GEOTECHNICAL LABORATORY EXPERIMENTS

1. DETERMINATION OF MOISTURE CONTENT
2. DETERMINATION OF SPECIFIC GRAVITY
3. FIELD DENSITY TEST
4. GRAIN SIZE ANALYSIS
   a.Sieve Analysis
   b.Hydrometer Analysis
5. DETERMINATION OF CONSISTENCY LIMITS
6. DENSITY INDEX/RELATIVE DENSITY TEST
7. PERMEABILITY TEST
   a.Constant Head Method
   b.Falling Head method
8. PROCTOR TEST
9. VANE SHEAR TEST
10. DIRECT SHEAR TEST
11. UNCONFINED COMPRESSION TEST
12. UNDRAINED TRIAXIAL TEST
13. CONSOLIDATED TEST
14. CALIFORNIA BEARING RATIO TEST

1. DETERMINATION OF MOISTURE CONTENT

OBJECTIVE

Determine the natural content of the given soil sample.

NEED AND SCOPE OF THE EXPERIMENT

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.

DEFINITION

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.

APPARATUS REQUIRED

1. Non-corrodible air-tight container.
2. Electric oven, maintain the temperature between 1050 C to 1100 C.
3. Desiccator
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 1050 C to 1100 C for a period varying with the type of soil but usually 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 600) possibly for a longer period.

Certain soils contain gypsum which on heating loses its water if crystallization. If itb is suspected that gypsum is present in the soil sample used for moisture content determination it shall be dried at not more than 800 C and possibly for a longer time.

OBSERVATIONS AND RECORDING

Data and observation sheet for water content determination

2. DETERMINATION OF SPECIFIC GRAVITY

OBJECTIVE

Determine the specific gravity of soil fraction passing 4.75 mm I.S sieve by density bottle.

NEED AND SCOPE

The knowledge of specific gravity is needed in calculation of soil properties like void ratio, degree of saturation etc.

DEFINITION

Specific gravity G is defined as the ratio of the weight of an equal volume of distilled water at that temperature both weights taken in air.

APPARATUS REQUIRED

1. Density bottle of 50 ml with stopper having capillary hole.
2. Balance to weigh the materials (accuracy 10gm).
3. Wash bottle with distilled water.
4. Alcohol and ether.

PROCEDURE

1. Clean and dry the density bottle

   a. wash the bottle with water and allow it to drain.
   b. Wash it with alcohol and drain it to remove water.

c. Wash it with ether, to remove alcohol and drain ether.

2. Weigh the empty bottle with stopper (W_1)

3. Take about 10 to 20 gm of oven soil sample which is cooled in a desiccator. Transfer it to the bottle. Find the weight of the bottle and soil (W_2).

4. Put 10ml of distilled water in the bottle to allow the soil to soak completely. Leave it for about 2 hours.

5. Again fill the bottle completely with distilled water put the stopper and keep the bottle

under constant temperature water baths (T_x^0).

6. Take the bottle outside and wipe it clean and dry note. Now determine the weight of the bottle and the contents (W_3).

7. Now empty the bottle and thoroughly clean it. Fill the bottle with only disttiled water and weigh it. Let it be W_4 at temperature (T_x^0 C).

8. Repeat the same process for 2 to 3 times, to take the average reading of it.

OBSERVATIONS

S. No.	Observation Number	1	2	3
1	Weight of density bottle (W_1 g)			
2	Weight of density bottle + dry soil (W_2 g)			
3	Weight of bottle + dry soil + water at temperature T_x^0 C (W_3 g)			
4	Weight of bottle + water (W_4 g) at temperature T_x^0 C			
	Specific gravity G at T_x^0 C			
	Average specific gravity at T_x^0 C			

CALCULATIONS

$$\textit{Specific gravity of soil} = \frac{\text{Density of water at 27 C}}{\text{Weight of water of equal volume}}$$

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

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

INTERPRETATION AND REPORTING

Unless or otherwise specified specific gravity values reported shall be based on water at 27^0C. So the specific gravity at $27^0\text{C} = K \times$ Sp. gravity at $T_x{}^0$C.

$$\textit{where} \quad K = \frac{\text{Density of water at temperature } T_x^0\text{C}}{\text{Density of water at temperature } T_x^0\text{C}}$$

The specific gravity of the soil particles lie with in the range of 2.65 to 2.85. Soils containing organic matter and porous particles may have specific gravity values below 2.0. Soils having heavy substances may have values above 3.0.

3. FIELD DENSITY TEST

SAND REPLACEMENT METHOD

OBJECTIVE

Determine the in situ density of natural or compacted soils using sand pouring cylinders.

