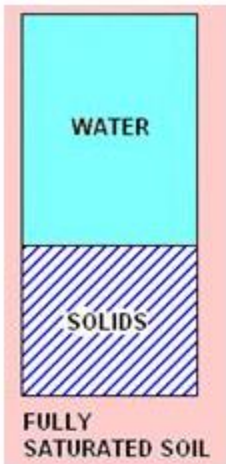
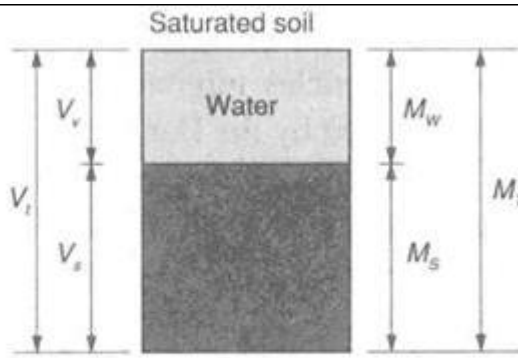
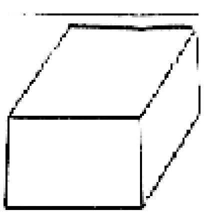
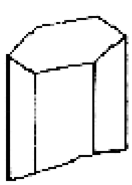
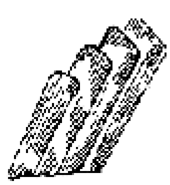
# WINTER-14 EXAMINATION

**Subject code: 17420** **Model Answer** **Pages:- 22**

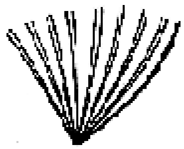
**Important Instructions to examiners:**

1) The answer should be examined by keywords and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language error such as grammatical, spelling errors should not be given more importance.(Not applicable for subject English and communication skill).
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figure drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In the some cases, the assumed constants values may vary and there may be some difference in the candidates answer and model answer.
6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidates understanding.

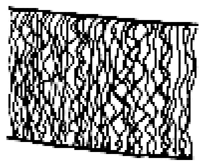
| **Q1) A** | **Attempt any SIX of the following** | **12** |
|---|---|---|
| **a)** | **State any four physical properties of minerals.** | |
| | i) External appearance and Internal Structure ii) Cleavage iii) Fracture iv) Hardness v) Specific gravity vi) Colour vii) Steak viii) Luster | ½ mark each any Four |
| **b)** | **State any two engineering uses of igneous rock.** | |
| | i) They are used architecturally as decorative work for flooring and walls<br>ii) Crushed igneous rock can be used as aggregate for extremely high strength concrete | 1<br>1 |
| **c)** | **Define outcrop and fold of rock.** | |
| | i) Out crop: The dip and strike of beds can be easily measured in the field from their exposures called outcrops<br>ii) Fold: Folds may be defined as undulations or bends that are developed in the rock of the Earth's crust, as a result of stresses (commonly lateral compression) To which these rock have been subjected to, from time to time in the past history of the Earth. | 1<br>1 |
| **d)** | **What do you mean by normal and reverse fault?** | |
| | i) Normal fault: A normal fault is the one in which the hanging wall has apparently moved down with respect to the foot-wall<br>ii) A Reverse fault is one in which the hanging wall has apparently moved up with respect to the footwall A reverse fault is that thrust which dips more than $45^0$ | 1<br>1 |
| **e)** | **Define water content and voids ration of soil.** | |
| | i) Water content: The water content w, also called as moisture content, is defined as the ratio of weight of water Ww to the weight of solids (Ws or Wd)in a given mass of soil w= Ww/Wd x 100<br>ii) Voids Ratio: Voids ratio e of a given soil sample is the ratio of the volume of voids to the volume of soil solids in the given soil mass. e=Vv/Vs | 1<br>1 |
| **f)** | **Define soil as per IS.** | |
| | As per Indian standards 2809-1972:<br>Soil is the sediment or other unconsolidated accumulation of solid particles produced by physical and chemical disintegration of rock. | 2 |
| **g)** | **Explain the use of soil as foundation material.** | |

| | | |
|---|---|---|
| | i) The foundation is rest on the soil<br>ii) Soil-cement mixture used as sub grade.<br>iii) Pervious and impervious soil is used in earthen dams<br>iv) Soil used as bed of foundation | 1 mark each any Two |
| **h)** | **Draw three phase diagram for fully saturated soil.** | |
| |     | 2 |
| **B )** | **Attempt any two of the following** | **8** |
| **a)** | **Explain different types of forms occurring in rock minerals.** | |
| i) | ii) Tabular structure: The mineral is flat than elongated<br><br>iii) Columnar: When the mineral is composed of thin and thick columns, some times flattened.<br><br>iv) Bladed: When the marginal appears as if it is composed of thin blade like parts<br> | 1 mark each any Four |

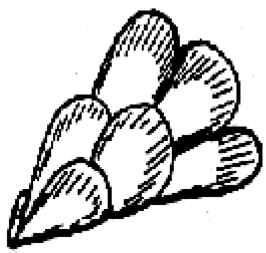
v) Acicular: When the mineral consist of thin sharp and slender needles



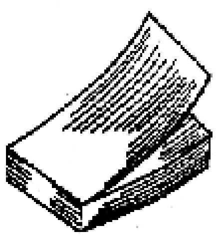
vi) Fibrous: When the mineral is made up of thread like fibres



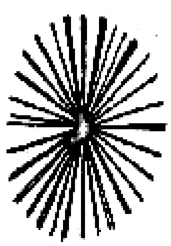
vii) Reniform: When the mineral possesses rounded prominences like those of kidney



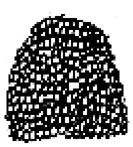
viii) Foliated: When the mineral consist of thin and separable sheets



ix) Radiating: When the fibres or needles are arranged around a central point



x) Granular: When the mineral contain numerous coarse or fine grains.



