

2014

Soil Mechanics Laboratory Manual



**Civil Engineering Department
BRCM College of Engg. & Tech.
Bahal-127 028, Bhiwani
Haryana**



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EXPERIMENT NO. 1:

Object

Determination of moisture content (water content) of soil.

Apparatus

Drying oven, Non-corrodible metal cans with lids, Balance (0.001 g accuracy for fine-grained soils), Spatula, Gloves, Tongs.

Procedure

1. Record the number of can and lid. Clean, dry, and record their weight.
2. Using a spatula, place about 15-30 g of moist soil in the can. Secure the lid, weigh and record.
3. Maintain the temperature of the oven at $110 \pm 5^\circ\text{C}$. Open the lid, and place the can in the oven. Leave it overnight.
4. After drying, remove the can carefully from the oven using gloves or tongs. Allow it to cool to room temperature.
5. Weigh the dry soil in the can along with lid.
6. For each soil, perform at least 3 sets of the test.

Tabulate observations and results of the tests as shown.

Test No.	1	2	3	4
Can No.				
Mass of can with lid, W_1 (g)				
Mass of can with lid + wet soil, W_2 (g)				
Mass of can with lid + dry soil, W_3 (g)				
Mass of water, $W_w = W_2 - W_3$ (g)				
Mass of dry soil, $W_s = W_3 - W_1$ (g)				
Moisture content, $w = \frac{W_w}{W_s} \times 100$ (%)				

Result

Average moisture content, w (%) =



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EXPERIMENT NO. 2:

Object

Determination of the specific gravity of soil particles finer than 2 mm.

Apparatus

Small pycnometer (density bottle of 50 ml capacity), Balance (accuracy 0.001 g), Funnel, Spoon, Distilled and deaired water, Vacuum pump, Thermometer.

Procedure

1. Wash, dry and weigh the pycnometer.
2. Place about 10 g of dry soil sample in the pycnometer. Weigh the bottle with the soil.
3. Add sufficient deaired water to cover the soil, and connect the bottle to a vacuum pump to remove all entrapped air.
4. Disconnect the pump and fill the bottle with water up to the calibration mark.
5. Clean the exterior surface of the bottle pycnometer with dry cloth, and weigh the bottle with contents.
6. Empty the bottle and clean it. Fill it with distilled water up to the mark and record its weight.
7. Conduct the test for 3 times.

Test temperature (°C) =

Test No.	1	2	3
Pycnometer / Density bottle No.			
Mass of pycnometer, W_1 (g)			
Mass of pycnometer + dry soil, W_2 (g)			
Mass of pycnometer + soil + water, W_3 (g)			
Mass of pycnometer + water, W_4 (g)			
Specific gravity of soil, $G_s = \frac{(W_2 - W_1)}{(W_2 - W_1) - (W_3 - W_4)}$			

Result

Average specific gravity of soil grains =



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EXPERIMENT NO. 3:

Object

Determination of quantitative size distribution of particles of soil down to fine-grained fraction.

Apparatus

Set of sieves (4.75 mm, 2.8 mm, 2 mm, 1 mm, 600 micron, 425 micron, 300 micron, 150 micron, 75 micron), Balance (0.1 g accuracy), Drying oven, Rubber pestle, Cleaning brush, Mechanical shaker.

Procedure

1. Take a suitable quantity of oven-dried soil. The mass of soil sample required for each test depends on the maximum size of material.
2. Clean the sieves to be used, and record the weight of each sieve and the bottom pan.
3. Arrange the sieves to have the largest mesh size at the top of the stack. Pour carefully the soil sample into the top sieve and place the lid over it.
4. Place the sieve stack on the mechanical shaker, screw down the lid, and vibrate the soil sample for 10 minutes.
5. Remove the stack and re-weigh each sieve and the bottom pan with the soil sample fraction retained on it.

