Weighing Balance
4. Oven
5. Sieve Shaker
6. Brush
7.

PROCEDURE

1. Weigh 500gms of oven dry soil sample, of which grain size distribution has to be studied.
2. Take the soil sample into 75µ sieve.
3. Wash the soil sample keeping it in the sieve. Washing of soil sample means: place the soil in the sieve and gently pour water over the soil so that it wets the soil and remove

the fine particles in the form of mud, leaving only the sand and gravel size particles in the sieve.

4. Transfer the soil retained in the sieve after washing into a tray. Invert the sieve into the tray and pour water gently so that all the soil particles retained in the sieve are transferred it to the tray.
5. Keep the tray in the oven for 24 hours at 105ºc to dry it completely.
6. Weigh the oven dry soil in the tray (W)
7. Clean the sieve set so that no soil particles were struck in them.
8. Arrange the sieves in order such that coarse sieve is kept at the top and the fine sieve is at the bottom. Place the closed pan below the finest sieve.
9. Take the oven dried soil obtained after washing into the top sieve and keep the lid to close the top sieve.
10. Position the sieve set in the sieve shaker and sieve the sample for a period of 10 minutes.
11. Separate the sieves and weigh carefully the amount of soil retained on each sieve, This is usually done by transferring the soil retained on each sieve on a separate sieve of paper and weighing the soil with the paper.
12. Enter the observations in the Table and calculate the cumulative percentage of soil retained on each sieve.
13. Draw the grain size distribution curve between grain size on log scale on the abscissa and the percentage finer on the ordinate.

OBSERVATIOS & CALCULATIONS

Weight of the soil taken for testing (W) =

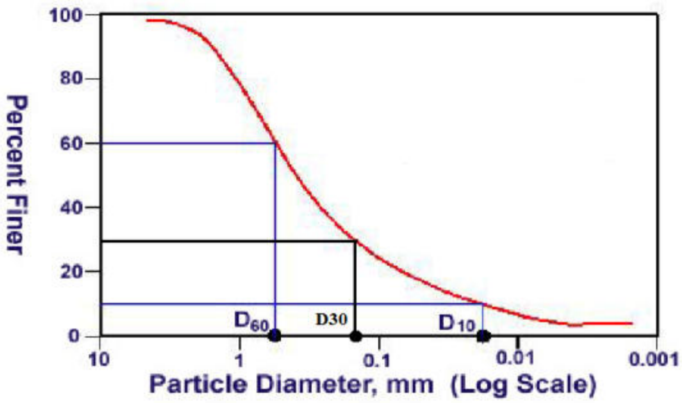
Sl.No	Aperture size of sieve in mm	Weight of soil Retained 'W1' (gm)	% Weight Retained (W1/W)x100	Cumulative Percentage Retained 'X'	Percentage Finer %finer=100-X
1	4.75mm				
2	2.36mm				
3	1.18mm				

4	0.600mm				
5	0.300mm				
6	0.212mm				
7	0.150mm				
8	0.075mm				

Plot the graph between percentage finer on y-axis and logarithmic grain size (mm) on x-axis. From the graph, obtain the percentage of coarse, medium and fine sands.

Uniformity coefficient $C_u = D_{60} / D_{10}$

Coefficient of Curvature $C_c = (D_{30})^2 / D_{60} \times D_{10}$



RESULT:

Percentage of gravel (>4.75mm) =

Percentage of coarse sand (4.75mm – 2.00 mm) =

Percentage of medium sand (2.00mm – 0.425 mm) =

Percentage of fine sand (0.425mm – 0.0.075 mm) =

Percentage of fines (<0.075 mm) =

Uniformity Coefficient C_u =

Coefficient of Curvature C_c =

Ex. No: 4
Date:

DETERMINATION OF FIELD DENSITY (UNIT WEIGHT) OF SOIL BY CORE CUTTER METHOD
(IS : 2720 (Part XXIX) – 1975)

AIM

To determine the fields density of soil by core cutter method.

THEORY AND APPLICATIONS

Unit weight is designed as the weight per unit volume. Here the weight and volume of soil comprise the whole soil mass. The voids in the soil may be filled with both water and air or only air or only water consequently the soil may be wet, dry or saturated. In soils the weight of air is considered negligible and therefore the saturated unit weight is maximum, dry unit weight is minimum and wet unit weight is in between the two. If soils are below water table, submerged unit weight is also estimated.

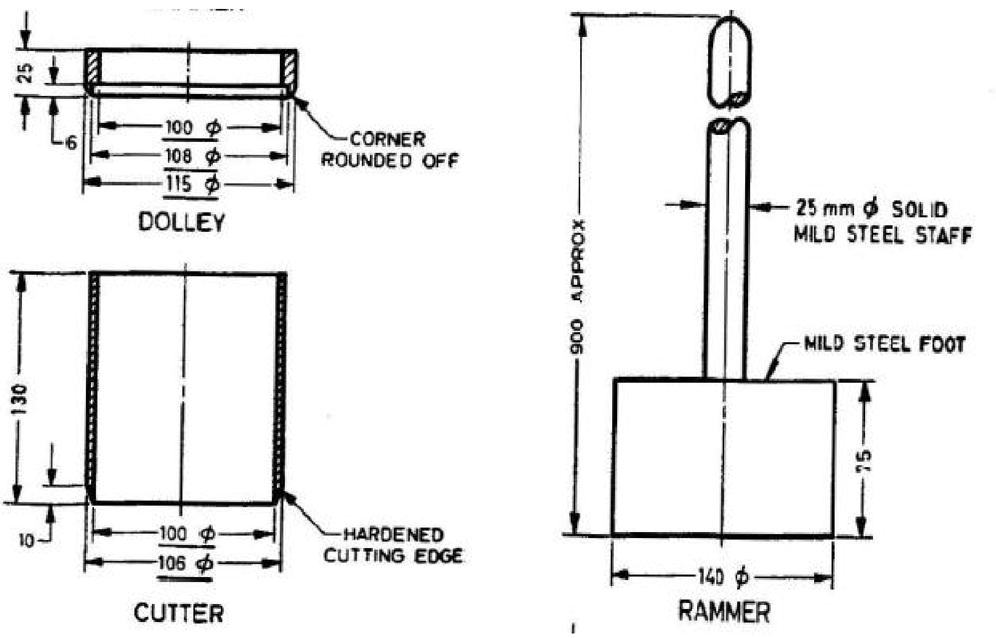
Unit weight of soil reflects the strength of soil against compression and shear. Unit weight of soil is used in calculating the stresses in the soil due to its overburden pressure. It is useful in estimating the bearing capacity and settlement of foundations. Earth pressure behind the retaining walls and in cuts is checked with the help of unit weight of the associated soils. It is the unit weight of the soil which controls the field compaction and it helps in the design of embankment slopes. Permeability of soil depends on its unit weight .It may be noted here that , in the field the unit weight refers to dry unit weight only because the wet unit weight of soil at location varies from season to season and based on the fluctuations of the local water table level and surface water.

APPARATUS

1. Cylindrical core cutter
2. Steel rammer
3. Steel dolly
4. Balance
5. Moisture content cups

PROCEDURE

1. Measure the height (h) and internal diameter (d) of the core cutter and apply grease to the inside of the core cutter.
2. Weigh the empty core cutter (W1).
3. Clean and level the place where density is to be determined.
4. Drive the core cutter, with a steel dolly on its top in to the soil to its full depth with the help of a steel rammer.
5. Excavate the soil around the cutter with a crow bar and gently lift the cutter without disturbing the soil in it.
6. Trim the top and bottom surfaces of the sample and clean the outside surface of the cutter.
7. Weigh the core cutter with soil (W2).
8. Remove the soil from the core cutter, using a sample ejector and take a representative soil sample from it and determine the moisture content (w).



OBSERVATIONS AND CALCULATIONS

Internal diameter of the core cutter (d)=

Height of the core cutter (h)=

Volume of the core cutter (V)=

Specific gravity of solids (G)=

Wet unit weight of the soil sample γ_b=W/V=

Dry unit weight of the soil sample $\gamma_d=\gamma_b/(1+w)$=

RESULT

1. **Dry unit weight of the soil** γ_d=
2. **Wet unit weight of the soil** γ_b=

Ex. No:

Date:

DETERMINATION OF FIELD DENSITY (UNIT WEIGHT) OF SOIL BY SAND REPLACEMENT METHOD

(IS : 2720 (Part XXVIII) -1974)

AIM

To determine the field density of soil at a given location by sand replacement method.

APPARATUS

1. Sand pouring Cylinder
2. Calibrating can
3. Metal tray with a central hole
4. Dry sand (Passing through 600 micron sieve)
5. Balance
6. Metal tray
7. Scraper tool
8. Glass plate

THEORY AND APPLICATIONS

In core cutter method the unit weight of soil obtained from direct measurement of weight and volume of soil obtained from field. Particularly for sandy soils the core cutter method is not possible. In such situations the sand replacement method is employed to determine the unit weight. In sand replacement method a small cylindrical pit is excavated and the weight of the soil excavated from the pit is measured. Sand, whose density is known, is filled into the pit. By measuring the weight of sand required to fill the pit and knowing the density of soil , volume of the pit is calculated .Knowing the weight of soil excavated from the pit and the volume of pit the density of soil is calculated. Therefore in this experiment there are two stages (1) Calibration of sand density and (2) Measurement of soil density.

PROCEDURE

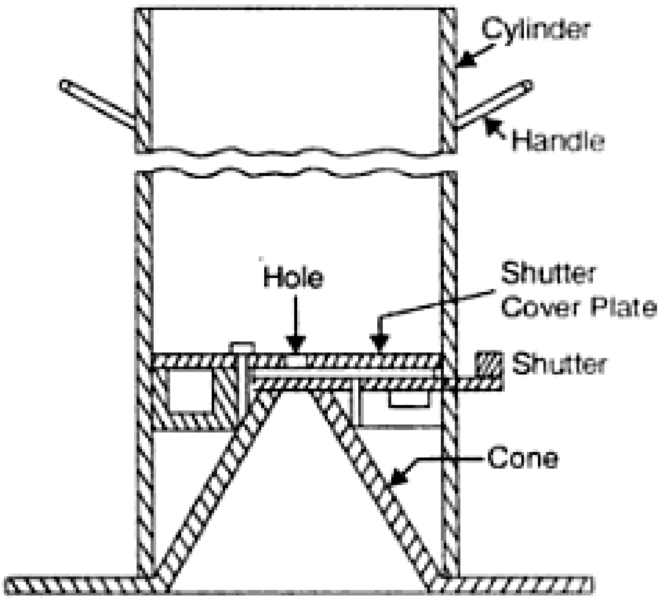
Determination of density of sand.