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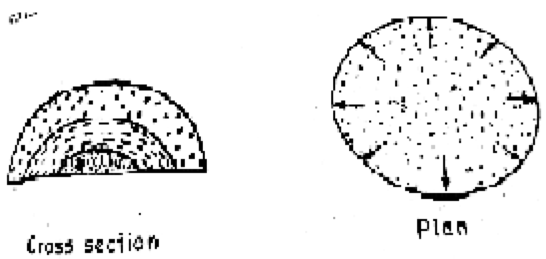
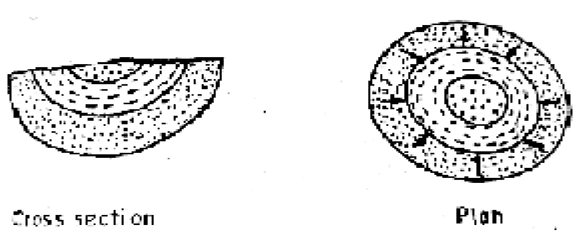
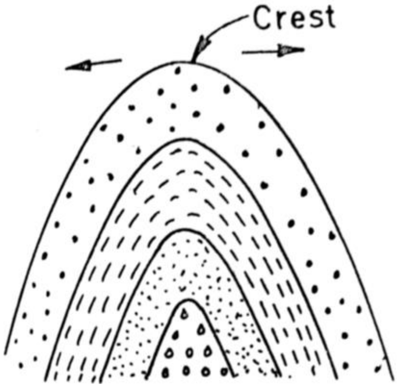
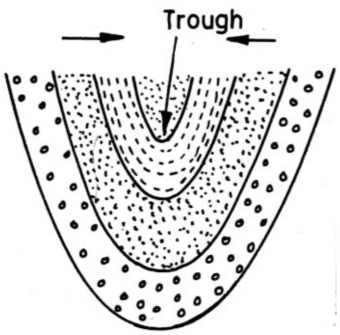
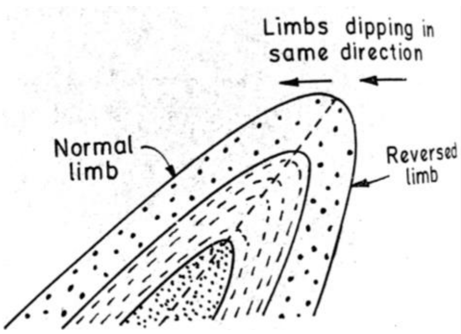
| **b)** | **Explain different types of folds occurs in rock.** | |
| | Folds generally do not occur singularly but in fact they often form a group in which individual members exhibit many similarities as well as dissimilarities<br>1. Anticlinorium: An anticlinorium fold is a large anticline which is further throw into smaller fold<br><br>2. Synclinorium: Syclinorium is a large syncline further consisting of smaller folds are very large in size<br>3. Domes and Basins: A dome is a special type of anticline in which the beds dip away from the central point in all directions.<br><br><br>4. A Basin is a special type of syncline in which the beds dip towards central point from all directions. In outline, domes and basins are generally oval or nearly circular in shape<br><br><br>5. Anticlines: Beds are up folded into arch like structure. | 1M each<br>Any four |