Observations and Calculations

Initial mass of soil sample taken for analysis (kg) =

Sieve size (mm)	Mass of sieve (g)	Mass of sieve + soil (g)	Soil retained (g)	Percent retained (%)	Cumulative percent retained (%)	Percent finer (%)
4.75 mm						
2.8 mm						
2 mm						
1 mm						
600 micron						
425 micron						
300 micron						
150 micron						
75 micron						
Pan						



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1. Obtain the mass of soil retained on each sieve. The sum of the retained masses should be approximately equal to the initial mass of the soil sample.
2. Calculate the percent retained on each sieve by dividing the mass retained on the sieve with the total initial mass of the soil.
3. Calculate the cumulative percent retained by adding percent retained on each sieve as a cumulative procedure.
4. Calculate the percent finer by subtracting the cumulative percent retained from 100 percent.
5. Make a grain size distribution curve by plotting sieve size on log scale and percent finer on ordinary scale.
6. Read off the sizes corresponding to 60%, 30% and 10% finer. Calculate the uniformity coefficient (C_u) and the curvature coefficient (C_c) for the soil.



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EXPERIMENT NO. 4:

Object

Determination of the liquid and plastic limits of a soil.

Apparatus

Liquid limit device and grooving tools, Metal rod of 3 mm diameter, Apparatus for moisture content determination, Porcelain evaporating dish, Spatula, Wash bottle filled with distilled water, Measuring cylinder, Glass plate.

Procedure for Liquid Limit

1. Take about 150 gm of dry soil passing 425 micron sieve, and mix it with distilled water in a porcelain dish to form a uniform paste.
2. Place a portion of the paste in the cup of liquid limit device with a spatula, press the soil down to remove air pockets, spread it to a maximum depth of 10 mm, and form an approximately horizontal surface.
3. By holding a grooving tool perpendicular to the cup, carefully cut through the sample from back to front, and form a clean straight groove in the centre by dividing into two halves.
4. Turn the crank handle of the device at a steady rate of two revolutions per second. Continue turning until the two halves of the groove is closed along a distance of 13 mm. Record the number of blows to reach this condition.
5. Take about 15 gm of the soil from the joined portion of the groove to a moisture can for determining water content.
6. Transfer the remaining soil from the cup into the porcelain dish. Clean and dry the cup and the grooving tool.
7. Repeat steps 2 to 6, and obtain at least four sets of readings evenly spaced out in the range of 10 to 40 blows.

Procedure for Plastic Limit

1. Use the remaining soil from the porcelain dish.
2. Take about 10 gm of the soil mass in the hand, form a ball, and roll it between the palm or the fingers and the glass plate using complete motion of the hand forward and reverse.
3. Apply only sufficient pressure to make a soil thread, and continue rolling until a thread of 3 mm diameter is formed. Comparison can be made with the metal rod.



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4. If the diameter becomes less than 3 mm without cracking, turn the soil into a ball again, and re-roll. Repeat this remoulding and rolling process until the thread starts just crumbling at a diameter of 3 mm.
5. Gather the pieces of crumbled thread and place them in a moisture can for determining water content.
6. Repeat steps 2 to 5 at least two more times with fresh samples of 10 gm each.

Observations and Calculations

Determination of Liquid Limit

Test No.	1	2	3	4	5
No. of blows					
Can No.					
Mass of can (g)					
Mass of can + wet soil, (g)					
Mass of can + dry soil, (g)					
Mass of water (g)					
Mass of dry soil (g)					
Water content (%)					

Calculate the water contents, and plot the number of blows (on log scale) versus the water content (on ordinary scale). Draw the best-fit straight line through the points.

Liquid Limit = Water content corresponding to 25 blows

Determination of Plastic Limit

Test No.	1	2	3	4	5
Can No.					
Mass of can (g)					
Mass of can + wet soil, (g)					
Mass of can + dry soil, (g)					
Mass of water (g)					
Mass of dry soil (g)					
Water content (%)					

Plastic Limit = Average of the computed water contents



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EXPERIMENT NO. 5:

Object

Determination of the coefficient of permeability of a soil using constant head apparatus or variable head apparatus.

Apparatus

Permeameter mould and accessories, Circular filter papers, Compaction device, Constant head reservoir, Graduated glass standpipes along with support frame and clamps, Measuring flask, Stop-watch.