1. Measure the internal dimensions diameter (d) and height (h) of the calibrating can and compute its internal volume V.

2. Fill the sand pouring cylinder (SPC) with sand with 1 cm top clearance to avoid any spillover during operation and find its weight (W1)
3. Place the SPC on a glass plate, open the slit above the cone by operating the valve and allow the sand to run down. The sand will freely run down till it fills the conical portion. When there is no further downward movement of sand in the SPC, close the slit.
4. Find the weight of the SPC along with the sand remaining after filling the cone (W2)
5. Place the SPC concentrically on top of the calibrating can. Open the slit to allow the sand to rundown until the sand flow stops by itself. This operation will fill the calibrating can and the conical portion of the SOC. Now close the slit and find the weight of the SPC with the remaining sand(W3).

Determination of Density of Soil

1. Clean and level the ground surface where the field density is to be determined.
2. Place the tray with a central hole over the portion of the soil to be tested.
3. Excavate a pit into the ground, through the hole in the plate , approximately 12cm deep (Close the height of the calibrating can) The hole in the tray will guide the diameter of the pit to be made in the ground.
4. Collect the excavated soil into the tray and weigh the soil (W)
5. Determine the moisture content of the excavated soil.
6. Place the SPC, with sand having the latest weight of W3, over the pit so that the base of the cylinder covers the pit concentrically.
7. Open the slit of the SPC and allow the sand to run into the pit freely, till there is no downward movement of sand level in the SPC and then close the slit.
8. Find the weight of the SPC with the remaining sand W4.



OBSERVATIONS AND CALCULATIONS

UNIT WEIGHT OF SAND

Sl.No	Description	Trial No 1	Trial No 2	Trial No 3
1	Volume of the calibrating container, V			
2	Weight of SPC + sand W1			
3	Weight of SPC + sand W2 After filling conical portion on a flat surface			
4	Weight of SPC + sand W3 After filling calibrating can			
5	Weight of sand required to fill cone Wc = W1-W2			
6	Weight of sand required to fill cone and can Wcc= W2-W3			
7	Weight of sand in calibrating can Wcc – Wc			
8	Unit weight of sand Wcc – Wc / V			

UNIT WEIGHT OF SOIL

Sl.No	Description	Trial No 1	Trial No 2	Trial No 3
1	Weight of SPC after filling the hole and Conical portion W4			
2	Weight of sand in the hole and cone W3 – W4			
3	Weight of sand in the pit Wp = (W3 – W4) – Wc			
4	Volume of sand required to fill the pit Vp = Wp /			
5	Weight of the soil excavated from the pit (W)			
6	Wet unit weight of the soil			
7	Dry unit weight of the soil			

RESULT

1. **Dry unit weight of the soil**
2. **Wet unit weight of the soil**

Ex. No:

Date:

DETERMINATION OF CONSISTENCY LIMITS

AIM

To determine liquid limit, plastic limit and shrinkage limit of the given soil sample and to find the flow index, toughness index, shrinkage ration and volumetric shrinkage of the soil.

THEORY AND APPLICATION

Liquid limit is the water content expressed in percentage at which the soil passes from zero strength to an infinitesimal strength, hence the true value of liquid limit cannot be determined. For determination purpose liquid limit is that water content at which a part of soil, cut by a groove of standard dimensions, will flow together for a distance of 12.5mm under an impact of 5 blows in a standard liquid limit apparatus with a height of fall of 1cm. The moisture content expressed in percentage at which the soil has the smallest plasticity is called the plastic limit. Just after plastic limit the soil displays the properties of a semi solid For determination purposes the plastic limit it is defined as the water content at which a soil just begins to crumble when rolled into a thread of 3mm in diameter.

The values of liquid limit and plastic limit are directly used for classifying the fine grained soils. Once the soil is classified it helps in understanding the behaviour of soils and selecting the suitable method of design construction and maintenance of the structures made-up or and resting on soils.

LIQUID LIMIT BY CASAGRANDE'S METHOD

(IS : 2720 (Part 5) – 1985)

APPARATUS

1. Casagrande Liquid limit device
2. Grooving tool
8. Moisture content bins
9. Drying oven

3. Glass plate
4. 425 micron sieve
5. Spatula
6. Mixing bowl
7. Wash bottle

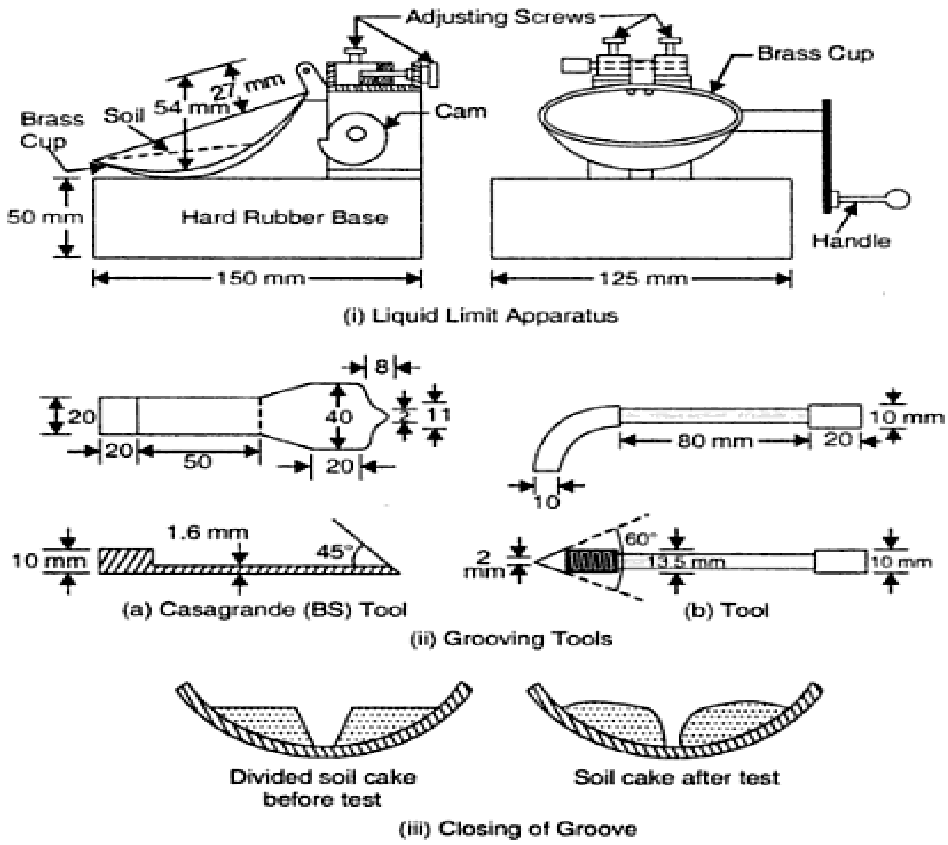
10. Sensitive balance

PROCEDURE

1. Adjust the cup of liquid limit apparatus with the help of grooving tool gauge and the adjustment plate to give a drop of exactly 1cm on the point of contact on the base.
2. Take about 120gm of an air dried soil sample passing 425µ sieve.
3. Mix the soil thoroughly with some distilled water to form a uniform paste.
4. Place a portion of the paste in the cup of the liquid limit device; smooth the surface with spatula to a maximum depth of 1 cm. Draw the grooving tool through the sample along the symmetrical axis of the cup, holding the tool perpendicular to the cup.
5. Turn the handle at a rate of 2 revolutions per second and count the blows until the two parts of the soil sample come in contact with each other, at the bottom of the groove ,along a distance of 10mm.
6. Transfer about 15 gm of the soil sample forming the wedge of the groove that flowed together to a water content bin, and determine the water content by oven drying.
7. Transfer the remaining soil in the cup to the main soil sample in the bowl and mix thoroughly after adding a small amount of water.
8. Repeat steps 4 – 7 .Obtain at least five sets of readings in the range of 10 – 40 blows.
9. Record the observations in the Table.

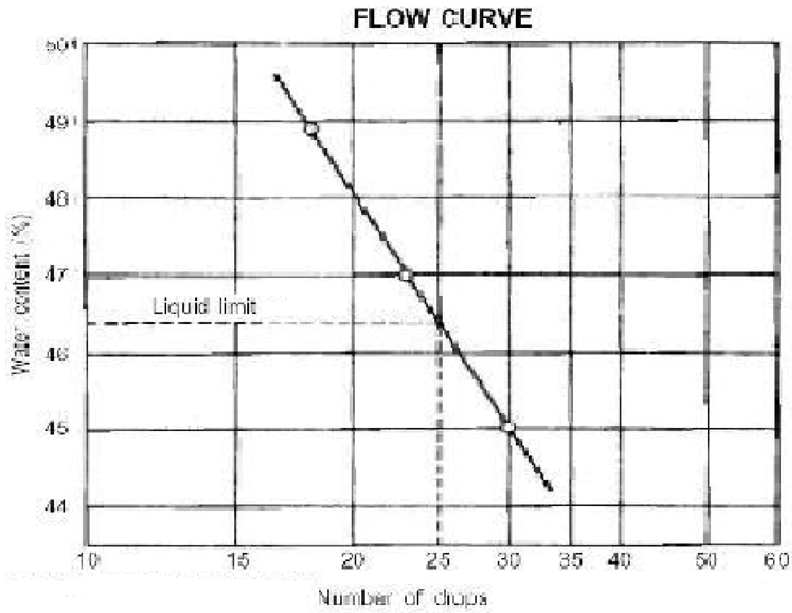
OBSERVATION AND CALCULATIONS

Sl.No	Description	1	2	3	4	5
1	No. of blows					
2	Container number					
3	Weight of container + wet soil					
4	Weight of container +dry soil					
5	Weight of water (3) – (4)					
6	Weight of container					
7	Weigh t of dry soil (4) – (6)					
8	Moisture content (w) (5) / (7)					
9	Moisture content in percentage					



1. Use the table for recording number of blows and calculating the moisture content.

   Use semi-log graph paper. Take number of blows on log scale (X –Axis) and water content on nominal scale (Y – axis). Plot all the points.



