Laboratory Manual

CE 353

Geotechnical Engineering I

University of Hail

Department of Civil Engineering

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Experiment No. 1

Layout of Geotechnical Lab

1. **Objective:**

- To visit the geo-tech Lab and acquaint the students with the basic working and location of equipment in Lab.
- The objective of plotting the layout of Geotechnical Lab was to introduce the students with the lab apparatus in the lab.

2. **List of Equipment:**

Sr. No.	Name of Equipment
1	
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3	
4	
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10	

3. **Question and Answers**

Question 1: Is geo-tech lab has all facilities of geo-tech investigation?

Question 2: What improvement you need to be done in the Lab?

Experiment No.2

Sieve Analysis of Soil

1. **Objective**

   To carry out sieve analysis of coarse grained soil and draw particles size distribution curve.

2. **Apparatus**

   Set of ASTM sieves containing sieve # 4, 10, 20, 40, 60, 100, 200, lid and pan, Balance sensitive to 0.1gm, Soil pulverizer, Sieve shaker, Soft brush for cleaning, oven dried Soil sample.

3. **Procedure**

   The procedure for the test is as following: -

i. Set the sieves in order so that sieves with largest openings are on the top and gradually reduced size below.
ii. Take oven dried soil sample about 300 to 500gmwhich has already been pulverized. Pour entire sample in to set of sieves.
iii. Place the sieve set in the sieve shaker and shake for 5 to 10 minutes.
iv. Remove the nest of sieves from the sieve shaker and obtain the mass of material retained on each sieve carefully. Compare sum of these mass to the actual mass taken.

4. **Observation and Data Collection**

   The observations to be taken during the test are shown on data Sheet.

Sieve No /Size (in)	Mass Retained (gm.)	Weight Retained %	Cumulated %	Passing %
4 (0.187 in)				
10 (0.0787 in)				
30 (0.0234 in)				
40 (0.0165 in)				
80 (0.0070 in)				
100 (0.0059 in)				

200 (0.0029 in)				
Pan				

Total retained mass =

4. Computation and interpretation

The computation to be done after the practical is as following: -

a. Compute the percent retained (cumulative) on each sieve by dividing the mass retained on each sieve by original sample mass.

b. Compute the percent passing by subtracting with 100% and subtracting the cumulative % retained for that sieve.

(1) % Retained = (Mass of soil retained / Total Mass of sample) x100

(2) % Passing = 100 – Cumulative percent retained

Particles % Retained and Passing on Sieve # 4 = Gravel =_____ %

Particles % Retained on sieve # 200 = Sand =_____ %

Particles Passing from sieve # 200 = Fines (Clay and Silt) = _____ %

c. Draw grain size curve between sieve size and percent passing on semi log paper.

d. Find the Diameter of particles from the graph curve.

D_{10} (Grain dia at 10% passing)	**D_{30} (Grain dia at 30% passing)**	**D_{60} (Grain dia at 60% passing)**	**Cu** **$= D_{60}/ D_{10}$**	**Cc** **$= (D_{30})^2/(D_{60}X\ D_{10})$**

Cu is the coefficient of uniformity, which is a measure of the particles size range.

Cc is the coefficient of curvature, which represents the shape of the particles size distribution curve.

- For well graded gravel **Cu** Greater than 4 and **Cc** between 1 and 3
- For well graded Sand **Cu** Greater than 6 and **Cc** between 1 and 3

5. Question and Answers

Question 1: What is the purpose of sieve analysis?

Question 2: What is the range of fine and coarse sand?

Question 3: The material accumulated in Pan is named as? Also we can do further analysis of this material?

EXPERIMENT NO. 3

Moisture Content by Oven Drying Method

1. **Objective**
   To determine the moisture content of soil by oven drying method

2. **Apparatus**
   Empty clean container, Moist Sample, Oven, Balance accurate to 0.01gm.

3. **Procedure**

a. Take an empty clean container and weigh the container as W_3.
b. Take the soil sample and place it in container and weigh the container with wet soil sample and record the mass as W_1.
c. Place the container with wet soil sample in the oven at constant temperature of 110 ± 5°C for 24 hours.
d. After 24 hours remove the container from oven and weigh the container with dry soil as W_2.