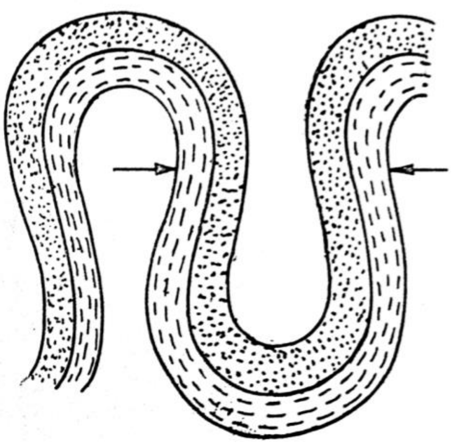

6. Sydine: Beds are down folded into a trough like structure.



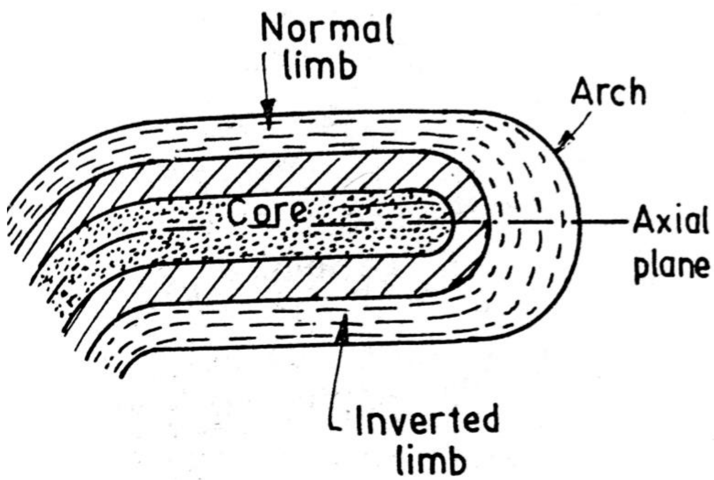

7. Overturned folds: Both the limbs of  afold may get overturned because of very high compression



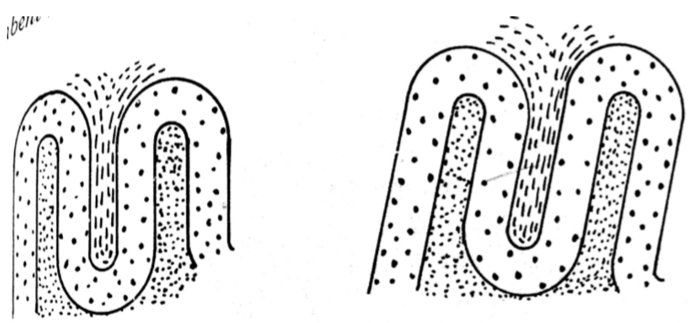

8. Fan fold: limbs dipping away from each other



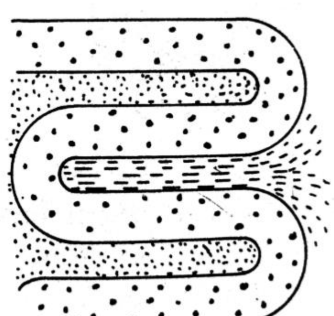
9. Recumbent Folds: One limb lies vertically above the other.




10. Isocline Folds: These folds may be vertical, inclined or horizontal are called as vertical isoclinal fold, inclined isoclinal fold, recumbent isoclinal fold.

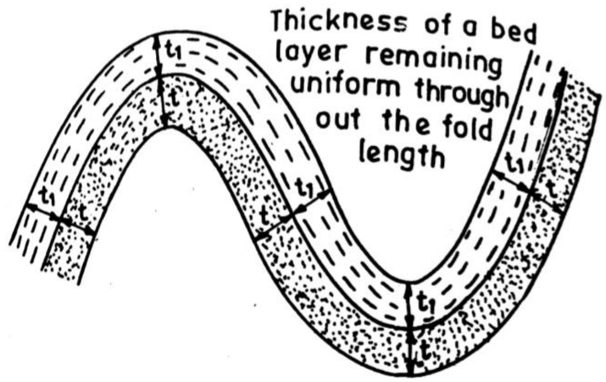


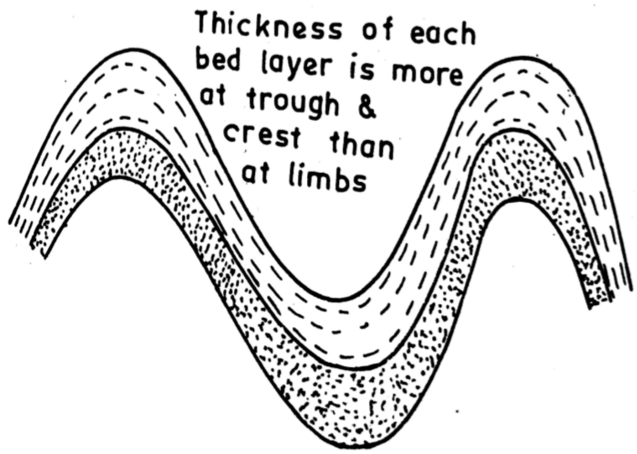
(a) Vertical Isoclinal fold (b) Inclined isoclinal folds



(c) Recumbent isoclinal folds

11. Open fold and closed fold: Thickness of bed is same throughout the layer are called as open fold and thickness is more at trough and crest at the limbs is called closed fold.

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| **c)** | **Explain any four field applications of geotechnical engineering knowledge.** | |
| | The field of geotechnical Engineering includes some important applications as:<br>a) Foundation design b) Pavement Design c) Design of earth retaining structures<br>d) Design of earth dams e) Design of embankments f) Underground structures<br>a) Foundation design: Foundation is most important to required to transmit the load of structure to soil safely and efficiently. Bearing capacity of soil is essential to knowledge of stress distribution below the loaded area, settlement of foundation, effect of vibration, effect of ground water.<br>b) Pavement Design: A pavement is hard crust placed on soil for the purpose of providing a smooth and strong surface on which vehicles can move. Thickness of pavement depends upon subsoil and its component parts. It is also depend on the effect of repetition of loading intensity of traffic, construction materials, earth fills or cut etc.<br>c) Design of Earth Retaining Structures: When sufficient space is not available for a mass of soil to spread and form a slope, structure is required to retain the soil. An earth | 1M each for any four |