2. Read the water content at 25 blows which is the value of liquid limit (w_L).

LIQUID LIMIT BY CONE PENETRATION METHOD
(IS : 2720 (Part 5) – 1985)

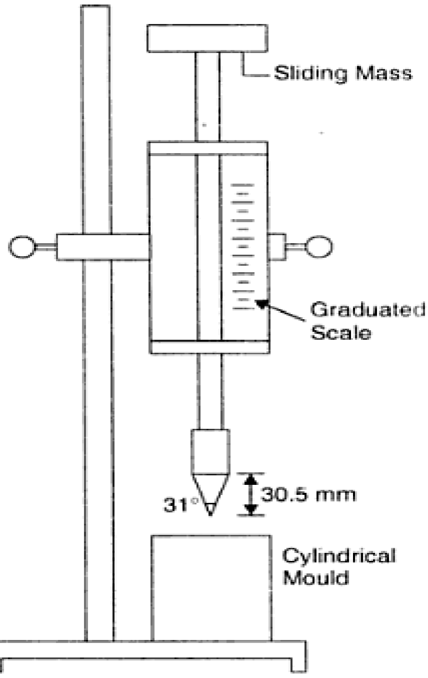
APPARATUS

1. Oven
2. Balance (0.01g accuracy)
3. IS Sieve [425 micron]
4. Cone penetrometer

PROCEDURE

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 leveled 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 millimeter.
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



OBSERVATION AND CALCULATIONS

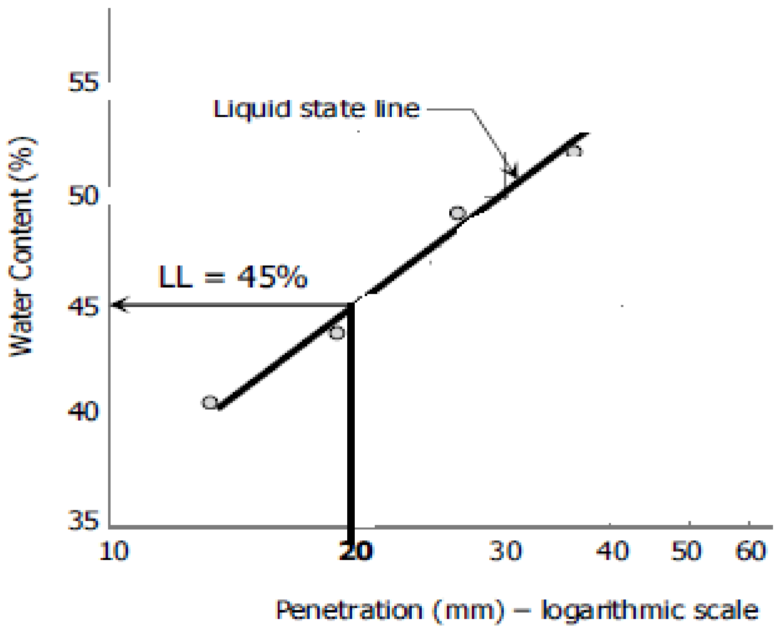
Sl.No	Description	1	2	3	4	5
1	Depth of penetration					
2	Container number					

3	Weight of container + wet soil					
4	Weight of container +dry soil					
5	Weight of water (3) – (4)					
6	Weight of container					
7	Weigh t of dry soil (4) – (6)					
8	Moisture content (w) (5) / (7)					
9	Moisture content in percentage					

1. Use the table for recording number of blows and calculating the moisture content.

   Use graph paper. Take depth of penetration (X –Axis) and water content on nominal scale (Y – axis). Plot all the points.

3. Read the water content at 20 mm penetration which is the value of liquid limit (w_L).



PLASTIC LIMIT
(IS : 2720 (Part 5) – 1985)

1. Take about 30g of air dried soil sample passing through 425μ sieve.
2. Mix thoroughly with distilled water on the glass plate until it is plastic enough to be shaped into a small ball.

3. Take about 10g of the plastic soil mass and roll it between the hand and the glass plate to form the soil mass into a thread of as small diameter as possible. If the diameter of the thread becomes less than 3 mm without cracks, it indicates that the water added to the soil is more than its plastic limit, hence the soil is kneaded further and rolled into thread again.
4. Repeat this rolling and remoulding process until the thread start just crumbling at a diameter of 3mm.
5. If the soil sample start crumbling before the diameter of thread reaches 3mm (i.e when the diameter is more than 3mm) in step 3, it shows that water added in step 2 is less than the plastic limit of the soil. Hence, some more water should be added and mixed to a uniform mass and rolled again, until the thread starts just crumbling at a dia of 3mm.
6. Collect the piece of crumbled soil thread at 3mm diameter in an airtight container and determine moisture content.
7. Repeat this procedure on the remaining masses of 10g.
8. Record the observations in Table and obtain the average value of plastic limit.

OBSERVATION AND CALCULATIONS

Sl.No	Description	1	2	3	4	5
1	Container number					
2	Weight of container + wet soil					
3	Weight of container +dry soil					
4	Weight of water (2) – (3)					
5	Weight of container					
6	Weigh t of dry soil (3) – (5)					
7	Moisture content/plastic limit (w_p) (4) / (6)					
8	Moisture content in percentage					

Average plastic limit of the soil

Flow Index $I_f = (W_1 - W_2) / \log_{10} (N_2 - N_1)$

Where W1 = Water content in % at N1 blows

W2 = Water content in % at N2 blows

Toughness Index $I_T = I_p / I_f$, Where I_p is plasticity index & $I_p = w_L - w_p$

RESULT

1. **Liquid limit of the soil (casagrande's method) =**
2. **Liquid limit of the soil (cone penetration method) =**
3. **Plastic limit of the soil =**
4. **Flow Index of the soil =**
5. **Toughness Index of the soil =**

SHRINKAGE LIMIT.

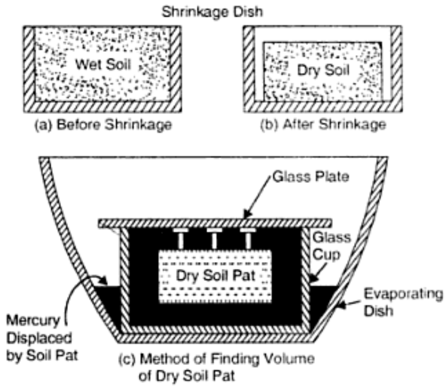
(IS : 2720 (Part 6) – 1972)

APPARATUS

1. Shrinkage dish
2. Porcelain evaporated dish
3. Mercury
4. Balance

PROCEDURE

1. About 30 gms of soil passing through 425 micron sieve is taken with distilled water.
2. The shrinkage dish is coated with a thin layer of Vaseline .The soil sample is placed in the dish by giving gentle taps. The top surface is surfaced with a straight edge.
3. The shrinkage dish with wet soil is weighed. The dish is dried first in air and then in oven.
4. The shrinkage dish is weighed with dry soil. After cleaning the shrinkage dish its empty weight is taken.
5. An empty porcelain dish which will be useful for weighing mercury is weighed.
6. The shrinkage dish is kept inside a large porcelain dish it is filled with mercury and the excess is removed by pressing the plain glass plate firmly over the top of the dish. The contents of the shrinkage dish are transferred to the mercury weighing dish and weighed.
7. The glass cup is kept in a large dish, filled it with over flowing mercury, the excess is removed by pressing the glass plate with three prongs firmly over the top of the cup.
8. It is placed in another large dish. The dry soil is placed on the surface of the mercury and submerge it under the mercury by pressing with the glass plate with prongs.
9. The mercury displaced by the dry soil pat is transferred to the mercury weighing dish and weighed.



OBSERVATION AND CALCULATIONS

Sl.No	Description	Trial 1	Trial 2	Trial 3
1	Weight of dish + wet soil pat in gms			
2	Weight of dish + dry soil pat in gms			
3	Weight of water present (2-3)			
4	Weight of shrinkage dish , empty (gms)			
5	Weight of dry soil pat $W_s = (2 – 4)$			
6	Initial water content (W1) = (4) / (6) x100			
7	Weight of weighing dish + Mercury			
8	Weight of weighing dish empty			
9	Weight of mercury (7 – 8)			
10	Volume of wet soil pat			
11	Weight of weighing dish + displaced mercury			
12	Weight of mercury displaced			
13	Volume of dry soi pat			
14	Shrinkage limit			
15	Shrinkage ratio			
16	Volumetric shrinkage			

RESULT

1. Shrinkage limit =

2. Shrinkage ratio =

3. Volumetric shrinkage =

Ex. No: 7

Date:

STANDARD PROCTOR COMPACTION TEST

(IS : 2720 (Part 7) – 1980)

AIM

To determine Optimum Moisture Content and Maximum dry density for a soil by conducting standard proctor compaction test.

THEORY AND APPLICATIONS

Compaction is the process of densification of soil mass, by reducing air voids under dynamic loading. On the other hand though consolidation is also a process of densification of soil mass but it is due to the expulsion of water under the action of continuously acting static load over a long period.