NEED AND SCOPE

The in situ density of natural soil is needed for the determination of bearing capacity of soils, for the purpose of stability analysis of slopes, for the determination of pressures on underlying strata for the calculation of settlement and the design of underground structures.

It is very quality control test, where compaction is required, in the cases like embankment and pavement construction.

APPARATUS REQUIRED

1. Sand pouring cylinder of 3 litre/16.5 litre capacity, mounted above a pouring come and separated by a shutter cover plate.

2. Tools for excavating holes; suitable tools such as scraper tool to make a level surface.

3. Cylindrical calibrating container with an internal diameter of 100 mm/200 mm and an internal depth of 150 mm/250 mm fitted with a flange 50 mm/75 mm wide and about 5 mm surrounding the open end.

4. Balance to weigh unto an accuracy of 1g.

5. Metal containers to collect excavated soil.

6. Metal tray with 300 mm/450 mm square and 40 mm/50 mm deep with a 100 mm/200 mm diameter hole in the centre.

7. Glass plate about 450 mm/600 mm square and 10mm thick.

8. Clean, uniformly graded natural sand passing through 1.00 mm I.S.sieve and retained on the 600micron I.S.sieve. It shall be free from organic matter and shall have been oven dried and exposed to atmospheric humidity.

9. Suitable non-corrodible airtight containers.

10. Thermostatically controlled oven with interior on non-corroding material to maintain the temperature between 105^0C to 110^0C.

11. A dessicator with any desiccating agent other than sulphuric acid.

THEORY

By conducting this test it is possible to determine the field density of the soil. The moisture content is likely to vary from time and hence the field density also. So it is required to report the test result in terms of dry density. The relationship that can be established between the dry density with known moisture content is as follows:

$$\gamma_d = \gamma_b / (1 + w)$$

$$\gamma_d = Dry\ density$$

$$\gamma_b = Bulk\ density$$

$$w = water\ content$$

PROCEDURE

Calibration of the Cylinder

1. Fill the sand pouring cylinder with clean sand so that the level of the sand in the cylinder is within about 10 mm from the top. Find out the initial weight of the cylinder plus sand (W_1) and this weight should be maintained constant throughout the test for which the calibration is used.

2. Allow the sand of volume equal to that of the calibrating container to run out of the cylinder by opening the shutter, close the shutter and place the cylinder on the glass sand takes place in the cylinder close the shutter and remove the cylinder carefully. Weigh the sand collected on the glass plate. Its weight(W_2) gives the weight of sand filling the cone portion of the sand pouring cylinder.
Repeat this step at least three times and take the mean weight (W_2) Put the sand back into the sand pouring cylinder to have the same initial constant weight (W_1)

Determination of Bulk Density of Soil

3. Determine the volume (V) of the container be filling it with water to the brim. Check this volume by calculating from the measured internal dimensions of the container.

4. Place the sand poring cylinder centrally on yhe of the calibrating container making sure that constant weight (W_1) is maintained. Open the shutter and permit the sand to run into the container. When no further movement of sand is seen close the shutter, remove the pouring cylinder and find its weight (W_3).

Determination of Dry Density of Soil In Place

5. Approximately 60 sqcm of area of soil to be tested should be trimmed down to a level surface,approximately of the size of the container. Keep the metal tray on the level surface and excavate a circular hole of volume equal to that of the calibrating

container. Collect all the excavated soil in the tray and find out the weight of the excavated soil (W_w). Remove the tray, and place the sand pouring cylinder filled to constant weight so that the base of the cylinder covers the hole concentrically. Open the shutter and permit the sand to run into the hole. Close the shutter when no further movement of the sand is seen. Remove the cylinder and determine its weight (W_3).

6. Keep a representative sample of the excavated sample of the soil for water content determination.

OBSERVATIONS AND CALCULATIONS

S. No.	Sample Details Calibration	1	2	3
1. 2. 3. 4. 5. 6.	Weight of sand in cone (of pouring cylinder) W_2 gm Volume of calibrating container (V) in cc Weight of sand + cylinder before pouring W_3 gm Weight of sand + cylinder after pouring W_3 gm Weight of sand to fill calibrating containers $W_a = (W_1\text{-}W_3\text{-}W_2)$ gm Bulk density of sand $g_s = W_a / V$ gm/cc			

S. No.	Measurement of Soil Density	1	2	3

1. 2. 3. 4. 5. 6. 7. 8. 9. 10.	Weight of wet soil from hole W_w gm Weight of sand + cylinder before pouring W_1 gm Weight of sand + cylinder after pouring W_4 gm Weight of sand in hole $W_b = (W_1-W_2-W_4)$ gm Bulk density $g_b = (W_w / W_b)\ g_s$ gm/cc Water content determination Container number Weight of wet soil Weight of dry soil Moisture content (%) Dry density $g_d = g_b / (1+w)$ gm/cc			

GENERAL REMARKS

1. While calibrating the bulk density of sand great care has to be taken.

2. The excavated hole must be equal to the volume of the calibrating container.

4. DIRECT SHEAR TEST

Objective

To determine the shearing strength of the soil using the direct shear apparatus.