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| | retaining structure is also required to keep the soil at different levels on it either side. The retaining structure may be a rigid retaining wall or a sheet pile bulkhead which is relatively flexible. The knowledge of the active earth pressure, passive earth pressure, density and moisture content is essential for design of earth retaining structures. The geotechnical engineering gives the theory of earth pressure on retaining structures.<br>d) Design of Earthen Dams: In construction of earthen dam, soil is main constituent, which may be homogeneous and heterogeneous. Therefore, its design requires thorough knowledge of index properties, plasticity characteristics, particle size distribution, specific gravity, permeability, consolidation, compaction and shear strength etc. Determination of optimum moisture content at which maximum density will occur is most essential for the design of earthen dam. | |
| **Q.2** | **Attempt any four of the following -** | **16** |
| **a)** | **Explain the formation process of soil. State various types of soils available in india.** | |
| | Soils are formed by numerous process of weathering both physical and chemical. A boulder pried loose from the side of mountain by rapidly flowing water of river and came along with the water ay has result of abrasive impact forces converted into sandy soil similarly due to other physical weathering process and environmental conditions.<br>Type of soil available in India:<br>i) Gravel ii) sand iii) silt iv) clay v) organic vi) peat | 2M<br><br>1M each for any two types |
| **b)** | **define the terms related to earthquake:**<br>**i) Focus**<br>**ii) Epicentre**<br>**iii) Intensity**<br>**iv) Seismograph** | |
| | i) Focus: The focus is the place beneath the Earth's surface from where an earthquake originates.<br>ii) Epicenter: The point or line on the Earth's surface immediately above the focus is called Epicenter<br>iii) Intencity: The intencity of an earthquake which expresses the violence of movement at any place depends on the distance of the place from the epicenter<br>iv) Seismograph: The energy released during faulting, produces seismic waves, which can be detected by sensitive and delicate instruments, called seismograph. | 1M<br>1M<br><br>1M<br><br>1M |

| | | |
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| **c)** | **State any two causes and effect of an earthquake.** | |
| | Possible cause of an earthquake are classified into two categories<br>i) Tectonic earthquakes<br>ii) Non-tectonic earthquakes<br>The tectonic earthquakes are perhaps caused by the slippage or movement of the rock masses along the rupture or break.<br>The non tectonic type of earthquakes includes earthquakes caused by a number of easily understandable processes such as volcanic eruption superficial movement like landslides.<br>These are generally very severe and area affected is often very large<br>All such processes may introduce vibrations into the ground by jerk | 1<br><br><br>1<br><br>1<br>1 |
| **d)** | **Enlist various types of seismic waves. How it can be recorded?** | |
| i) | ii) P or Primary waves<br>iii) S or Secondary waves<br>iv) L or long waves<br>The vibrations that are set up when an earthquake propagated as number of different types of waves. Different types seismograph are designed to record these waves, and seismological stations equipped with various types of seismograph have been set up all over the world. A major shock recorded by seismograph and its epicenter, time of origin, depth of focus, magnitude etc. | 2<br><br>2 |
| **e)** | **State the types of earthquakes based on focus and Richter scale.** | |
| | Earthquakes based on focus distributed in three general depth ranges:<br>i) Shallow earthquakes originate within about 60 kilometers of the surfaces<br>ii) Intermediate earthquakes have foci between 60 to 300 kilometers down<br>iii) Deep seated earthquakes originate at depths below 300 kilometers<br>The Richter scale of magnitude infact, classifies the various shocks in magnitude varying from 1to 10<br>i) Magnitude from 3 to 9 maximum known as 8.9<br>ii) Smaller than 5 causes several damages<br>iii) Magnitude 2 represents the smallest tremor that can be felt. | 2<br><br>2 |
| **f)** | **Explain the determination of plastic limit of given soil sample.** | |
| | Plastic limit is the boundary between plastic and semi-solid state of soil. It is also define as the minimum moisture content at which the soil can be rolled in to 3 mm thread without showing any sign of cracks.<br>Procedure:<br>1) Sieve the soil sample through 425 micron IS sieve.<br>2) Take 20 gm of soil sample and mix it with distilled water till the soil becomes | 1M each for any four points |

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| | plastic enough to be moulded with fingers.<br>3) Prepare a ball of uniform diameter of the above wet sample.<br>4) Roll it on glass plate with just sufficient finger pressure till 3 mm diameter threads are formed.<br>5) Take a portion of crumbled soil thread and find its moisture content by<br>$W = \frac{W1 - W2}{W2} \times 100$<br>Where, W= % moisture content<br>W1 = Weight of wet soil thread<br>W2 = Wet of dry soil thread<br>6) Take three observations and record the average value as the plastic limit of given sample of soil. | |

| **Q3.** | Solution | 16M |
|---|---|---|
| **a)** | **1. Find coefficient of curvature for soil particle.**<br>Coefficient of curvature = $C_c = \frac{(D_{30})^2}{(D_{10})\,x\,(D_{60})}$<br>Coefficient of curvature = $C_c = \frac{(1.78)^2}{(0.43)\,x\,(2.39)} = 3.08$<br>**2. Coefficient of Uniformity**<br>Coefficient of Uniformity: - $\frac{(D_{60})}{(D_{30})} = \frac{2.39}{1.78} = 1.343$ | 2M<br>2M |
| **b)** | **Explain any four Factor Affecting Permeability of Soil.** | |
| | Factors Affecting Permeability of Soil: -<br>**Factors affecting Permeability of Soil:-**<br>**1. Grain Size: -** Permeability varies approximately as the square of the grain size. The permeability of coarse grain soil is more than fine grained soil. The permeability can be expressed as $k=CD_{10}^2$. Where 'k' is coefficient of permeability in (cm/sec) & $D_{10}$ is the effective grain size of soil.<br>**2. Effect of properties of Pore Fluids:-** The permeability is directly proportional to unit weight of water and inversely proportional to its viscosity. The unit weight of water does not change much with change in temperature but viscosity changes with change in temperature.<br>**3. Effect of void ratio:-** Increase in void ratio increases the area available for flow hence permeability increases for critical condition..<br>**4. Effect of structural arrangement of particles and stratification: -** The structural arrangement of particle may vary at the same void ratio depending upon the method of compacting of soil mass. The structure may be entirely different for a disturbed sample as | 1M each any (Four Factors) |