The degree of compaction of a soil is measured in terms of its dry density. The degree of compaction mainly depends upon its moisture content during compaction, compaction energy and the type of soil. For a given compaction energy, every soil attains the maximum dry density at a particular water content which is known as optimum moisture content (OMC)

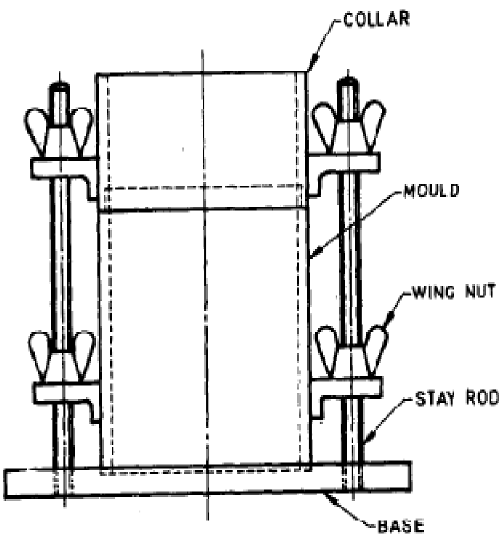
Compaction of soil increases its dry density, shear strength and bearing capacity. The compaction of soil decreases its void ratio permeability and settlements. The results of this test are useful in studying the stability earthen structures like earthen dams, embankments roads and airfields .In such constructions the soils are compacted. The moisture content at which the soils are to be compacted in the field is estimated by the value of optimum moisture content determined by the Proctor compaction test.

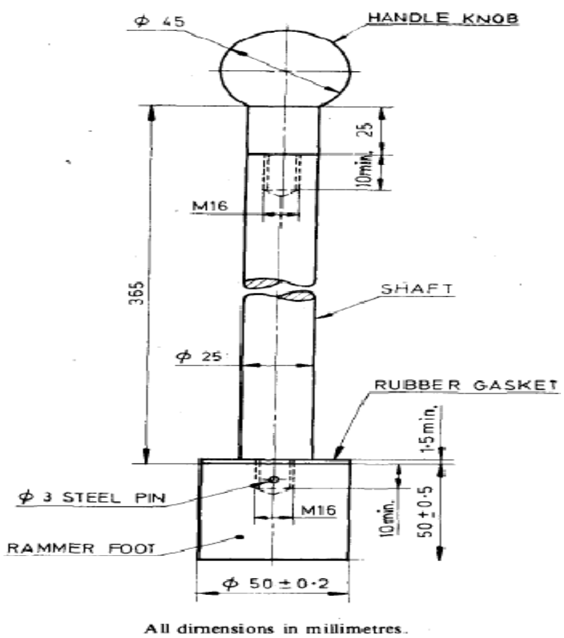
APPARATUS

1. Cylindrical mould of capacity 1000cc ,internal diameter 100mm and height 127.3 mm
2. Rammer 2.6 kg
3. Mould accessories
4. Balance
5. Graduated jar
6. Straight edge
7. Spatula
8. Oven
9. Moisture bins

PROCEDURE

1. Take about 3 kg of air dried soil
2. Sieve the soil through 20mm sieve.Take the soil that passes through the sieve for testing
3. Take 2.5 kg of the soil and add water to ti to bring its moisture content to about 4% in coarse grained soils and 8% in case of fine grained soils
4. Clean , dry and grease the mould and base plate .Weigh the mould with base plate. Fit the collar.
5. Compact the wet soil in three equal layers by the rammer with 25 evenly distributed blows in each layer from a height of 310 mm.
6. Remove the collar and trim off the soil flush with the top of the mould. In removing the collar rotate it to break the bond between it and the soil before lifting it off the mould.
7. Clean the outside of the mould and weigh the mould with soil and base plate.
8. Remove the soil from the mould and obtain a representative soil sample from the bottom, middle and top for water content determination
9. Repeat the above procedure with 8,12,16 and 210 % of water contents for coarse grained soil and 14,18,22 and 26 % for fine grained soil samples approximately. The above moisture contents are given only for guidance. However, the moisture contents may be selected based on experience so that, the dry density of soil shows the increase in moisture content.Each trial should be performed on a fresh sample.





OBSERVATIONS AND CALCULATIONS

Diameter of the mould, d (cm) =

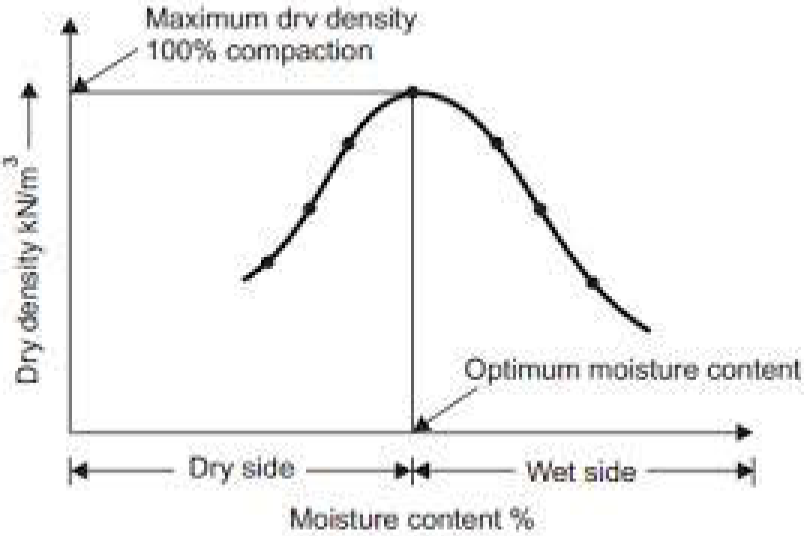
Volume of the mould v (cm^3) =

Height of the mould, h (cm) =

Weight of the mould W1 (gms) =

Sl.No	Description	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
1	Weight of mould + Compacted wet soil (W2) in gms					
2	Weight of Compacted wet soil W = W2 – W1 in gms					
3	Wet density of soil					
4	Bin number					
5	Empty weight of bin in gms					
6	Weight of bin + wet soil in gms					
7	Weight of bin + dry soil in gms					
8	Weight of water (6) – (7)					
9	Weight of dry soil (7) – (5)					
10	Moisture content w (8) /(9)					
11	Moisture content in percentage					
12	Dry density					

Plot the moisture content on X axis and dry density on Y axis .Draw a smooth curve passing through the points called compaction curve. Read the point of maximum dry density and corresponding water content from the compaction curve.



RESULT

1. Optimum Moisture Content OMC (%) =

2. Maximum dry density (gm/cc) =

Ex. No:8

Date:

MODIFIED PROCTOR COMPACTION TEST

(IS : 2720 (Part 8) – 1983)

AIM

To determine Optimum Moisture Content and Maximum dry density for a soil by conducting modified proctor compaction test.

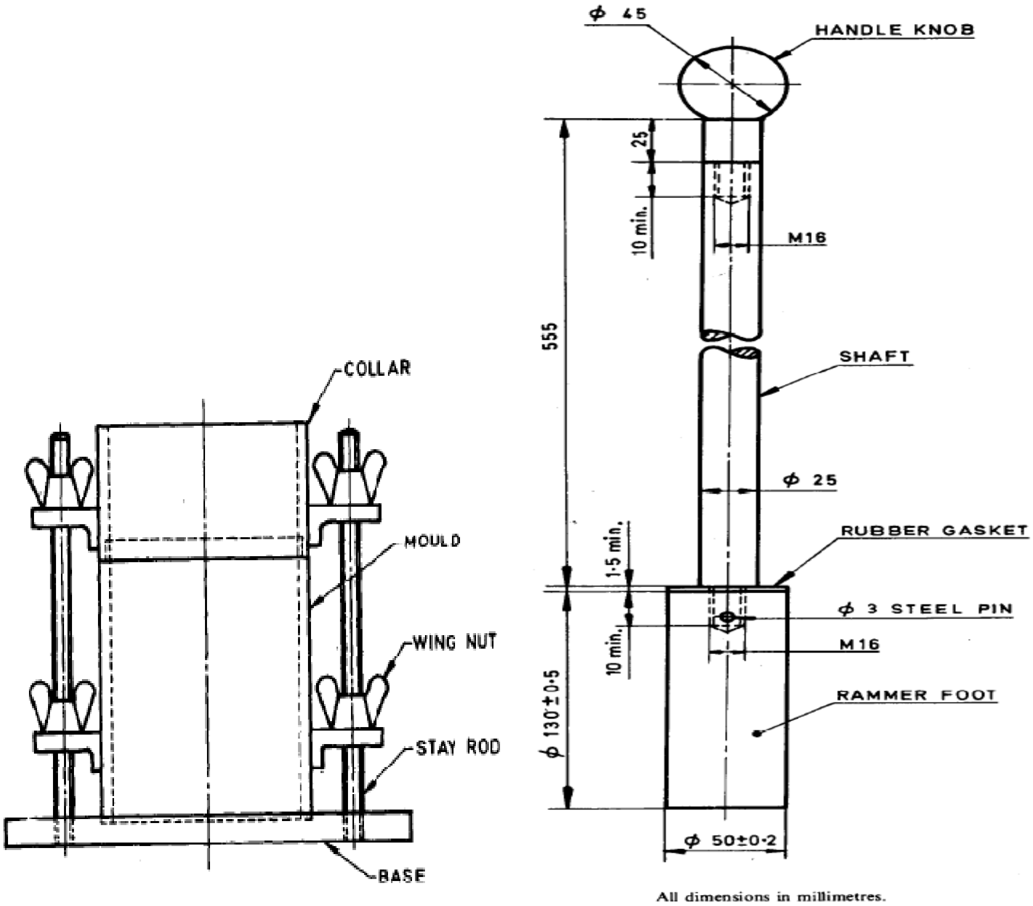
APPARATUS

1) Cylindrical mould of capacity 1000cc ,internal diameter 100mm and height 127.3 mm
2) Rammer 4.9 kg
3) Mould accessories
4) Balance
5) Graduated jar
6) Straight edge
7) Spatula
8) Oven
9) Moisture bins

PROCEDURE

1. Take about 3 kg of air dried soil
2. Sieve the soil through 20mm sieve. Take the soil that passes through the sieve for testing
3. Take 2.5 kg of the soil and add water to it to bring its moisture content to about 4% in coarse grained soils and 8% in case of fine grained soils
4. Clean , dry and grease the mould and base plate .Weigh the mould with base plate. Fit the collar.
5. Compact the wet soil in five equal layers by the rammer with 25 evenly distributed blows in each layer from a height of 450 mm.
6. Remove the collar and trim off the soil flush with the top of the mould. In removing the collar rotate it to break the bond between it and the soil before lifting it off the mould.
7. Clean the outside of the mould and weigh the mould with soil and base plate.