NEED AND SCOPE

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 laboratory report cover the laboratory procedures for determining these values for cohesionless soils.

PLANNING AND ORGANIZATION

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. Check the inner dimension of the soil container.

2. Put the parts of the soil container together.

3. Calculate the volume of the container. Weigh the container.

4. Place the soil in smooth layers (approximately 10 mm thick). If a dense sample is desired tamp the soil.

5. Weigh the soil container, the difference of these two is the weight of the soil. Calculate the density of the soil.

6. Make the surface of the soil plane.

7. Put the upper grating on stone and loading block on top of soil.

8. Measure the thickness of soil specimen.

9. Apply the desired normal load.

10.Remove the shear pin.

11. Attach the dial gauge which measures the change of volume.

12. Record the initial reading of the dial gauge and calibration values.

13. Before proceeding to test check all adjustments to see that there is no connection between two parts except sand/soil.

14. Start the motor. Take the reading of the shear force and record the reading.

15.Take volume change readings till failure.

16. Add 5 kg normal stress 0.5 kg/cm^2 and continue the experiment till failure

17. Record carefully all the readings. Set the dial gauges zero, before starting the experiment

DATA CALCULATION SHEET FOR DIRECT SHEAR TEST

Normal stress 0.5 kg/cm^2 L.C=....... P.R.C=.........

Horizontal Gauge Reading (1)	Vertical Dial gauge Reading (2)	Proving ring Reading (3)	Hori.Dial gauge Reading Initial reading div. gauge (4)	Shear deformation Col.(4) x Leastcount of dial (5)	Vertical gauge reading Initial Reading (6)	Vertical deformation= div.in col.6 xL.C of dial gauge (7)	Proving reading Initial reading (8)	Shear stress = div.col.(8)x proving ring constant Area of the specimen(kg/cm^2) (9)
0								
25								
50								
75								
100								
125								
150								
175								
200								
250								
300								
400								
500								
600								

700								
800								
900								

Normal stress 1.0 kg/cm^2 L.C=....... P.R.C=........

Horizontal Gauge Reading (1)	Vertical Dial gauge Reading (2)	Proving ring Reading (3)	Hori.Dial gauge Reading Initial reading div. gauge (4)	Shear deformation Col.(4) x Leastcount of dial (5)	Vertical gauge reading Initial Reading (6)	Vertical deformation= div.in col.6 xL.C of dial gauge (7)	Proving reading Initial reading (8)	Shear stress = div.col.(8)x proving ring constant Area of the specimen(kg/cm^2) (9)
0								
25								
50								
75								
100								
125								
150								
175								
200								
250								
300								
400								
500								

600 700 800 900								

Normal stress 1.5 kg/cm^2 L.C=....... P.R.C=........

Horizontal Gauge Reading (1)	Vertical Dial gauge Reading (2)	Proving ring Reading (3)	Hori.Dial gauge Reading Initial reading div. gauge (4)	Shear deformation Col.(4) x Leastcount of dial (5)	Vertical gauge reading Initial Reading (6)	Vertical deformation= div.in col.6 xL.C of dial gauge (7)	Proving reading Initial reading (8)	Shear stress = div.col.(8)x proving ring constant Area of the specimen(kg/cm^2) (9)
0 25 50 75 100 125 150 175 200 250 300								

400 500 600 700 800 900								

OBSERVATION AND RECORDING

Proving Ring constant.......

Least count of the dial........

Calibration factor.......

Leverage factor........

Dimensions of shear box 60 x 60 mm

Empty weight of shear box........

Least count of dial gauge.........

Volume change.......

S.No	Normal load (kg)	Normal stress(kg/cm^2) load x leverage/Area	Normal stress(kg/cm^2) load x leverage/Area	Shear stress proving Ring reading x calibration / Area of container
1 2 3				

GENERAL REMARKS

1. In the shear box test, the specimen is not failing along its weakest plane but along a predetermined or induced failure plane i.e. horizontal plane separating the two halves of the shear box. This is the main draw back of this test. Moreover, during loading, the state of stress cannot be evaluated. It can be evaluated only at failure condition i.e Mohr�s circle can be drawn at the failure condition only. Also failure is progressive.