Procedure for Constant Head Test

1. Take 2.5 kg of dry soil and prepare it to obtain desired water content.
2. Apply little grease on to the interior sides of the permeameter mould.
3. Keep a solid metal plate in the groove of the compaction base plate. Assemble the base plate, mould and collar. Compact the soil into the mould.
4. Remove the collar and base plate, and replace the solid metal plate with a porous stone covered with filter paper.
5. Trim off excess soil from the top of the mould and place another porous stone with filter paper on it. Attach the top cap of the permeameter.
6. Connect a constant head reservoir to the bottom outlet of the mould. Open the air vent of the top cap, and allow water to flow in and upwards till the soil gets saturated.
7. Disconnect the reservoir from the bottom outlet and connect it to the top inlet. Close the air vent and allow water to establish a steady flow.
8. Collect the water in a measuring flask for a convenient time interval. For similar time intervals, measure the flow quantity for at least three times.
9. After the test, measure the temperature of the water.

Procedure for Variable Head Test

1. Follow the same steps 1 to 6 as for the constant head test.
2. Disconnect the reservoir from the bottom outlet and connect a selected standpipe to the top inlet.



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3. Fill the standpipe with water, close the air vent and allow water to flow .
4. Open the bottom outlet and record the time interval required for the water surface in the standpipe to fall between two levels as measured from the centre of the outlet.
5. Measure time intervals for similar drops in head at least three times after re-filling the standpipe.
6. At the end of the test, measure the temperature of the water.

Observations and Calculations

Constant Head Flow

Diameter of sample, D (cm) =

Length of sample, L (cm) =

Area of sample, A (cm²) =

Volume of sample, V (cm³) =

Initial mass of sample, W (g) =

initial water content, w (%) =

Moulding density (g/cm³) =

Head loss, h (cm) =

Hydraulic gradient, i = h / L =

Temperature of water, T (°C) =

Test No.	1	2	3
Time interval, t (sec)			
Quantity of flow, Q (cm ³)			
Coefficient of permeability (cm/sec), $k = \frac{Q}{Ait}$			

$$C_T = \frac{\eta_T}{\eta_{27}}$$

Correction factor due to temperature, η is viscosity of water.

Permeability at 27°C = Average of the computed values x C_T



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Variable Head Flow

Diameter of standpipe, d (cm) =

Cross-sectional area of standpipe, a (cm²) =

Test No.	1	2	3
Initial head, h ₁ (cm)			
Final head, h ₂ (cm)			
Time interval in seconds, (t ₂ - t ₁)			
$k = \frac{2.3La \log_{10} \left(\frac{h_1}{h_2} \right)}{A(t_2 - t_1)}$ Coefficient of permeability (cm/sec),			

Permeability at 27°C = Average of the computed values x C_T



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EXPERIMENT NO. 6:

Object

Determination of the in-situ density of soils by core cutter method or sand replacement method.

Core Cutter Method

Apparatus

Cylindrical core cutter, Dolly, Rammer, Balance (1 g accuracy), Spade, Straight edge knife, Sample extruder, Apparatus for moisture content determination.

Procedure

1. Measure the internal dimensions of the core cutter and weigh it.
2. Clean and level the site surface where the field density is to be determined.
3. Place the dolly on the cutter and press both into the soil using the rammer until only about 15 mm of the dolly protrudes above the surrounding soil surface.
4. Remove the soil around the cutter with the spade, lift up the cutter, and trim carefully the top and bottom surfaces of the soil sample.
5. Clean the outside surface of the cutter and weigh it with the soil.
6. Remove the soil core from the cutter and take three representative samples in moisture cans for water content determination.

Sand Replacement Method

For hard and gravelly soils, the core-cutter method is not suitable. In its place, sand replacement method can be used, and it involves making a hole in the ground, weighing the excavated soil and determining the volume of the hole.

Apparatus

Sand pouring cylinder, Calibrating cylinder, Clean and dry sand, Metal tray with a central circular hole, Balance (1 g accuracy), Glass plate, Trowel, Scraper tool, Apparatus for moisture content determination.

Procedure

1. An inverted cone forms the base of the sand pouring cylinder, and a shutter at the cone tip controls the release of sand through a uniform free fall.



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2. First determine the bulk density of the sand to be used in the field. For this, measure the internal dimensions of the calibrating cylinder so as to obtain its volume. Fill the pouring cylinder with sand and weigh. Place it concentrically on top of the calibrating cylinder, and allow sand to run out and fill both the calibrating cylinder and the inverted conical portion.
3. To obtain only the mass of sand filling up the conical portion, lift the pouring cylinder and then weigh with remaining sand. Place it on a glass plate, and allow sand to run out. Weigh again the pouring cylinder with left over sand.
4. Calculate the mass of sand that fills up the calibrating cylinder, and from its known volume, work out the bulk density of the sand for the allowed free fall.
5. Clean and level the site surface, and place the square tray with a central hole. Excavate a hole of diameter equal to that of the tray hole and depth equal to about 15 cm. Collect the excavated soil in the tray, weigh and then take representative samples for water content determination.
6. Fill the pouring cylinder with the same sand, place it concentrically over the hole, open the shutter and allow sand to fill up the hole.
7. When there is no further movement of sand, close the shutter, remove the cylinder and weigh it with the remaining sand.