4. **Observation and Data Collection**
   The observations to be taken during the test are shown on data Sheet.

Mass of wet soil + container	$\mathbf{W_1}$			
Mass of dry soil + container	$\mathbf{W_2}$			
Mass of empty container	$\mathbf{W_3}$			
Mass of water ($W1 - W_2$)	$\mathbf{W_w}$			
Mass of soil ($W_2 - W_3$)	$\mathbf{W_s}$			
Moisture content (Ww/Ws) x100 (%)	**M.C**			

Average Moisture Content =

<u>Computation and interpretation</u>

The computation to be done after the practical is as following: -

a. Obtain the mass of water (Ww) in soil and the mass of soil solids in soil (Ws) by using equations:
$Ww = W_1 - W_2$

$Ws = W_2 - W_3$

6. Question and Answers

Question 1: Why we find moisture content?

Question 2: What is the relationship between moisture content and compaction?

Question 3: What is meant by Optimum moisture content?

EXPERIMENT NO. 4

Liquid Limit Test of Soil

1. **Objective**
   To determine the Liquid limit of a cohesive soil

2. **Apparatus**
   Liquid limit device (Casagrande Apparatus), grooving tools, balance, spatula. Evaporating dish, containers, oven, Mortar, pestle and No. 40 sieve with led and pan.

3. **Procedure**

   The procedure for the test is as following:-

   Liquid Limit (L.L)

i. Take 250 gm of soil sample passing through No. 40 (425μm) sieve. Place about 250 gm of soil sample in a dish. Add water very slowly and using spatula, mix the soil thoroughly until it becomes a thick paste. Be careful not to add to much water.

ii. Place a portion of the soil paste in a cup and by means of spatula level and smooth the surface of soil paste.

iii. Cut a clean, straight groove in the paste by drawing grooving tool. This groove must be 5/64" (2mm) at the bottom.

iv. Turn the crank of the liquid limit device at the rate of two blows/ sec, and count the number of blows until the two parts of soil come into contact at the bottom of the groove along a distance of 0.5 inch (12.7mm).

v. Take about 20 to 40 gm sample of paste from the closed part of the groove for moisture content.

vi. Repeat steps 3, 4, 5 and 6 at least 4 times using the same soil sample to which further small increment of water has been added.

vii. The test should always proceed from the drier to the wetter condition.

4. **Observations and Data Collection**

   The observations to be taken during the test are shown on the Data Sheet.

   Computations and Interpretation of Results

   Plot graph between the moisture content along the ordinate versus the No. of blows along the abscissa and draw the best fitting straight line among them. The moisture content corresponding to 25 blows is the liquid limits of the soil.

5. Data Sheet

No of blows	**N**			
Wt of wet soil + container **(g)**	**W_1**			
Wt of dry soil + container **(g)**	**W_2**			
Wt of empty container **(g)**	**W_3**			
Wt of water (W1 -W_2) **(g)**	**W_w**			
Wt of soil (W_2 -W_3) **(g)**	**W_s**			
Moisture content (%) = (Ww/Ws) x100	**M.C**			

Liquid Limit from graph (L.L) = %

6. Question and Answers

Question 1: What is the purpose of liquid limit test?

Question 2: Plot the graph to find liquid limit of soil sample?

Question 3: Soil sample is passed through which sieve for liquid limit test?

EXPERIMENT NO. 5

Plastic Limit Test of Soil

1. Objective

To determine the Plastic limit of a cohesive soil

2. Apparatus

Balance, Spatula, Containers, Oven, Sieve No. 40 with led and pan

3. Procedure

The procedure for the test is as following:-

Plastic Limit (P.L)

i. Take about 20 gm of soil passing No.40 (425μm) sieve. Mix water to make it plastic enough to be shaped into a ball.

ii. Take about 8 gm of the plastic soil, make a ball of it and roll it between the palm and the glass plate with just sufficient pressure to roll the mass into a thread of uniform diameter of 1/8" (3mm) throughout its length. Continue the process until the thread just crumbles at 1/8" (3mm) dia.

iii. Collect the crumbled soil thread in the container for moisture content determination.

iv. Repeat the procedure for 3 to 4 times.