2. Direct shear test is simple and faster to operate. As thinner specimens are used in shear box, they facilitate drainage of pore water from a saturated sample in less time. This test is also useful to study friction between two materials � one material in lower half of box and another material in the upper half of box.

3. The angle of shearing resistance of sands depends on state of compaction, coarseness of grains, particle shape and roughness of grain surface and grading. It varies between 28^o(uniformly graded sands with round grains in very loose state) to 46^o(well graded sand with angular grains in dense state).

4. The volume change in sandy soil is a complex phenomenon depending on gradation, particle shape, state and type of packing, orientation of principal planes, principal stress ratio, stress history, magnitude of minor principal stress, type of apparatus, test procedure, method of preparing specimen etc. In general loose sands expand and dense sands contract in volume on shearing. There is a void ratio at which either expansion contraction in volume takes place. This void ratio is called critical void ratio. Expansion or contraction can be inferred from the movement of vertical dial gauge during shearing.

5. The friction between sand particle is due to sliding and rolling friction and interlocking action.

The ultimate values of shear parameter for both loose sand and dense sand approximately attain the same value so, if angle of friction value is calculated at ultimate stage, slight disturbance in density during sampling and preparation of test specimens will not have much effect.

5. CONSOLIDATION TEST

OBJECTIVE

To determine the settlements due to primary consolidation of soil by conducting one dimensional test.

NEED AND SCOPE

The test is conducted to determine the settlement due to primary consolidation. To determine :

i. Rate of consolidation under normal load.
ii. Degree of consolidation at any time.
iii. Pressure-void ratio relationship.
iv. Coefficient of consolidation at various pressures.
v. Compression index.

From the above information it will be possible for us to predict the time rate and extent of settlement of structures founded on fine-grained soils. It is also helpful in analyzing the stress history of soil. Since the settlement analysis of the foundation depends mainly on the values determined by the test, this test is very important for foundation design.

PLANNING AND ORGANIZATION

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.

PRINCIPAL INVOLVED

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.

1) 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 60 % of 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.

OBSERVATION AND READING

Table I

Data and observation sheet for consolidation test pressure, compression and time.

Project : Name of the project

Borehole no. : 1

Depth of the sample : 2m

Description of soil :

Empty weight of ring : 635 gm

Area of ring : 4560 mm^2 (45.60 cm^2)

Diameter of ring : 76.2 mm (7.62 cm)

Volume of ring : 115.82 cm^3

Height of ring : 25.4 (2.54 cm)

Specific gravity of soil sample

No:

Dial Gauge = 0.0127 mm (least count)

Pressure Intensity (Kg/cm^2)	0.1	0.2	0.5	1	2	4	8
Elapsed Time							
0.25							
1							

2.5 4 6.25 9 16 25 30 1 hr 2 hrs 4 hrs 8 hrs 24 hrs	

Observation Sheet for Consolidation Test : Pressure Voids Ratio

Applied pressure	Final dial reading	Dial change	Specimen hieght	Height solids	Height of voids	Void ration
0 0.1 0.2 0.5 1.0 2.0 4.0 8.0 4.0						

2.0						
1.0						
0.5						
0.2						
0.1						

CALCULATIONS

1. **Height of solids** (H_S) is calculated from the equation

$$H_S = W_S/G \wr A$$

2. **Void ratio.** Voids ratio at the end of various pressures are calculated from equation

$$e = (H * H_S)/H_S$$

3**. Coefficient of consolidation**. The Coefficient of consolidation at each pressures increment is calculated by using the following equations :

i. $C_v = 0.197\ d^2/t_{50}$ (Log fitting method)
ii. $C_v = 0.848\ d^2/t_{90}$ (Square fitting method)

In the log fitting method, a plot is made between dial reading and logarithmic of time, the time corresponding to 50% consolidation is determined.

In the square root fitting method, a plot is made between dial readings and square root of time and the time corresponding to 90% consolidation is determined. The values of C_v are recorded in table II.

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

5. Coefficient of compressibility. It is calculated as follows

$$a_v = 0.435\ C_c/\text{Avg. pressure for the increment}$$

where C_c = Coefficient of compressibility

6. Coefficient of permeability. It is calculated as follows

$$K = C_v.a_v * (\text{unit weight of water})/(1+e).$$

Graphs

1. Dial reading V_S log of time or

   Dial reading V_S square root of time.