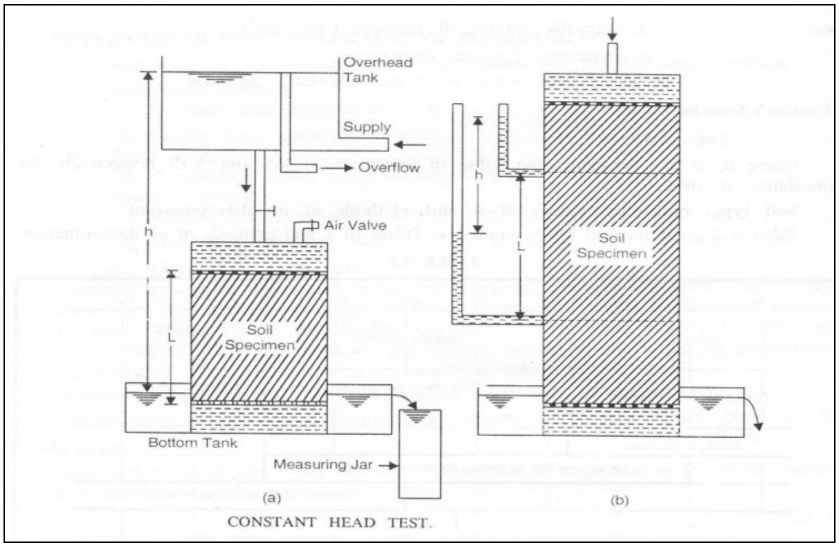
compared to undisturbed sample.

**5. Effect of Degree of Saturation:** - The permeability is reduced if air is entrapped in the voids thus reducing its degree of saturation. Organic foreign matter has a tendency to move towards critical flow channel and choke them up thus decreasing the permeability.

**6. Effect of absorbed water:-** The absorbed water surrounding the fine soil particles is not free to move and reduces the effective pore spaces available for the passage of water

**c)** **Explain the procedure to determine the coefficient of Permeability by Constant Head Permeability Method.**

**Procedure for determination of constant head test for finding out coefficient of permeability of soil :-**




2M for Diagram

**Procedure:**

**Preparation of remoulded specimen.**

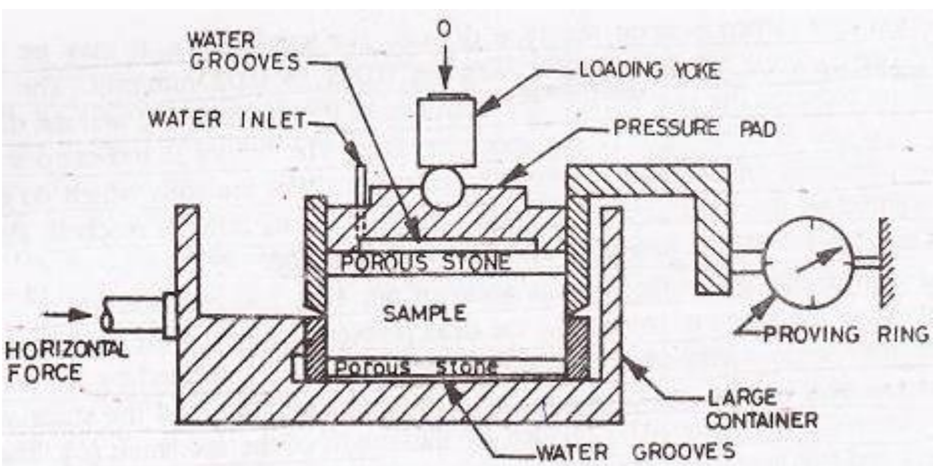
1. Choose moisture content and the density at which the specimen has to be remolded from the compaction curve. Let $\rho_d$ (g/cm$^3$) be the dry density and w% is the water content.
2. Weigh dry soil equal to 1000 $\rho_d$ g.
3. Add 1000 ρd x w/100 g of water to this soil. Mix the soil with water thoroughly. Fix the base plate and collar to the permeameter mould. Fill the soil water mix in the mould and compact it in three layer giving 25 blows of the rammer per layer.
4. Trim off the top surface of the soil to be in flush with the top of the mould. Detach the base plate and the collar from the mould. Fix the mould with soil to the base plate and drainage cap.
5. **Procedure for constant head test:**
6. Connect the outlet tube of the constant head tank to inlet nozzle of permeameter after removal of air. Measure the value of constant head. Start the stop watch and simultaneously start cock of permeameter and collect the discharge in measuring cylinder in a convenient time interval.
7. Repeat the procedure and take more readings.