8. Remove the soil from the mould and obtain a representative soil sample from the bottom, middle and top for water content determination
9. Repeat the above procedure with 8,12,16 and 210 % of water contents for coarse grained soil and 14,18,22 and 26 % for fine grained soil samples approximately. The above moisture contents are given only for guidance. However, the moisture contents may be selected based on experience so that, the dry density of soil shows the increase in moisture content.Each trial should be performed on a fresh sample.



OBSERVATIONS AND CALCULATIONS

Diameter of the mould, d (cm) =

Volume of the mould v (cm^3) =

Height of the mould, h (cm) =

Weight of the mould W1 (gms) =

Sl.No	Description	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
1	Weight of mould + Compacted wet soil (W2) in gms					
2	Weight of Compacted wet soil W = W2 – W1 in gms					
3	Wet density of soil					
4	Bin number					
5	Empty weight of bin in gms					
6	Weight of bin + wet soil in gms					
7	Weight of bin + dry soil in gms					
8	Weight of water (6) – (7)					
9	Weight of dry soil (7) – (5)					
10	Moisture content w (8) /(9)					
11	Moisture content in percentage					
12	Dry density					

Plot the moisture content on X axis and dry density on Y axis .Draw a smooth curve passing through the points called compaction curve. Read the point of maximum dry density and corresponding water content from the compaction curve.

RESULT

1. Optimum Moisture Content OMC (%) =

2. Maximum dry density (gm/cc) =

Ex. No:9

Date:

DETERMINATION OF PERMEABILITY OF SOIL BY CONSTANT HEAD METHOD

(IS : 2720 (Part 17)-1986)

AIM

To determine the coefficient of permeability of the soil by conducting constant head method.

THEORY AND APPLICATION

The property of the soil which permits water to percolate through its continuously connected voids is called its permeability .Water flowing through the soil exerts considerable seepage forces which has direct effect on the safety of hydraulic structures. The quantity of water escaping through and beneath and earthen dam depends on the permeability of the embankment and the foundation soil respectively. The rate of settlement of foundation depends on the permeability properties of the foundation soil.

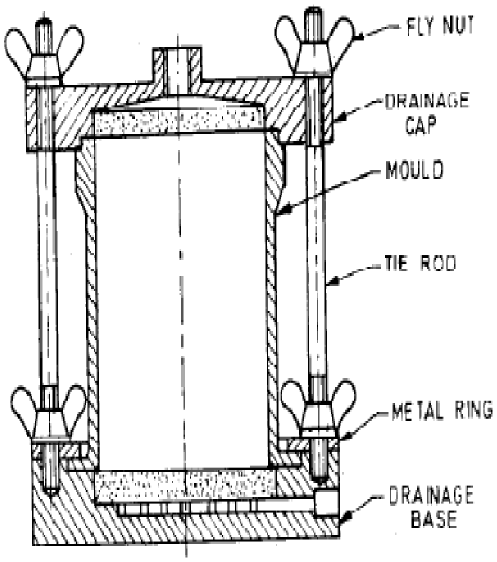
APPARATUS

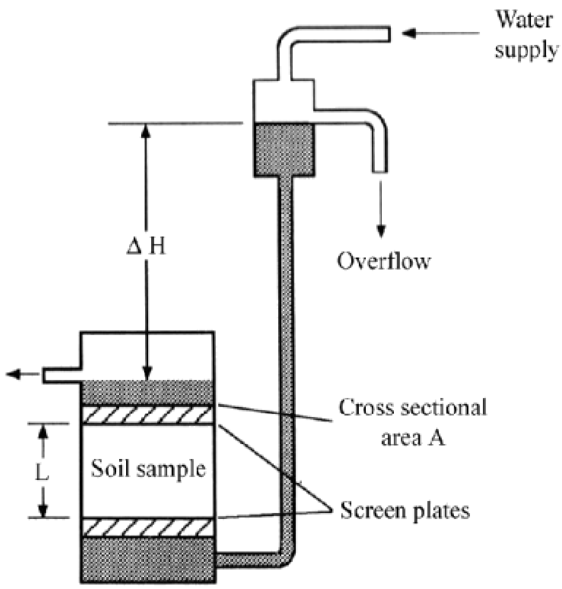
1. Permeability apparatus with accessories
2. Stop watch
3. Measuring jar

PROCEDURE

1. Compact the soil into the mould at a given dry density and moisture content by a suitable device. Place the specimen centrally over the bottom porous disc and filter paper.
2. Place a filter paper, porous stone and washer on top of the soil sample and fix the top collar.
3. Connect the stand pipe to the inlet of the top plate. Fill the stand pipe with water.
4. Connect the reservoir with water to the outlet at the bottom of the mould and allow the water to flow through and ensure complete saturation of the sample.
5. Open the air valve at the top and allow the water to flow out so that the air in the cylinder is removed.

6. When steady flow is reached, collect the water in a measuring flask for a convenient time intervals by keeping the head constant. The constant head of flow is provided with the help of constant head reservoir
7. Repeat the for three more different time intervals





OBSERVATIONS AND CALCULATIONS

Calculate the coefficient of permeability of soil using the equation

K = QL / Ath

Where

K = Coefficient of permeability

Q = Quantity of water collected in time t sec (cc)

t = Time required (sec)

A = Cross sectional area of the soil sample (sq.cm)

h = Constant hydraulic head (cm)

L = Length of soil sample (cm)

(i) Length of soil sample (cm) =

(ii) Area of soil sample (sq.cm) =

Trial No	Hydraulic head h in cm	Time interval T (sec)	Quantity of Water collected(cc)	Coefficient of Permeability K(cm/sec)

RESULT

Coefficient of permeability of the given soil sample K=

Ex. No: 10

Date:

DETERMINATION OF PERMEABILITY OF SOIL BY VARIABLE HEAD METHOD

(IS : 2720 (Part 17)-1986)

AIM

To determine the coefficient of permeability of a given soil sample by conducting Variable head test.

THEORY AND APPLICATION

The property of the soil which permits water to percolate through its continuously connected voids is called its permeability .Water flowing through the soil exerts considerable seepage forces which has direct effect on the safety of hydraulic structures. The quantity of water escaping through and beneath and earthen dam depends on the permeability of the embankment and the foundation soil respectively. The rate of settlement of foundation depends on the permeability properties of the foundation soil.

APPARATUS

1. Permeability apparatus with accessories
2. Stop watch
3. Measuring jar
4. Funnel

PROCEDURE

1. Compact the soil into the mould at a given dry density and moisture content by a suitable device. Place the specimen centrally over the bottom porous disc and filter paper.
2. Place a filter paper, porous stone and washer on top of the soil sample and fix the top collar.
3. Connect the stand pipe to the inlet of the top plate. Fill the stand pipe with water.
4. Connect the reservoir with water to the outlet at the bottom of the mould and allow the water to flow through and ensure complete saturation of the sample.
5. Open the air valve at the top and allow the water to flow out so that the air in the cylinder is removed.
6. Fix the height h1 and h2 on the pipe from the top of water level in the reservoir

7. When all the air has escaped, close the air valve and allow the water from the pipe to flow through the soil and establish a steady flow.
8. Record the time required for the water head to fall from h1 to h2.
9. Change the height h1 and h2 and record the time required for the fall of head.

OBSERVATIONS AND CALCULATIONS

Calculate the coefficient of permeability of soil using the equation.

K = 2.303 Al / At Log_{10}(h1/h2)

K = Coefficient of permeability

a = Area of stand pipe (sq.cm)

t = Time required for the head to fall from h1 to h2 (sec)

A = Cross sectional area of the soil sample (sq.cm)

L = Length of soil sample (cm)

h1 = Initial head of water in the stand pipe above the water level in the reservoir (cm)

h2 = final head of water in the stand pipe above the water level in the reservoir (cm)

(iii) Diameter of the stand pipe (cm) =

(iv) Cross sectional area of stand pipe (sq.cm) =

(v) Length of soil sample (cm) =

(vi) Area of soil sample (sq.cm) =

Trial No.	Initial head h1 in cm	Final head h 2 in cm	Time interval t (sec)	Coefficient of Permeability(cm/sec)

RESULT

Coefficient of permeability of the given soil sample K =

Ex. No:11

Date:

UNCONFINED COMPRESSION TEST

(IS: 2720(Part 10): 1991)

AIM

To determine shear parameters of cohesive soil

THEORY AND APPLICATION

It is not always possible to conduct the bearing capacity test in the field. Some times it is cheaper to take the undisturbed soil sample and test its strength in the laboratory. Also to choose the best material for the embankment, one has to conduct strength tests on the samples selected. Under these conditions it is easy to perform the unconfined compression test on undisturbed and remoulded soil sample.