Core Cutter Method

Observations and Calculations

Size of box (mm) =
Area of box (cm²) =
Volume of box (cm³) =

Least count of displacement dial gauge (mm/div.) =
Proving ring constant (kg/div.) =

Soil Specimen No. =

Mass of soil (kg) =
Density of soil (kg/cm³) =
Normal stress applied (kg/cm²) =



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Horizontal dial reading (Div)	Horizontal displacement (mm)	Shear strain	Load dial reading (Div)	Horizontal shear force (kg)	Shear stress (kg/cm ²)

1. Calculate the density of the soil specimen from the mass of soil and the volume of the shear box.
2. Convert the dial readings to the appropriate displacement and load units by multiplying with respective least counts.
3. Calculate shear strains by dividing horizontal displacements with the specimen length, and obtain shear stresses by dividing horizontal shear forces with the shear area.
4. Plot the shear stress versus horizontal displacement. Read the maximum value of shear stress if failure has occurred, otherwise read the shear stress at 20% shear strain.
5. Plot the maximum shear stress versus the corresponding normal stress for each test, draw the Mohr-Coulomb failure envelope, and determine the cohesion and the angle of shearing resistance of the soil.

Results

Cohesion (kg/cm²) =

Angle of shearing resistance (°) =



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EXPERIMENT NO. 7:

Object

Determination of shear strength parameters of a silty or sandy soil at known density and moisture content.

Apparatus

Shear box with clamping screws, Box container, Porous stones, Grid plates (serrated and perforated), Tamper, Balance, Loading frame, Proving ring, Deformation dial gauges, Apparatus for moisture content determination.

Procedure

1. Measure shear box dimensions, set up the box by fixing its upper part to the lower part with clamping screws, and then place a porous stone at the base.
2. For undrained tests, place a serrated grid plate on the porous stone with the serrations at right angle to the direction of shear. For drained tests, use a perforated grid over the porous stone.
3. Weigh an initial amount of soil in a pan. Place the soil into the shear box in three layers and for each layer apply a controlled amount of tamping with a tamper. Place the upper grid plate, porous stone and loading pad in sequence on the soil specimen. Weigh the pan again and compute the mass of soil used.
4. Place the box inside its container and mount it on the loading frame. Bring the upper half of the box in contact with the horizontal proving ring assembly. Fill the container with water if soil is to be saturated.
5. Complete the assembly, remove the clamping screws from the box, and initialize the horizontal displacement gauge, vertical displacement gauge and proving ring gauge to zero.
6. Set the vertical normal stress to a predetermined value. For drained tests, allow the soil to consolidate fully under this normal load. Avoid this step for undrained tests.
7. Start the motor with a selected speed and apply shear load at a constant rate of strain. Continue taking readings of the gauges until the horizontal shear load peaks and then falls, or the horizontal displacement reaches 20% of the specimen length.
8. Determine the moisture content of the specimen after the test. Repeat the test on identical specimens under different normal stress values.



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Size of box (mm) =

Area of box (cm²) =

Volume of box (cm³) =

Least count of displacement dial gauge (mm/div.) =

Proving ring constant (kg/div.) =

Soil Specimen No. =

Mass of soil (kg) =

Density of soil (kg/cm³) =

Normal stress applied (kg/cm²) =

Horizontal dial reading (Div)	Horizontal displacement (mm)	Shear strain	Load dial reading (Div)	Horizontal shear force (kg)	Shear stress (kg/cm ²)

1. Calculate the density of the soil specimen from the mass of soil and the volume of the shear box.

2. Convert the dial readings to the appropriate displacement and load units by multiplying with respective least counts.

3. Calculate shear strains by dividing horizontal displacements with the specimen length, and obtain shear stresses by dividing horizontal shear forces with the shear area.