2M

Calculations: The coefficient of permeability is calculated from equation.

$$K = \frac{Q \; X \; L}{A \; X \; h \; X \; t}$$

Where; Q = Quantity of flow, t = Time interval , L = Length of the sample

| | | |
|---|---|---|
| | A = Cross sectional area of the sample, h = Constant head | |
| **d)** | **Explain Direct Shear Test carried out on given soil sample.** | |
| | 1. Take 250gm of dry sand in a shear box of 60mm x 60mm x 50mm and fix the upper part and lower part of box by locking screw and attach the base plate to lower part.<br>2. Place the grid plate above the base plate.<br>3. Fill the shear box with sand layer compact each layer with tamper.<br>4. Weight the remaining sand and by the difference find the sand required to fill the box.<br>5. Calculate the density of sand in the shear box and assemble the two halves of the box.<br>6. Place the box in the container and the container on the direct shear test apparatus.<br>7. Place the loading pad on the top and adjust the proving ring dial gauge reading to zero.<br>8. Mount loading yoke and dial gauge and apply a stress of 0.05N/mm$^2$ to record vertical and horizontal displacement.<br>9. Remove locking screw and using spacing screw raised the upper part slightly above the lower part to create 1mm gap.<br>10. Remove spacing screw and apply a horizontal shear load of 1.25mm/min and record the reading for shear failure.<br>11. Plot the graph taking values of maximum shear on Y axis and normal stress on X axis.<br>12. The angle gives the shearing resistance and the intercept gives cohesion.<br><br> | ½ M each for (any 6 points)<br><br>1M for Diagram |
| **e)** | **Draw Shear Strength Envelope for Purely Cohesive and Cohesion less soil with its equation.** | |

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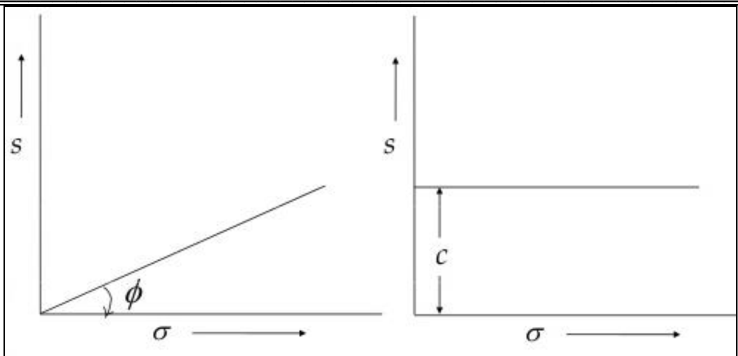
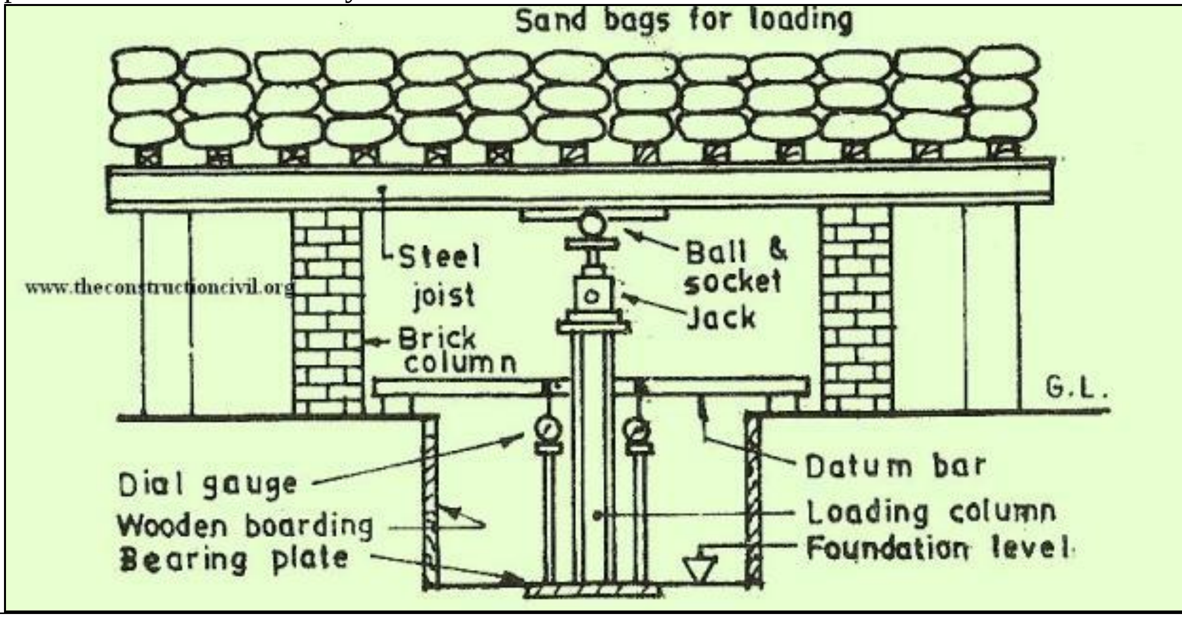
|---|---|---|
| |   Coulomb envelope for ideal (pure) friction material    Coulomb envelope for purely cohesive material<br>1. **For Purely Cohesive Soil : -1)** $\tau_f = C$ 2) $Ø = 0$<br>2. **For Cohesion less Soil : -** 1) $\tau_f = \sigma \tan ø$ 2) $C = 0$ | 2M for diagram<br><br>2M |
| **f)** | **State any four assumptions made by Terzaghis analysis of Bearing Capacity of Soil.** | |
| | **Assumptions in Terzaghis analysis :-**<br>i) The soil is homogeneous and isotropic and its shear strength is represents by Coulomb's equation.<br>ii) The strip footing has rough base and the problem in essentially two dimensional.<br>iii) the shear strength of soil above the base of footing is neglected. The soil above the base is replaced by a uniformity surcharge $\gamma D_f$<br>iv) The load on the footing is vertical and is uniformly distributed.<br>v) The footing is long i.e. L/B ratio is infinite, where B is the width and L is the length of footing.<br>vi) The elastic zone has straight boundaries inclined at $\psi = \varphi$ to the horizontal, and the plastic zones fully developed. | 1M each (for any 4 assumpti ons) |
| **Q.4** | | 16M |
| **a)** | **Draw the experimental setup of plate load test using gravity loading.** | |
| | **Plate Load Test :-**<br>**1. Bearing Plate: -** It is either circular or square made up mild steel of not less than 25mm thickness and varying in size from 300 to 750mm with grooved bottom. For clayey soil a 450mm square plate concrete block is used. In case of sandy soil three plates of size 300mm to 750mm depending upon loading.<br>**2. Test Pit: -** The test pit at foundation level should have width equal to five times the test plate and it should be cleaned and leveled at bottom. The test pit should have steps to continently go in to the pit for taking observation.<br>**3. Loading Arrangement:-** The loading may be applied with the help of hydraulic jack by any two methods a) Gravity loading Platform Method b) Reaction Truss Method.<br>**4. Setting of Plate:-** The test plate should be placed over fine sand layer having maximum thickness of 5mm. A minimum seating pressure of 70g/cm$^2$ shall be applied and removed before starting the load test.<br>**5. Load Increment: -** Apply the load to soil in cumulative equal increment up to 1kg/cm$^2$ or one fifth of the estimated ultimate bearing capacity whichever is less.<br>**6. Settlement and observation:-** The settlement should be observed for each increment of load after an interval of 1, 2.25, 4, 6.25, 9, 16 and 25 minute and thereafter hourly interval to nearest 0.02mm. The test shall be continued till a settlement of 25mm in normal case and | ½ M each for any four points |