4. Observations and Data Collection

The observations to be taken during the test are shown on the Data Sheet.

Computations and Interpretation of Results

The moisture content at which the thread 1/8 inches is formed is called the plastic limit of soil.

5. Data Sheet

No of blows				
Wt of wet soil + container	W_1			
Wt of dry soil + container	W_2			
Wt of empty container	W_3			
Wt of water (W1 -W_2)	Ww			
Wt of soil (W_2 -W_3)	Ws			
Moisture content =(Ww/Ws) x100 (%)	M.C			

Plastic Limit (P.L) = 13%

Liquid Limit from graph (L.L) = 15%

Plasticity Index (P.I) = (LL –PL) = %

6. Question and Answers

Question 1: What is the purpose of Plastic limit test?

Question 2: What do you mean by plasticity index?

Question 3: What is importance of the plastic limit and liquid limit in soil mechanics?

EXPERIMENT NO. 6

Standard Proctor Test

1. Objective

To determine the Optimum Moisture Content (OMC) and Maximum Dry Density (MDD) of soil by standard proctor test

2. Apparatus

Standard proctor mould, balance, tray, rammer of 2.5Kg (5.5 lb) of fall 25.4 cm (12”), moisture container, oven, sieve 19 mm (3/4”) and 9.5mm (3/8”) and straight edge.

3. Procedure

The procedure for the practical is as follows:-

i. If the soil sample is damp, dry it in air or in an oven. Then, thoroughly break up the aggregations. Select a representative sample, weighing approximately 4kg for standard proctor and 7kg for modified compaction. Pass the representative soil from sieve 19 mm (3/4”). Weigh the retained material on 19mm (3/4”) sieve and discard. Then replace these discard material with material passing from sieve 19 mm (3/4”) and retained on 4.75mm (# 4) sieve.

ii. Mix the selected sample with 2 to 3% water to the sample weight to dampen it to approximately four to six percent points below optimum moisture content.

iii. Compact the sample in 4” mould (with collar attached) in three equal layers for Standard Compaction Test. Compact each layer by 25 distributed blows with rammer dropping free from a height of 30.5 Cm (12”) for Standard Compaction Test.

iv. After compaction, remove the extension collar, trim the compacted soil by means of a straight edge and weigh the mould. Remove the material from the mould and weigh the empty mould.

v. Take a representative sample of the material for moisture content. The moisture sample shall weight not be less than 100 gm.

vi. Thoroughly break up the same sample and add more water and repeat the procedure for each increment of water added. Continue this procedure until there is either a decrease or no change in wet weight of the compacted soil.

4. Observation and Data Collection:-

- Internal dia of proctor mould = inch
- Height of proctor mould = inch
- Volume of proctor mould = A* h
- Standard rammer fall = inch
- Standard rammer weight = lbs
- Number of layers in standard compaction =

Calculation of Density

Observation		1	2	3	4	5
Wt of mould + Compacted soil (gm)	W_1					
Wt of mould (gm)	W_2					
Wt of compacted soil (gm) = W1-W2	W_3					
Volume of mould Cm^3	V					
Wet density of soil, γ_{wet} (gm/Cc)	W_3/V					
Dry density of soil, γ_{dry} (gm/Cc)	$\gamma_{wet}/(1+mc/100)$					

Moisture Content

Observation		1	2	3	4	5
Wt of container + Wet soil (gm)	W_1					
Wt of container + Dry soil (gm)	W_2					
Wt of container (gm)	W_3					

Wt of water (gm)	Ww					
Wt of dry soil (gm)	Ws					
Moisture content (M.C) %	(Ww/Ws)x100					

5. Computations and Interpretation of Results

The computations after the test are as following:-

i. Find out γ_{wet} = W3/V = gm/ cc (lbs/cft).

ii. Find out $\gamma_{dry} = \gamma_{wet} / (1+mc/100)$ = gm/ cc (lbs/cft).

iii. Find out MC= (Ww / Ws) x100 = %

iv. Draw graph between Dry density and moisture content.

v. Find out Optimum moisture content (OMC) and maximum dry density (MDD) by SPT.