APPARATUS

1. Compression device
2. Dial gauge
3. Stop watch
4. Oven
5. Balance
6. Split mould 3.5cm diameter and 7 cm long.

PROCEDURE

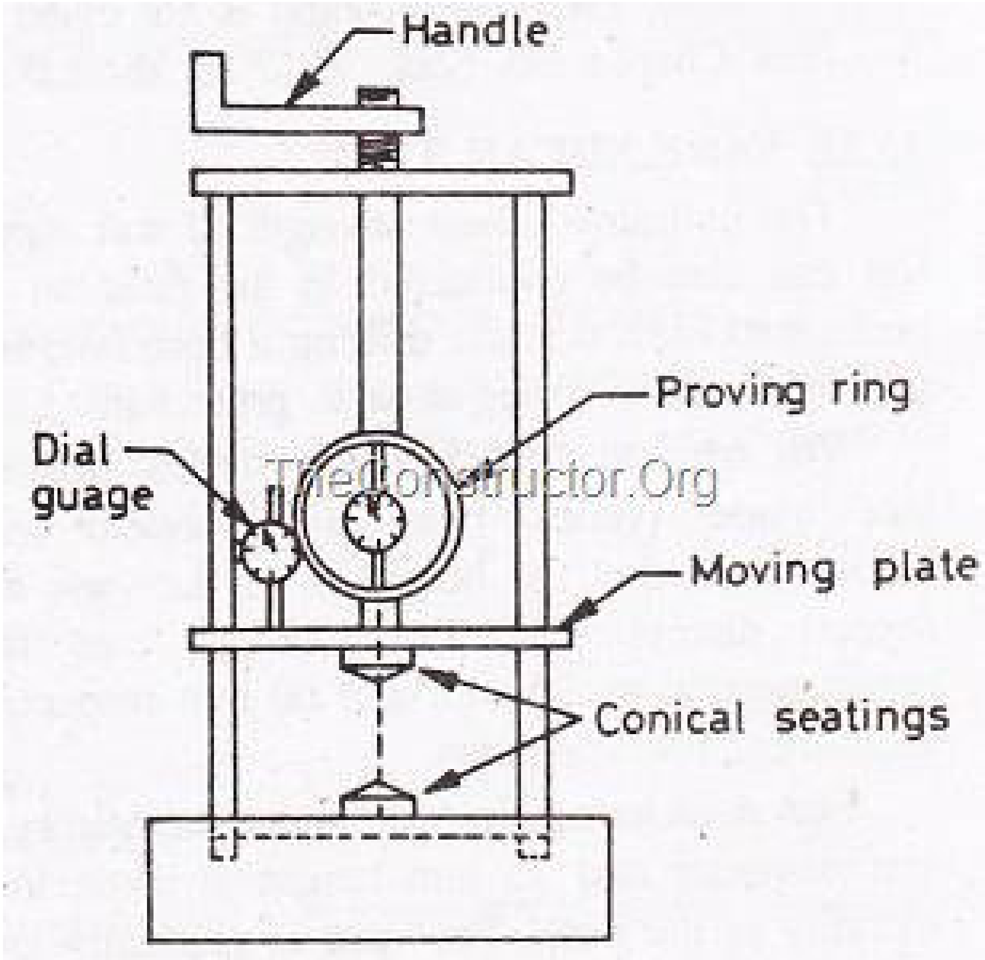
Preparation of soil specimen

1. Undisturbed cylindrical specimen may be cut from the bigger undisturbed sample obtained from the field.
2. Remoulded sample may be prepared by compacting the soil at the desired water content and dry density in a bigger mould and then cut by the sampling tube to obtain the specimen of 3.5 cm diameter and 7 cm long.

Test procedure

1. Measure the initial length and diameter of the specimen.
2. Put the specimen on the bottom plate of the loading device. Adjust the upper plate to make contact with the specimen.

3. Set the proving ring gauge and dial gauge to zero.
4. Compress the specimen until cracks have definetly developed or the stress strain curve is well past its peak or until a vertical deformation of 20 percent is reached.
5. Take the readings for every 1 mm or 5 mm deformation of the specimen.
6. Continue loading till the failure is complete.



OBSERVATIONS AND CALCULATIONS

Initial diameter of the specimen (D_0) =

Initial length of the specimen (L_0) =

Initial area of the specimen (A_0) =

Proving ring constant K =

Elapsed time (minutes)	Compression dial gauge reading (ΔL) (mm)	Strain $e=\Delta L/L_0$	Area $A=A_0/(1-e)$ cm^2	Proving ring reading (Divns.)	Axial load 'P' (kg)=K x proving ring reading	Compressive stress $q_u = P/A$ (kg/cm^2)

Results:

Unconfined compression strength of the soil = q_u =

Shear strength of the soil = $q_u/2$ =

Ex. No: 12

Date:

DIRECT SHEAR TEST

(IS : 2720 (Part 13) – 1986)

AIM

To determine shear parameters of soil using direct shear test apparatus.

THEORY AND APPLICATION

In many engineering problems such as design of foundation, retaining walls, slab bridges, pipes, sheet piling, the value of the angle of internal friction and cohesion of the soil involved are required for the design. Direct shear test is used to predict these parameters quickly. The purpose of direct shear test is to get the ultimate shear resistance, peak shear resistance, cohesion, angle of shearing resistance and stress-strain characteristics of the soils. Shear parameters are used in the design of earthen dams and embankments. These are used in calculating the bearing capacity of soil-foundation systems. These parameter help in estimating the earth pressures behind the retaining walls. The values of these parameters are also used in checking the stability to natural slopes, cuts and fills.

APPARATUS

1. Direct shear box apparatus
2. Loading frame (motor attached).
3. Dial gauge.
4. Proving ring.
5. Tamper.
6. Straight edge.
7. Balance to weigh upto 200 mg.
8. Aluminum container.
9. Spatula.

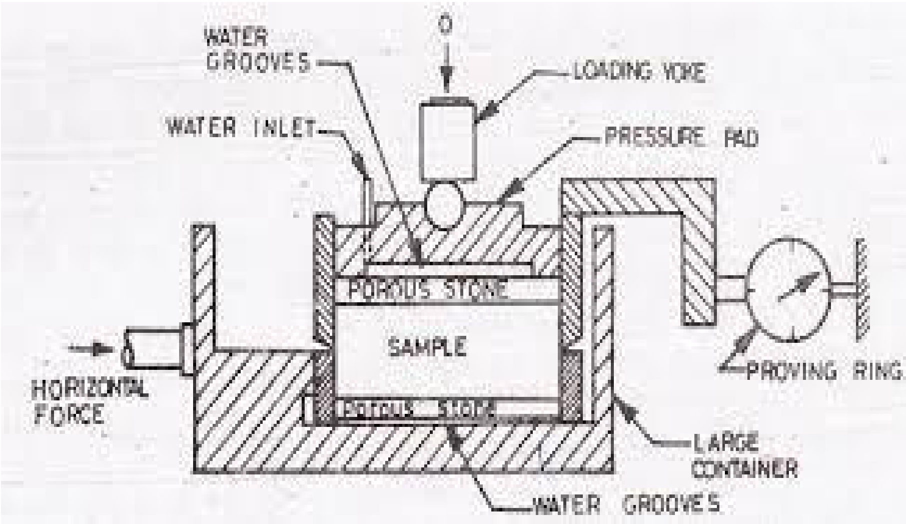
KNOWLEDGE OF EQUIPMENT:

Strain controlled direct shear machine consists of shear box, soil container, loading unit, proving ring, dial gauge to measure shear deformation and volume changes. A two piece square shear box is one type of soil container used.

A proving ring is used to indicate the shear load taken by the soil initiated in the shearing plane.

PROCEDURE

1. Prepare a soil specimen of size 60 mm * 60mm* 25 mm either from undisturbed soil sample or from compacted or remoulded sample. Soil specimen may also be directly prepared in the box by compaction.
2. Fix the upper part of the box to the lower box by fixing screws. Attach the base plate to the lower part.
3. Place the porous stone in the box.
4. Transfer the soil specimen prepared into the box.
5. Place the upper grid, porous stone, and loading pad in the order on soil specimen.
6. Place the box inside the container and mount it on loading frame.
7. Bring the upper half of the box in contact with the proving ring assembly. Contact is observed by the slight movement of proving ring dial gauge needle.
8. Mount the loading yoke on the ball placed on the loading pad.
9. Put the weight on the loading yoke to apply a given value of normal stress intensity.
10. Add the weight of the yoke also in the estimation of normal stress intensity.
11. Remove the fixing screws from the box and raise slightly the upper box with the help of the spacing screws. Remove the spacing screws also.
12. Adjust the entire dial gauge to read zero.
13. Shear load is applied at constant rate of strain.
14. Record the readings of proving ring and dial readings at a fixed interval.
15. Continue the observations till the specimen fails.
16. Repeat the test on the identical specimen under increasing normal stress and record the corresponding reading.



OBSERVATIONS AND CALCULATIONS

Proving Ring constant K=

Least count of dial gauge LC=

Area of specimen=A_0= L*B=

For sand

Shear Displacement		Shear strain $E=\delta/L$	Shear force 'P'		Corrected area $A_c=A_0(1-\delta/3)$	Shear stress $\tau=P/A_c$
Divisions	δ=divisions*LC		divisions	Divisions*K		

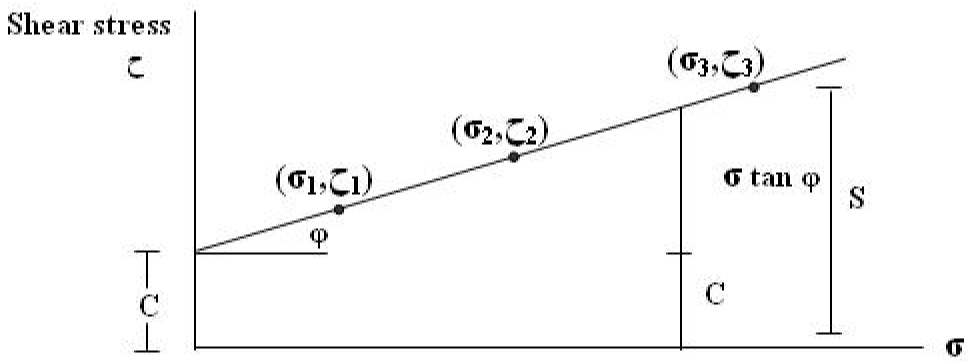
Normal stress	Dial gauge		Shear force 'P'		Corrected area $A_c=A_0(1-\delta/3)$	Shear stress $\tau=P/A_c$
	Divisions	δ=divisions*LC	divisions	Divisions*K		

For soil

Shear Displacement		Shear strain $e=\delta/L$	Shear force 'P'		Corrected area $A_c=A_0(1-\delta/3)$	Shear stress $\tau=P/A_c$
Divisions	δ=divisions*LC		divisions	Divisions*K		

Normal stress	Dial gauge		Shear force 'P'		Corrected area	Shear stress
	Divisions	δ=divisions*LC	divisions	Divisions*K	$A_c=A_0(1-\delta/3)$	$\tau=P/A_c$

1. Plot shear stress vs shear strain and determine maximum shear stress and corresponding shear strain.
2. Plot Normal stress vs shear stress and determine c and Ø



Results:

For sand:

Cohesiveness c=

Angle of shearing resistance Ø =

For soil:

Cohesiveness c=

Angle of shearing resistance Ø =

Ex. No:13

Date:

UNDRAINED TRIAXIAL TEST

(IS: 2720 (Part II) : 1993)

AIM

To determine shear parameters of soil using triaxial test apparatus.