2. Voids ratio V_S $\log\sigma$ (average pressure for the increment).

7.UNCONFINED COMPRESSION TEST

OBJECTIVE

determine shear parameters of cohesive soil

NEED AND SCOPE OF THE EXPERIMENT

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. Now we will investigate experimentally the strength of a given soil sample.

PLANNING AND ORGANIZATION

We have to find out the diameter and length of the specimen.

EQUIPMENT

1. Loading frame of capacity of 2 t, with constant rate of movement. What is the least count of the dial gauge attached to the proving ring!
2. Proving ring of 0.01 kg sensitivity for soft soils; 0.05 kg for stiff soils.
3. Soil trimmer.

4. Frictionless end plates of 75 mm diameter (Perspex plate with silicon grease coating).
5. Evaporating dish (Aluminum container).
6. Soil sample of 75 mm length.
7. Dial gauge (0.01 mm accuracy).
8. Balance of capacity 200 g and sensitivity to weigh 0.01 g.
9. Oven, thermostatically controlled with interior of non-corroding material to maintain the temperature at the desired level. What is the range of the temperature used for drying the soil
10. Sample extractor and split sampler.
11. Dial gauge (sensitivity 0.01mm).
12. Vernier calipers

EXPERIMENTAL PROCEDURE (SPECIMEN)

1. In this test, a cylinder of soil without lateral support is tested to failure in simple compression, at a constant rate of strain. The compressive load per unit area required to fail the specimen as called Unconfined compressive strength of the soil.

Preparation of specimen for testing

A. Undisturbed specimen

1. Note down the sample number, bore hole number and the depth at which the sample was taken.
2. Remove the protective cover (paraffin wax) from the sampling tube.
3. Place the sampling tube extractor and push the plunger till a small length of sample moves out.

4. Trim the projected sample using a wire saw.
5. Again push the plunger of the extractor till a 75 mm long sample comes out.
6. Cutout this sample carefully and hold it on the split sampler so that it does not fall.
7. Take about 10 to 15 g of soil from the tube for water content determination.
8. Note the container number and take the net weight of the sample and the container.
9. Measure the diameter at the top, middle, and the bottom of the sample and find the average and record the same.
10. Measure the length of the sample and record.
11. Find the weight of the sample and record.

B. Moulded sample

1. For the desired water content and the dry density, calculate the weight of the dry soil Ws required for preparing a specimen of 3.8 cm diameter and 7.5 cm long.

2. Add required quantity of water W_w to this soil.

$$W_w = W_S \times W/100 \text{ gm}$$

3. Mix the soil thoroughly with water.
4. Place the wet soil in a tight thick polythene bag in a humidity chamber and place the soil in a constant volume mould, having an internal height of 7.5 cm and internal diameter of 3.8 cm.

5. After 24 hours take the soil from the humidity chamber and place the soil in a constant volume mould, having an internal height of 7.5 cm and internal diameter of 3.8 cm.
6. Place the lubricated moulded with plungers in position in the load frame.
7. Apply the compressive load till the specimen is compacted to a height of 7.5 cm.
8. Eject the specimen from the constant volume mould.
9. Record the correct height, weight and diameter of the specimen.

Test procedure

1. Take two frictionless bearing plates of 75 mm diameter.
2. Place the specimen on the base plate of the load frame (sandwiched between the end plates).
3. Place a hardened steel ball on the bearing plate.
4. Adjust the center line of the specimen such that the proving ring and the steel ball are in the same line.
5. Fix a dial gauge to measure the vertical compression of the specimen.
6. Adjust the gear position on the load frame to give suitable vertical displacement.
7. Start applying the load and record the readings of the proving ring dial and compression dial for every 5 mm compression.
8. Continue loading till failure is complete.
9. Draw the sketch of the failure pattern in the specimen.

Project : Tested by :

Location : Boring No. :

Depth :

Sample details

Type UD/R : soil description

Specific gravity (G_S) 2.71 Bulk density

Water content Degree of saturation .%

Diameter (D_o) of the sample cm Area of cross-section = cm^2

Initial length (L_o) of the sample = 76 mm

Elapsed time (minutes) 1	Compression dial reading (L) (mm) 2	Strain $\Delta L/L_o$ (%) L } 10 (e) 3	Area A $A_o/(1-e)$ $(cm)^2$ 4	Proving ring reading (Divns.) 5	Axial load (kg) 6	Compressive stress (kg/cm^2) 7

Interpretation and Reporting

Unconfined compression strength of the soil = q_u =

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

Sensitivity = (q_u for undisturbed sample)/ (q_u for remoulded sample).