6. Question and Answers

Question 1: What do you mean by SPT and OMC?

Question 2: What do you mean by maximum dry density?

Question 3: What is the weight and height of drop of hammer used in SPT test?

EXPERIMENT NO. 7

Modified Proctor Compaction Test

1. Objective

To determine the Optimum Moisture Content (OMC) and Maximum Dry Density (MDD) of soil by standard proctor test

2. Apparatus

Standard proctor mould, balance, tray, rammer of 4.54Kg (10 lb), of fall 38Cm (18"), moisture container, oven, sieve 19 mm (3/4") and 9.5mm (3/8") and straight edge.

3. Procedure

The procedure for the practical is as follows:-

i. If the soil sample is damp, dry it in air or in an oven. Then, thoroughly break up the aggregations. Select a representative sample, weighing approximately 4kg for standard proctor and 7kg for modified compaction. Pass the representative soil from sieve 19 mm (3/4"). Weigh the retained material on 19mm (3/4") sieve and discard. Then replace these discard material with material passing from sieve 19 mm (3/4") and retained on 4.75mm (# 4) sieve.

ii. Mix the selected sample with 2 to 3% water to the sample weight to dampen it to approximately four to six percent points below optimum moisture content.

iii. Compact the sample in 4" mould (with collar attached) in five layers for Modified Compaction Test. Compact each layer by 25 distributed blows with rammer dropping free from a height of 42.7 Cm (18") for Modified Compaction Test.

iv. After compaction, remove the extension collar, trim the compacted soil by means of a straight edge and weigh the mould. Remove the material from the mould and weigh the empty mould.

v. Take a representative sample of the material for moisture content. The moisture sample shall weight not be less than 100 gm.

vi. Thoroughly break up the same sample and add more water and repeat the procedure for each increment of water added. Continue this procedure until there is either a decrease or no change in wet weight of the compacted soil.

4. Observation and Data Collection:-

- Internal dia of proctor mould = 4 inch
- Height of proctor mould = 4.58 inch
- Volume of proctor mould = A* h
- Modified rammer fall = 18 inches
- Modified rammer weight = 10lbs
- Number of layers in Modified compaction = 5

Calculation of Density

Observation		1	2	3	4	5
Wt of mould + Compacted soil (gm)	W_1					
Wt of mould (gm)	W_2					
Wt of compacted soil (gm)	W_3					
Volume of mould Cm^3	V					
Wet density of soil, γ_{wet} (gm/Cc)	W_3/V					
Dry density of soil, γ_{dry} (gm/Cc)	$\gamma_{wet}/(1+mc/100)$					

Moisture Content

Observation		1	2	3	4	5
Wt of container + Wet soil (gm)	W_1					
Wt of container + Dry soil (gm)	W_2					
Wt of container (gm)	W_3					
Wt of water (gm)	Ww					
Wt of dry soil (gm)	Ws					
Moisture content (M.C) %	(Ww/Ws)x100					

5. Computations and Interpretation of Results

The computations after the test are as following:-

i. Find out γ_{wet} = W3/V = gm/Cc (lbs/cft).

ii. Find out $\gamma_{dry} = \gamma_{wet}/(1+mc/100)$ = gm/Cc (lbs/cft).

iii. Find out MC= (Ww / Ws)x100.

iv. Draw graph between Dry density and moisture content.

v. Find out Optimum moisture content (OMC) and maximum dry density (MDD) by MPT.

6. Question and Answers

Question 1: What do you mean by MPT and OMC?

Question 2: What is the difference between SPT and MPT?

Question 3: What is the weight and height of drop of hammer used in MPT test?

Experiment No. 8

Specific Gravity of Soils

1. Objective

Specific gravity of a soil is an important soil parameter that is used together with other soil parameter (such as void ratio, degree of saturation etc) to compute other useful soil parameters.

2. Apparatus Volumetric flask 250 ml, Balance, thermometer, soil pulverizer

3. Procedure

The procedure for the test is as following:-

i. Wash the volumetric flask (Pycnometer) and dry it. Weigh the volumetric flask to the nearest 0.01 gm and record the Mass as W_1.

ii. Take about 50 to 100 gm oven dried pulverize soil sample and put it in to the volumetric flask. Record the Mass of flask and dry soil as W_2.

iii. Add fresh distilled water till a mark specified on the neck of the flask. Heat it gently so as to remove all air voids, cool and Mass. Record the Mass as W_3.

iv. Empty the flask, fill it with distilled water and record the Mass as W_4.

v. Record the temperature of soil mixture.