4. Plot the shear stress versus horizontal displacement. Read the maximum value of shear stress if failure has occurred, otherwise read the shear stress at 20% shear strain.

5. Plot the maximum shear stress versus the corresponding normal stress for each test, draw the Mohr-Coulomb failure envelope, and determine the cohesion and the angle of shearing resistance of the soil.

Results

Cohesion (kg/cm²) =

Angle of shearing resistance (°) =



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EXPERIMENT NO. 8:

Object

Determination of unconfined compressive strength of a clayey soil either in undisturbed or remoulded condition.

Apparatus

Compression machine, Proving ring, Deformation dial gauge, Timer, Sampling tube, Specimen extruder, Split mould, Specimen trimming tools, Vernier calipers, Balance, Apparatus for moisture content determination.

Procedure

1. Prepare the test specimen, which may be either undisturbed, remoulded or compacted. Undisturbed specimens can be carved from a large soil block, or obtained through a sampling tube from which the specimen can be extruded to a split mould using a sample extruder.
2. Trim the two ends of the soil specimen, remove it from the mould, and measure the length, diameter and weight.
3. Place the specimen on the bottom plate of the compression machine, and adjust the upper plate to make contact with the specimen. Initialize the vertical displacement gauge and proving ring gauge to zero. Select an axial strain rate between 0.5% to 2.0% per minute and apply compression load.
4. Record the load and displacement readings at every 20 to 50 divisions of displacement gauge, or at every 15 seconds.
5. Compress the specimen till the load peaks and then falls, or till the vertical deformation reaches 20% of the specimen length.
6. Remove the specimen from the machine, and take soil samples for water content determination.

Observations and Calculations

Least count of deformation dial gauge (mm/div.) =

Proving ring constant (kg/div.) =

Soil Specimen No. =

Type of specimen: Undisturbed/Remoulded

Initial length of specimen, L_0 (mm) =

Initial diameter of specimen, D_0 (mm) =

Initial area of specimen, A_0 (cm²) =



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[illegible]

1. Convert the dial readings to the appropriate vertical deformation and compressive load units by multiplying with respective least counts.
2. Calculate vertical strain, corrected cross-sectional area and then compressive stress.
3. Plot stress-strain curve, and show unconfined compressive strength q_u as the peak stress or the stress at 20% strain.
4. Draw a Mohr circle using q_u , and determine undrained shear strength s_u = undrained cohesion $c_u = q_u/2$
5. Compute the water content, w (%).

Results

Water content (%) =

Unconfined compressive strength (kg/cm²) =

Undrained shear strength (kg/cm²) =



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EXPERIMENT NO. 9:

Object

Determination of shear strength parameters of soils under triaxial loading conditions.

Apparatus

Triaxial cell, Compression machine, Cell pressure application system, Pore pressure measuring device, Volume change measuring device, Proving ring, Deformation dial gauge, Split mould, Trimming knife, Rubber membrane, Membrane stretcher, Rubber 'O' rings, Balance, Apparatus for moisture content determination.

Procedure

1. Prepare a test specimen of necessary diameter and length, and measure its weight. Place a rubber membrane around the specimen using the membrane stretcher.
2. De-air the outlet line at the pedestal of the triaxial base, place on its top a saturated porous stone with a filter paper disc, and then position the soil specimen with the membrane stretcher around it. Put a loading cap on the specimen top, and seal the membrane on to the bottom pedestal and the top cap with 'O' rings.
3. Assemble the triaxial cell with the loading ram initially clear of the top cap. Fill the cell with water, raise the water pressure to the desired value, and maintain the pressure constant. Raise the platform of the compression machine to bring the ram in contact with the seat on the top cap.
4. Set both the proving ring dial gauge and the deformation dial gauge to zero, select an axial strain rate, and verify that the cell pressure remains constant.
5. For undrained shearing of saturated samples, either close the outlet valve at the base of the cell or connect it to a pore pressure transducer. For drained shearing of saturated samples, connect the outlet to a burette for volume change measurements.
6. Apply axial compression load and take readings of the proving ring at intervals of 0.20 mm vertical deformation till the peak load has been passed, or till the strain reaches 20% of the specimen length. Record also burette or pore pressure readings, as applicable.
7. Remove the axial load, drain the water from the cell, remove the specimen, make a sketch of the failure pattern, and take soil samples for water content determination.
8. Repeat the test on identical soil specimens under different cell pressures.