50mm in special case or till the failure.

7. **Loading Settlement Curve and Ultimate Bearing Capacity: -** Load settlement curve is plotted where load intensity is on X axis and Settlement is on Y axis.

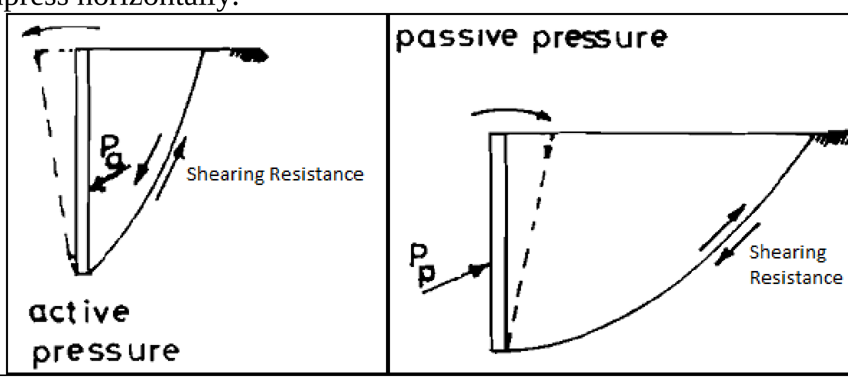



2M for diagram

**b)** **Define active and passive earth pressure using necessary sketches.**

**Active Earth Pressure: -** It is pressure exerted on retaining wall resulting from slight movement of wall away from filling. — 2M

**Passive Earth Pressure: -** when the movement of the retaining wall is such that the soil tends to compress horizontally.




2M for Diagram

**c)** **Differentiate between compaction and consolidation with minimum four points.**

1M each for any four points.

| Sr. No. | Compaction | Consolidation |
|---|---|---|
| 1. | Instant compression of soil under load under dynamic load is called as compaction. | Gradual compression under a steady load is called as consolidation. |
| 2 | Compaction takes place before building of structure. | Consolidation takes place after building of structure. |
| 3 | Compaction is very fast process. | Consolidation is very slow process. |
| 4 | Compaction is carried out for improving properties of soil. | Consolidation occurs naturally due to load of structure and it does not improve property of |

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| | | | soil. |
| | 5 | Settlement is prevented due to compaction. | Settlement takes place due to consolidation. |
| | 6 | Compaction is an artificial process. | Consolidation is a natural process. |
| | 7 | In compaction pore water pressure is not very important. | In consolidation pore water pressure is very important. |

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| **d)** | **Define Soil Stabilization. State any three points of necessary of soil stabilization.** | |
| | **Define: -**<br>Soil Stabilization is defined as improving the engineering performance of soil by artificial means.<br>**Necessity of Soil Stabilization : -**<br>1. To increase the shear strength of soil.<br>2. To reduce construction cost by use of locally available material.<br>3. To improve stability of slopes.<br>4. To increase strength against displacement and deformation.<br>5. To reduce settlement of structures.<br>6. To increase the density of soil.<br>7. To reduce permeability of soil. | 2M<br><br>½ M each (for any four points) |
| **e)** | **Explain Standard Proctor Test to obtain OMC & MDD values for given soil.** | |
| | **Procedure of standard proctor compaction test to determine MDD and OMC.**<br>1. Measure the dimensions of empty mould. From these observations volume of mould is calculated.<br>2. The mass of empty mould with base plate is determined and grease is applied to the mould from inside.<br>3. About 3 kg of air-dried material (sample) passing through 4.75 mm I.S. sieve is taken. It is thoroughly mixed with about 150 ml of water to start with.<br>4. Collar is attached to mould fixed to the base plate.<br>5. The standard (prepared) soil is filled in the mould in three layers and compacted with 25 blows each layer with the 2.6 kg hammer dropping from 310 mm height , collar is removed and excessive soil is trimmed off and top of the mould is leveled. - The mass of mould with base plate and compacted soil is determined.<br>6. -The soil is extracted from the mould and representative sample is taken from the mould for determination of water content.<br>7. The soil is broken up and again additional 150 ml. of water is added and the soil is thoroughly mixed.<br>8. The soil is again compacted in the mould in three layers with 25 blows each.<br>9. This process is repeated and observations are noted down.<br>10. From the above observations, dry density of mass of compacted soil is calculated.<br>11. Graph of $\rho_d$Vs water content is determined. This is called as Compaction curve or Moisture density curve.<br>12. Also graph of penetration stress Vs water content and penetration stress Vs dry density can be plotted.<br>13. The value of MDD and OMC are calculated from graph | ½ M each for any four Points |