4. Observations and Data Collection

The observations to be taken during the test are shown on the Data Sheet.

Computations and Interpretation

The Specific gravity of the soil can be computed using the equation: -

$$Gs = ((W_2 - W_1) / [(W_4 - W_1) - (W_3 - W_2)) \times K]$$

Mass of flask	W_1		
Mass of flask + dry soil	W_2		
Mass of flask + soil + Water	W_3		
Mass of flask + Water	W_4		

Specific gravity = $(W_2 - W_1) / [(W_4 - W_1) - (W_3 - W_2) \times K]$	Gs		

Specific Gravity of soil (foundation analysis and design by Joseph E. Bowles)

Gravel ----------2.65 to 2.68, Sand----------2.63 to 2.67, Silt----------2.65 to 2.68,

Clay----------2.67 to 2.9, Organic soil less than 2

5. Question and Answers

Question 1: What do you mean by Specific Gravity of Soil?

The specific gravity we mean the ration of soil with water at equal volume.

Question 2: What is range of specific gravity of gravel and silt?

2 to 3

Question 3: What is range of specific gravity of organic soil?

Less than 2

EXPERNMENT NO.9

Permeability Test for Granular Soil

(Constant Head Method)

1. Objective

To determine the coefficient of permeability for granular soil by constant head method

2. Apparatus

Constant head Permeameter device (including constant head filter tank and manometer tubes), 500ml beaker, Balance Stop watch, and Thermometer.

3. Procedure

i. Measure the inside dia "D" of Permeameter and calculate the cross sectional area "A" of the specimen, length "L" between manometer out lets ,calculate the volume of the specimen needed for length "L". calculate the mass of soil needed for volume. Also calculate the bulk density of soil. Place the prepared soil sample by one of the following procedures in uniform thin layers approximately equal in thickness after compaction to the maximum size of particle, but not less than approximately 15mm (0.6 in).

ii. For soil having a maximum size of 9.5mm (3/8") or less, place the appreciate size of funnel in the permeability device with the spout in contact with lower screen, Or previously formed layer and fill the funnel with sufficient soil to form a layer and spread the soil with a slow spiral motion, so that a uniform layer is formed. Remix the soil in pan for each successive layer to reduce segregation.

iii. Compact successive layers of soil to the desired relative density as follows to a height of about 2 cm (0.8 in) above the upper manometer tube.

iv. Continue placing layers of soil in succession by one of the procedures described in 1 & 2, until the device is filled to the proper level.

v. Level the upper surface of soil, place the upper screen and allow water to flow through the sample for at least 10 minutes in order to saturate it.

vi. When constant head flow condition have achieved, measure the hydraulic head "h" that is h_1 and h_2 across the sample.

vii. Using a 500ml graduated cylinder record the time "t" required to collect water. Repeat two or three additional times until two run agree reasonably well. Also record the temperature "T" of water.

4. Observation and data collection sheet

a. weight of specimen = gm
b. Dia of specimen = cm
c. Length of specimen = cm.
d. Area of specimen = cm^2
e. volume of specimen = cm^3
f. wet density of specimen = gm/ cm^3
g. Head difference " h" =h1-h2 = cm
h. Quantity of water discharged through specimen "Q" (cm^3/ sec)
i. Total time for discharged " t " = 300 (sec)
j. Temperature of water (T) = 25 ºC

Q = kAht/QL

Test No.	**h_1 (cm)**	**h_2 (cm)**	**$h=h_1 - h_2$ (cm)**	**t (Sec)**	**Q (cc/sec)**

The coefficient of permeability can be computed the following equation

k= QL/Ath = (cm/Sec)

Whereas,

K = Coefficient of permeability (cm/Sec) from table No. 1
Q = Quantity (volume) of water discharged during test (cm^3)
L = Length of specimen (cm)
A = Cross sectional area specimen (cm^2)
H = Head (difference in manometer levels) during test ($h_1 - h_2$) in cm

5. Question and Answers

Question 1: What do you mean by permeability of Soil?