Observations and Calculations



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Least count of deformation dial gauge (mm/div.) =
Proving ring constant (kg/div.) =

Soil Specimen No. =

Confining cell pressure, σ_3 (kg/cm²) =
Initial diameter of specimen, D_0 (mm) =
Initial length of specimen, L_0 (mm) =
Initial area of specimen, A_0 (cm²) =
Initial volume of specimen, V_0 (cm³) =

Deformation dial reading (ΔL)		Vertical strain $\xi = \frac{\Delta L}{L_0}$	Burette reading (mV) (cm ³)	Pore pressure change (mV) (kg/cm ²)	Proving ring dial reading		Corrected area for undrained test $A = \frac{A_0}{1 - \xi}$ (cm ²)	Corrected area for drained test $A = \frac{V_0 - \Delta V}{L_0 - \Delta L}$ (cm ²)	Deviatoric stress ($\sigma_1 - \sigma_3$) (kg/cm ²)
(div.)	(mm)				(div.)	(kg)			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10) = (7)/A

1. Convert the dial readings to the appropriate vertical deformation and compressive load units by multiplying with respective least counts.

$$A = \frac{A_0}{1 - \xi}$$

2. Calculate vertical strain, and compute corrected area as $A = \frac{A_0}{1 - \xi}$ for undrained tests, and as

$$A = \frac{V_0 - \Delta V}{L_0 - \Delta L} \text{ for drained tests. Determine the deviatoric stress.}$$

3. Plot stress-strain curve, and obtain the peak stress or the stress at 20% strain.

4. Draw Mohr circles using effective principal stresses at failure for all tested specimens. From the Mohr-Coulomb failure envelope, determine the cohesion and the angle of shearing resistance of the soil.

5. Compute the water content, w (%).

Results

Water content (%) =

Cohesion (kg/cm²) =

Angle of shearing resistance (°) =



EXPERIMENT NO. 10

Object

To determine the dry density and optimum moisture content

Theory

Compaction is measured in term of dry density achieved. This is a function of water content, the compactive effort and the nature of soil/aggregate. Standard proctor compaction test apparatus (as shown in figure 4.6) is used to determine optimum moisture content and maximum dry density as per IS: 2720(part 8). This method describes the procedure for determining the relationship between the moisture content and dry density of aggregate. A graph is plotted between dry density and moisture content, the moisture content corresponding to the maximum dry density achieved is known as the optimum moisture content.

$$\text{Dry density} = (M/V) / (1+w)$$

Where M=total mass of soil, V =volume of soil, w = water content

Apparatus

- (1) A cylindrical metal mould with a nominal capacity of 1000ml and internal diameter of 101.6 mm and a height of 116.3 mm. The mould will be fitted with a detachable collar and base plate (figure4.6).
- (2) A metal rammer having a 50.8 mm diameter circular face with a 2.6kg weight which will drop freely for a distance of 450 mm.
- (3) Set of IS sieve
- (4) Desiccators
- (5) Weighting balance
- (6) Graduated jar
- (7) Mixing tools- trowels, spoons



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PROCEDURE

- (1) Take about 5 kg of air dried soil/GSB/WMM sample. Sieve it through 20mm and 4.75 mm sieves.
- (2) Calculate the percentage retained on 20mm sieve, 4.75 mm sieves and the percentage passing 4.75 sieves. Do not use the aggregate retained on 20mm sieve. Determine the ratio of fraction retained and that passing 4.75mm sieve.
- (3) If percentage retained on 4.75mm sieve is greater than 20, use the larger mould of 150mm diameter. If it is less than 20% the standard mould of 100 mm diameter can be used.
- (4) Clean and dry the mould and the base plate. Grease them lightly.
- (5) Weight the mould with the base plate.
- (6) Take the sample and add water according to the sample requirement.
- (7) Take the sample on the mould in three different layers. Each layer is compacted properly with the rammer by giving 25 blows to each layer.
- (8) Remove the collar and trim off the excess material projecting above the mould using a straight edge.
- (9) Clean the base plate and the mould from the outside and Weight the sample.
- (10) Remove the soil from the mould.
- (11) Take the sample for the water content determination.

CALCULATION

Dry density= $(M/V) / (1+w)$