THEORY AND APPLICATION

The standard consolidated undrained test is compression test, in which the soil specimen is first consolidated under all round pressure in the triaxial cell before failure is brought about by increasing the major principal stress. The principle behind a triaxial shear test is that the stress applied in the vertical direction (along the axis of the cylindrical sample) can be different from the stresses applied in the horizontal directions perpendicular to the sides of the cylinder, i.e. the confining pressure). In a homogeneous and isotropic material this produces a non-hydrostatic stress state, with shear stress that may lead to failure of the sample in shear. In homogeneous and anisotropic samples (e.g. bedded or jointed samples) failure may occur due to bending moments and, hence, failure may be tensile. Also combinations of bending and shear failure may happen in inhomogeneous and anisotropic material.It may be perform with or without measurement of pore pressure although for most applications the measurement of pore pressure is desirable.

KNOWLEDGE OF EQUIPMENT:

A constant rate of strain compression machine of which the following is a brief description of one is in common use.

a) A loading frame in which the load is applied by a yoke acting through an elastic dynamometer, more commonly called a proving ring which used to measure the load. The frame is operated at a constant rate by a geared screw jack. It is preferable for the machine to be motor driven, by a small electric motor.

b) A hydraulic pressure apparatus including an air compressor and water reservoir in which air under pressure acting on the water raises it to the required pressure, together with the necessary control valves and pressure dials.

A triaxial cell to take 3.8 cm dia and 7.6 cm long samples, in which the sample can be subjected to an all round hydrostatic pressure, together with a vertical compression load acting through a piston. The vertical load from the piston acts on a pressure cap. The cell is usually designed with a non-ferrous metal top and base connected by tension rods and with walls formed of perspex.

APPARATUS

1. 3.8 cm (1.5 inch) internal diameter 12.5 cm (5 inches) long sample tubes.
2. Rubber ring.
3. An open ended cylindrical section former, 3.8 cm inside dia, fitted with a small rubber tube in its side.
4. Stop clock.
5. Moisture content test apparatus.
6. A balance of 250 gm capacity and accurate to 0.01 gm.

PROCEDURE

1. The sample is placed in the compression machine and a pressure plate is placed on the top. Care must be taken to prevent any part of the machine or cell from jogging the sample while it is being setup, for example, by knocking against this bottom of the loading piston. The probable strength of the sample is estimated and a suitable proving ring selected and fitted to the machine.
2. The cell must be properly set up and uniformly clamped down to prevent leakage of pressure during the test, making sure first that the sample is properly sealed with its end caps and rings (rubber) in position and that the sealing rings for the cell are also correctly placed.
3. When the sample is setup water is admitted and the cell is fitted under water escapes from the beed valve, at the top, which is closed. If the sample is to be tested at zero lateral pressure water is not required.
4. The air pressure in the reservoir is then increased to raise the hydrostatic pressure in the required amount. The pressure gauge must be watched during the test and any necessary adjustments must be made to keep the pressure constant.

5. The handle wheel of the screw jack is rotated until the underside of the hemispherical seating of the proving ring, through which the loading is applied, just touches the cell piston.
6. The piston is then removed down by handle until it is just in touch with the pressure plate on the top of the sample, and the proving ring seating is again brought into contact.
7. Apply the compressive force at constant rate of axial compression, such that failure is produced in a period of approximately 5 to 15 minutes.
8. Take the simultaneous reading of load and deformation dials.
9. Continue the test until the maximum value of stress has been passed or until an axial strain of 20% has been passed.
10. Unload the specimen and drain off the cell fluid. Dismantle the cell and take out the specimen. Remove the rubber membrane and note down the mode of failure.

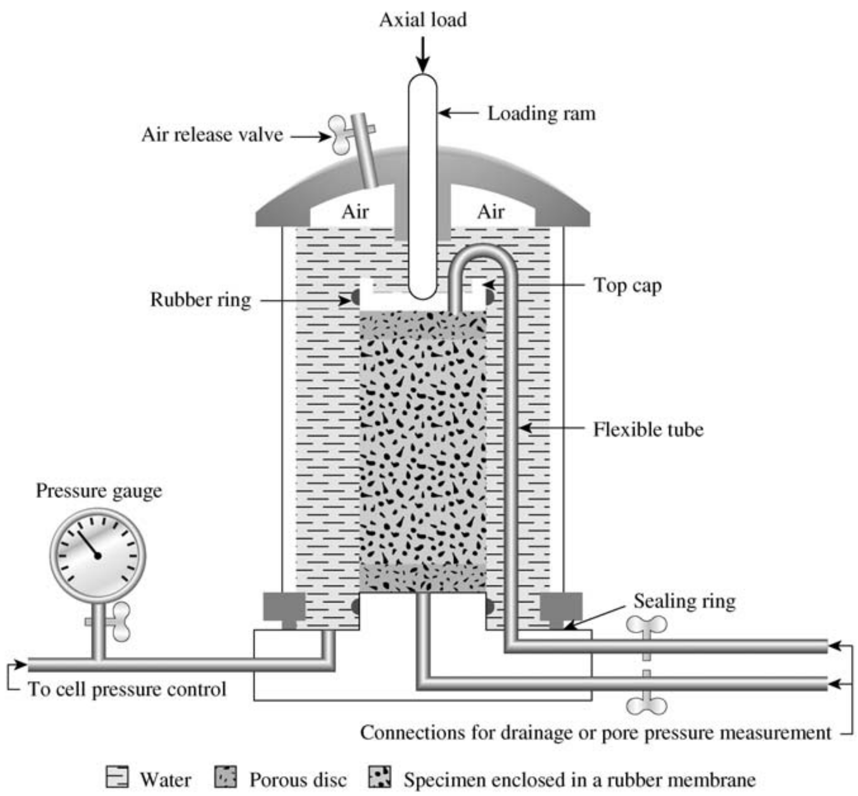


Diagram of triaxial test equipment

OBSERVATIONS AND CALCULATIONS

Proving Ring constant K=

Least count of dial gauge LC=

Cross section area of specimen=A_0= L*B=

Cell pressure σ_3=

Shear Displacement		Shear strain	Shear force 'P'		Corrected area	Vertical stress	Deviator stress
Divisions	δ=divisions*LC	e=δ/L	divisions	Divisions* K	$A_c=A_0/(1-\delta)$	$\sigma_1=P/A_c$	$\sigma_1-\sigma_3$

Test No.	Cell pressure σ_3	Dial gauge		Shear force 'P'		Corrected area	Vertical stress	Deviator stress
		Div	δ=Div*LC	Div	Divisions*K	$A_c=A_0/(1-\delta)$	$\sigma_1=P/A_c$	$\sigma_1-\sigma_3$

Plot Mohr's circle using principle stress difference ($\sigma_1-\sigma_3$) and draw the failure envelope tangential to the circles. Determine the shear parameters c and Ø.

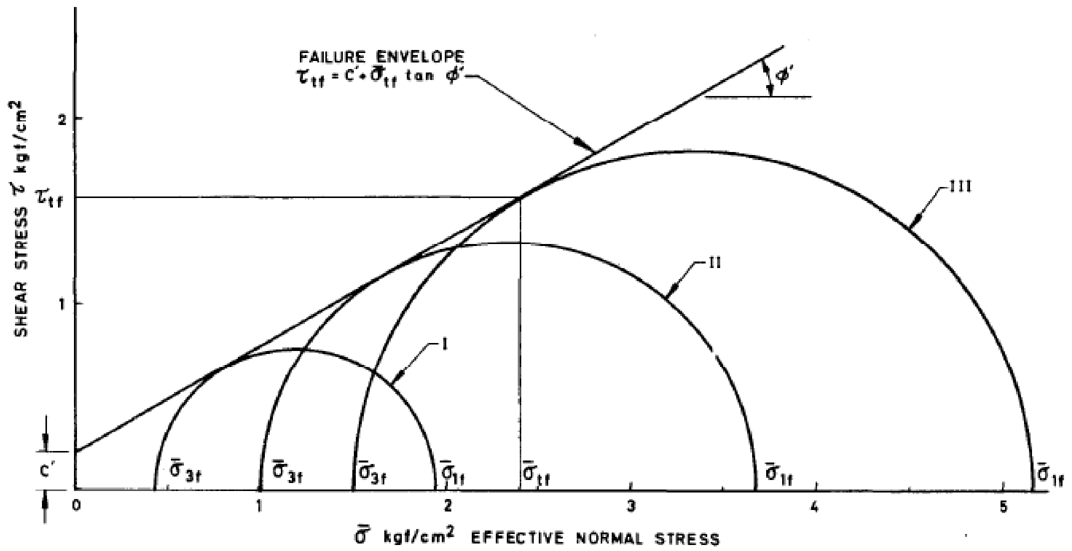


FIG. 6 STRESS CONDITIONS AT FAILURE IN TERMS OF EFFECTIVE STRESSES

Results:

Cohesiveness c=

Angle of shearing resistance Ø =

Ex. No:14

Date:

VANE SHEAR TEST

(IS : 2720 (Part 30) – 1980)

AIM

To determine the shear strength of a given soil specimen.

THEORY AND APPLICATION

The structural strength of soil is basically a problem of shear strength. Vane shear test is a useful method of measuring the shear strength of clay. It is a cheaper and quicker method. The test can also be conducted in the laboratory. The laboratory vane shear test for the measurement of shear strength of cohesive soils, is useful for soils of low shear strength (less than 0.3 kg/cm^2) for which triaxial or unconfined tests can not be performed. The test gives the undrained strength of the soil. The undisturbed and remoulded strength obtained are useful for evaluating the sensitivity of soil.