The permeability of soil mean pemission of water to pass through the soil

Question 2: Is degree of saturation effect the permeability of soil?

Negative effect on permability

Question 3: What is relation between pore size and permeability of soil?

More pores more permeability

EXPERNMENT NO. 10

Permeability Test for Granular Soil

Falling Head Method

1. Objective

To determine the co-efficient of permeability for fine grain soil by falling head method

2. Apparatus

Falling head Permeameter device, Ring stand with test tube clamp, Burette (100ml), Balance, stop watch, thermometer.

3. Procedure

i. Measure the inside dia "D" of Permeameter, length of the specimen "L".

ii. Weigh the Permeameter mould as $W_{1.}$

iii. Take undisturbed soil sample in the mould and record the weight as $W_{2.}$

iv. Attach the Permeameter with water supply and allow water to flow. This flow period should be permitted to continue until the specimen is saturated.

v. After saturation full the burette with water record some flow periods, record the beginning height of water in burette as h_1 start the stop watch to note the flow period time "t" . denote the closing point as h_2 also note the temperature and note the k value from the table No. 1

4. Observation and data collection sheet

Weight of specimen + mould = W1	=	gm
Weight of mould = W2	=	gm
Weight of specimen W3= (W1-W2)	=	gm
Diameter of specimen	=	cm
Length of specimen	=	cm
Area of specimen	=	cm^2
Volume of mould	=	cm^3
Wet density of soil specimen	=	gm/ cm^3
Temperature of water (T)	=	^oC
Cross-sectional area of burette =a	=	cm^2

Test No.	h_1 (cm)	h_2 (cm)	T (Sec)
1			
2			
3			

The coefficient of permeability can be computed the following equation

$k = (2.3aL/ At) \log h_1 / h_2$

Whereas,

k = coefficient of permeability in cm/sec
a= Cross-sectional area of burette in cm^2
t= Time for water in burette to drop from h_1 to h_2 in cm
L= Length of specimen in cm
A= cross sectional area specimen in cm^2
h_1=Hydraulic head at the beginning of test in cm
h_2= Hydraulic head at the end of test in cm

5. Question and Answers

Question 1: What do you mean by falling test for permeability of Soil?

Question 2: The constant and falling head tests are used for which type of soils respectively?

Question 3: What is relation between head of water and permeability of soil?

EXPERIMENT NO. 11

Direct Shear Test

1. Objective

To determine the shear strength parameter i.e. the angle of internal friction (ϕ)and cohesion (C) of soil.

2. Apparatus

Direct shear machine with complete accessories, dial gauges, sample ejector, sensitive balance and tools for preparing sample.

3. Procedure

i. Take undisturbed soil sample by means of core cutter and eject the sample by ejector.

ii. Place the soil sample in the shear box, so that it is fully in contact with shear box grips.

iii. Put the desire vertical load on hanger but hold it so that the load not applied on the sample.

iv. Set the dial gauges at its zero position.

v. Apply vertical load and horizontal load at the same time and start taking readings. Keep taking readings till the failure occurs.

4. Observation and data Collection

The observations to be taken during the test are shown on the data sheet. Some of the initial readings to be taken before the start for the test are as follow.

Sr. No.	Item	Specification
1	Weight of specimen	
2	Dia of specimen, D	
3	Area of specimen	
4	Each normal load	

Trial No	Normal Load (Kg)	Normal stress (KPa)	Dial Reading	Load (KN)	Shear stress (KPa)
1					
2					
3					

Normal stress = Norma load /area of specimen

Load (force) = Dial reading x Proving ring constant (PRC)

Shear stress = Load / area of specimen

5. Question and Answers

Question 1: What do you mean by direct shear test of Soil?

Question 2: What is drawback in direct shear test of soil?

Question 3: What we find in direct shear test of soil?

EXPERMENT NO.12

Unconfined Compression Test

1. Objective

To determine the un-drained shear strength parameter i.e. cohesion of soil

2. Apparatus

Unconfined compression testing machine, sample ejector, trimming device and balance.

3. Procedure

The procedure for the test is as follows:-

i. Prepare 1.5in diameter, 3in long or 2in diameter, 4in long sample by jacking a thin walled lubricated tube into the undisturbed or compacted soil sample. Eject the sample from the mould by means of sample ejector and trim it.

ii. Place the sample between the loading platens of testing machine. Adjust the deformation and proving ring dial gauges to zero.

iii. Start the test by loading the specimen at a constant rate of strain, and record load and deformation readings simultaneously every 30 seconds or at every 25 deformation reading until the load decreased by at least two readings or remain constant by two readings beyond 20% strain.

iv. Repeat the test for one or more specimen.

4. Observation and Data Collection

The observations to be taken during the test are shown on the data sheet. Some of the initial readings to be taken before the start for the test are as following.

DATA SHEET

A	Weight of specimen	gm
B	Diameter of specimen, D	cm
C	Initial Area of specimen, Ao	cm^2
D	Initial height of specimen , Lo	cm
E	Proving ring constant (PRC)	Kg/ Divn

1Kpa = 0.1 bar = 0.0102 kg/cm^2

DATA SHEET

Deformation		**Axial Strain**	**X- sec Area**	**Proving ring Dial Reading**	**Applied Axial force (kgf)**	**Unit Axial Load (kg/cm^2)**
Dial Reading (DR)	**DR x Gauge least count (mm)**	**Є**	**Ac (cm^2)**			
1	2	3=2/Lo	4= Ao/(1- Є)	5	6=5xPRC	7=6/4

5. Question and Answers

Question 1: What do you mean by unconfined compression test of Soil?

Question 2: Is unconfined test can be used for sand samples?

Question 3: What is the relationship of length and diameter of the sample for testing?

EXPERIMENT NO. 13

Tri-axial Compression Test

1. Objective

To determine the shear strength parameter i.e. the angle of internal friction (ϕ) and cohesion (C) of soil in term of total stresses by Unconsolidated un drained tri-axial test.

2. Apparatus

Tri-axial compression machine, tri-axial cell, rubber membrane stretcher, O-ring etc.

3. Procedure

The procedure for the test is as follows:

i. Take out the exact size of sample by means of sampler and ejector. The size of sample to be tested is 5 cm dia and 10 cm long or 10 cm and 20 cm long. Slip two rubber O- rings over each end of a suction membrane stretcher an apply vacuum.

ii. Place the specimen on lower platen and insert sample into the membrane. Attach the upper platen. Release suction and roll off the rubber O-ring to grip and seal the ends of the membrane on to the top and bottom platen.

iii. Apply a predetermined Cell pressure δ_3 by means of water pressure. Raise the loading plat form of the testing machine to bring the loading ram close the loading cap with the ram about 0.5 cm above the sample. Start the motor drive at the rate to be used during the test and adjust the dial gauge on proving ring to zero. Attach a deformation dial to the machine and set it to zero.

iv. Set the compression machine to the desired strain rate. Start the machine and take load and deformation dial readings at suitable intervals till the load holds constant or begins to decrease.

4. Observation and Data Collection

The observations to be taken during the test are shown on the data sheet. Some of the initial readings to be taken before the start for the test are as following,

A	Weight of specimen	gm
B	Dia of specimen, D	cm
C	Area of specimen, Ao	cm^2
D	Initial height of specimen, Lo	cm
E	Proving ring constant (PRC)	Kg/ Divn
F	Cell Chamber pressure	Kpa

1Kpa = 0.1 bar = 0.0102 kg/cm^2

DATA SHEET

Deformation		**Axial Strain Є**	**X- sec Area Ac (cm^2)**	**Proving ring Dial Reading**	**Applied Axial force (kgf)**	**Unit Axial Load (kg/cm^2)**
Dial Reading (DR)	**DR x Gauge least count (mm)**					
1	2	3=2/Lo	4= Ao/(1- Є)	5	6=5xPRC	7=6/4

6. Question and Answers

Question 1: What do you mean by tri-axial test of Soil?

Question 2: Which type of soil can be used for tri-axial testing?

Question 3: What type of tri-axial test can be performed with soil sample?