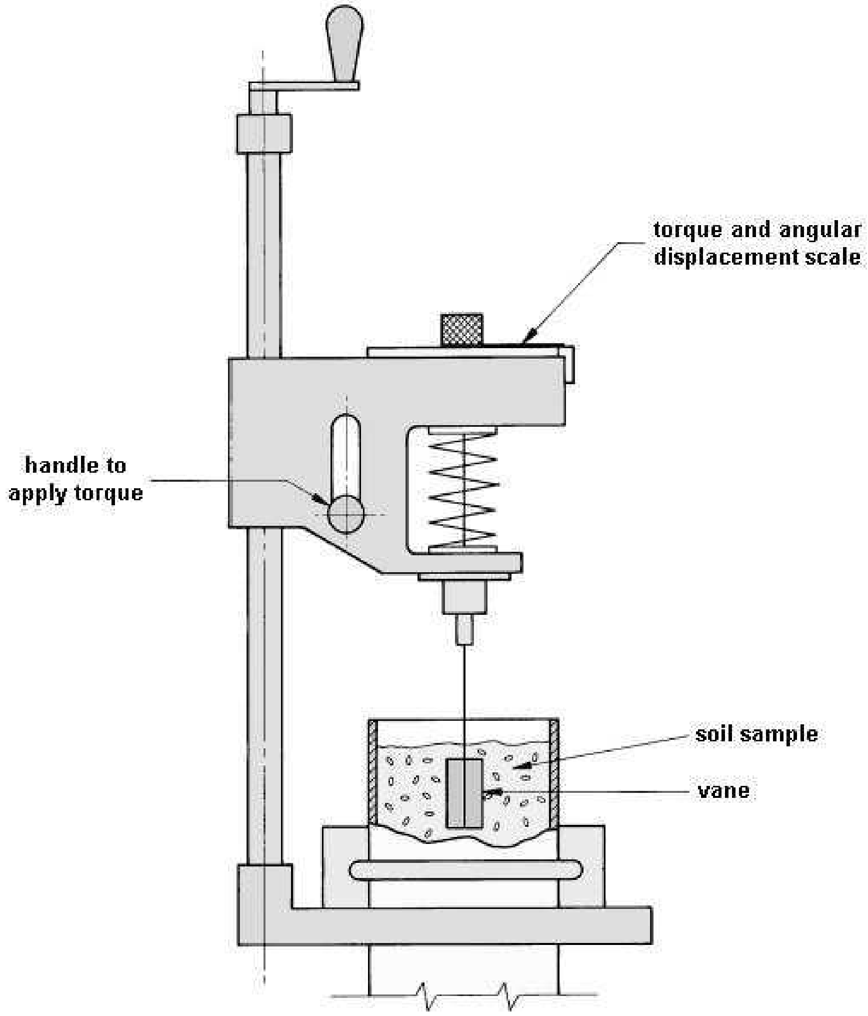
APPARATUS

1. Vane shear apparatus.
2. Specimen.
3. Specimen container.
4. Callipers.

PROCEDURE

1. Prepare two or three specimens of the soil sample of dimensions of at least 37.5 mm diameter and 75 mm length in specimen.(L/D ratio 2 or 3).
2. Mount the specimen container with the specimen on the base of the vane shear apparatus. If the specimen container is closed at one end, it should be provided with a hole of about 1 mm diameter at the bottom.
3. Gently lower the shear vanes into the specimen to their full length without disturbing the soil specimen. The top of the vanes should be atleast 10 mm below the top of the specimen. Note the readings of the angle of twist.

4. Rotate the vanes at an uniform rate say 0.1°/s by suitable operating the torque application handle until the specimen fails.
5. Note the final reading of the angle of twist.
6. Find the value of blade height in cm.
7. Find the value of blade width in cm.



OBSERVATIONS AND CALCULATIONS

Shear strength, $S=\dfrac{T}{\pi\left[\dfrac{D^2H}{2}+\dfrac{D^3}{6}\right]}$

Where S= Shear strength of the soil in kg/cm^2

T= Torque in cm kg

D=Overall diameter of vane in cm

H=Height of vane in cm

The equation is based on following assumptions:

1. The shearing strength in the horizontal and vertical directions are the same.
2. At the peak value the shearing strength is equally mobilized at the end surface as well as at the centre.
3. The shear surface is cylindrical and has the diameter equal to the diameter of the vane.

Trial No.	Initial Reading (Deg)	Final Reading (Deg.)	Difference (Deg.)	T=Spring Constant/180* Difference Kg-cm	S Kg/cm^2	Average 'S' Kg/cm^2

Results:

Shear strength of soil S=

Ex. No:15

Date:

CONSOLIDATION TEST

(IS : 2720 (Part 15) – 1986)

AIM

To determine the consolidation parameters of soil by conducting one dimensional consolidation test.

THEORY AND APPLICATION

When a compressive load is applied to soil mass, a decrease in its volume takes place, the decease in volume of soil mass under stress is known as compression and the property of soil mass pertaining to its tendency to decrease in volume under pressure is known as compressibility. In a saturated soil mass having its void filled with incompressible water, decrease in volume or compression can take place when water is expelled out of the voids. Such a compression resulting from a long time static load and the consequent escape of pore water is termed as consolidation.

Then the load is applied on the saturated soil mass, the entire load is carried by pore water in the beginning. As the water starts escaping from the voids, the hydrostatic pressure in water gets gradually dissipated and the load is shifted to the soil solids which increases effective on them, as a result the soil mass decrease in volume. The rate of escape of water depends on the permeability of the soil.

APPARATUS

1. Consolidometer consisting essentially
    a) A ring of diameter = 60mm and height = 20mm
    b) Two porous plates or stones of silicon carbide, aluminum oxide or porous metal.
    c) Guide ring.
    d) Outer ring.
    e) Water jacket with base.
    f) Pressure pad.
    g) Rubber basket.

2. Loading device consisting of frame, lever system, loading yoke dial gauge fixing device and weights.
3. Dial gauge to read to an accuracy of 0.002mm.
4. Thermostatically controlled oven.
5. Stopwatch to read seconds.
6. Sample extractor.
7. Miscellaneous items like balance, soil trimming tools, spatula, filter papers, sample containers.

SAMPLE PREPARATION

1) Undisturbed sample

From the sample tube, eject the sample into the consolidation ring. The sample should project about one cm from outer ring. Trim the sample smooth and flush with top and bottom of the ring by using a knife. Clean the ring from outside and keep it ready from weighing.

2) Remoulded sample :

a) Choose the density and water content at which samples has to be compacted from the moisture density relationship.

b) Calculate the quantity of soil and water required to mix and compact.

c) Compact the specimen in compaction mould in three layers using the standard rammers.

d) Eject the specimen from the mould using the sample extractor.

PROCEDURE

1. Saturate two porous stones either by boiling in distilled water about 15 minute or by keeping them submerged in the distilled water for 4 to 8 hrs. Wipe away excess water. Fittings of the consolidometer which is to be enclosed shall be moistened.
2. Assemble the consolidometer, with the soil specimen and porous stones at top and bottom of specimen, providing a filter paper between the soil specimen and porous stone. Position the pressure pad centrally on the top porous stone.
3. Mount the mould assembly on the loading frame, and center it such that the load applied is axial.

4. Position the dial gauge to measure the vertical compression of the specimen. The dial gauge holder should be set so that the dial gauge is in the begging of its releases run, allowing sufficient margin for the swelling of the soil, if any.
5. Connect the mould assembly to the water reservoir and the sample is allowed to saturate. The level of the water in the reservoir should be at about the same level as the soil specimen.
6. Apply an initial load to the assembly. The magnitude of this load should be chosen by trial, such that there is no swelling. It should be not less than 50 g/cm^3 for ordinary soils & 25 g/cm^2 for very soft soils. The load should be allowed to stand until there is no change in dial gauge readings for two consecutive hours or for a maximum of 24 hours.
7. Note the final dial reading under the initial load. Apply first load of intensity 0.1 kg/cm^2 start the stop watch simultaneously. Record the dial gauge readings at various time intervals. The dial gauge readings are taken until 90% consolidation is reached. Primary consolidation is gradually reached within 24 hrs.
8. At the end of the period, specified above take the dial reading and time reading. Double the load intensity and take the dial readings at various time intervals. Repeat this procedure fir successive load increments. The usual loading intensity are as follows :
    a. 0.1, 0.2, 0.5, 1, 2, 4 and 8 kg/cm^2.
9. After the last loading is completed, reduce the load to the value of the last load and allow it to stand for 24 hrs. Reduce the load further in steps of the previous intensity till an intensity of 0.1 kg/cm^2 is reached. Take the final reading of the dial gauge.
10. Reduce the load to the initial load, keep it for 24 hrs and note the final readings of the dial gauge.
11. Quickly dismantle the specimen assembly and remove the excess water on the soil specimen in oven, note the dry weight of it.

OBSERVATIONS AND CALCULATIONS

Initial height of the specimen H_0=

Initial cross sectional area of the specimen A_0=

Initial Volume of the specimen V_0=

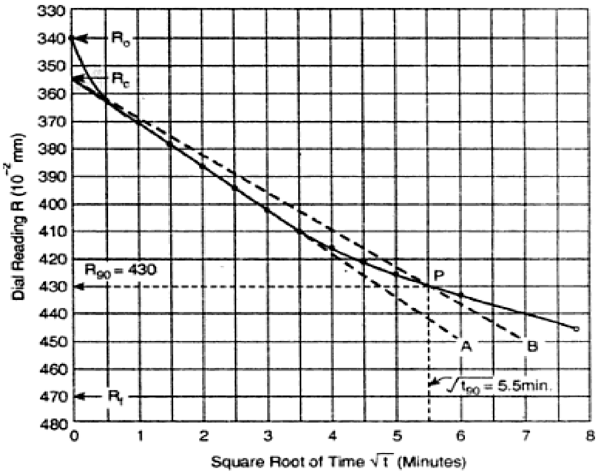
Weight of the specimen W=

Specific Gravity of the specimen G=

Height of solids H_s=W/(G $A_0\gamma_w$)=

Elapsed time 't'	Applied Pressure σ'	Final dial gauge reading (mm)	Dial change ΔH (mm)	Specimen height $H=H_0+\Delta H$ (mm)	Height of voids $H-H_s$ (mm)	Void ratio $e= (H-H_s)/ H$

A plot is made between dial readings and square root of time and the time corresponding to 90% consolidation is determined.



Coefficient of consolidation $C_v = 0.848\, d^2/t_{90}$

Where d=Average drainage path for the pressure increment.

$d=(H_i+H_f)/4$, H_i & H_f are initial and final height of the specimen.

t_{90}=time corresponding to 90% consolidation.

Compression Index C_c To determine the compression index, a plot of voids ratio (e) V_s log t is made. The initial compression curve would be a straight line and the slope of this line would give the compression index C_c.

Results:

Coefficient of consolidation C_v =

Compression Index C_c =