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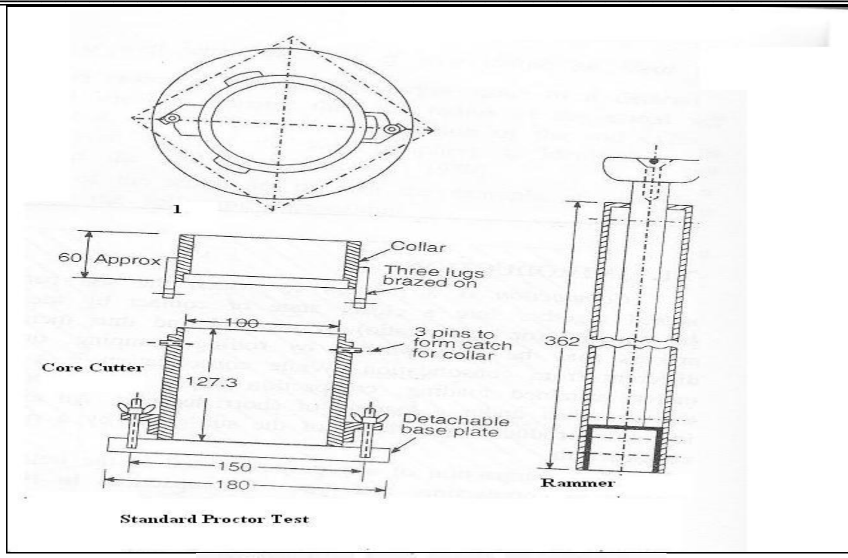
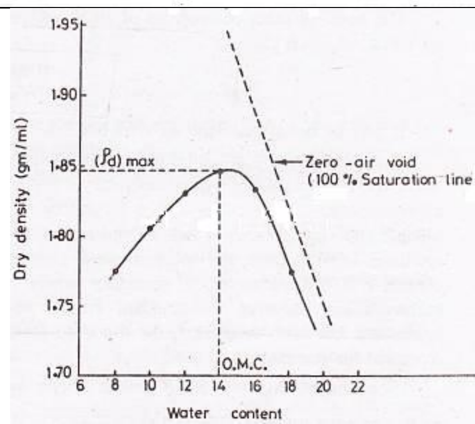
| | <br><br>**Figure : Standard proctor compaction test** | 2M for Diagram |
| **f)** | **Explain Dry Strength and Dilatancy Test on soil in Brief.** | |
| | **Dilatancy test :**<br>i) This is simple test for fine fractions of soil<br>ii) Militancy means reaction to shaking. About 5 cc soil sample is taken and enough water is added to nearly saturate it.<br>iii) The pat of soil is placed in the open palm of the hand and shaken horizontally by striking vigorously against the other hand several times. The pat is then squeezed between the fingers.<br>iv) the appearance and disappearance of water with shaking and squeezing is called a positive reaction. This reaction is called quick , if water appears and disappearsrapidly, slow if water appears and disappears slowly and no reaction if water condition does not appear to change.<br>v) The type of reaction is observed and recorded . Inorganic silts show a quick reaction where as clays shows no reaction or slow reaction.<br>**Dry Strength Test : -**<br>1. Dilatancy means reaction to shaking. About 5cc soil is taken and enough water is added to nearly saturate it.<br>2. The pat of the soil is taken in the open palm of hand and shaken horizontally by striking vigorously against the other hand several times.<br>3. The pat is the squeezed between the fingers.<br>4. The appearance and disappearance of water with shaking and squeezing is called a | ½ M each for any 4 points<br><br>½ M each for any four points.. |

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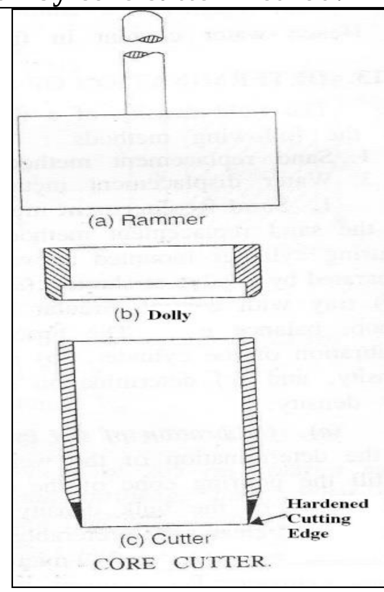
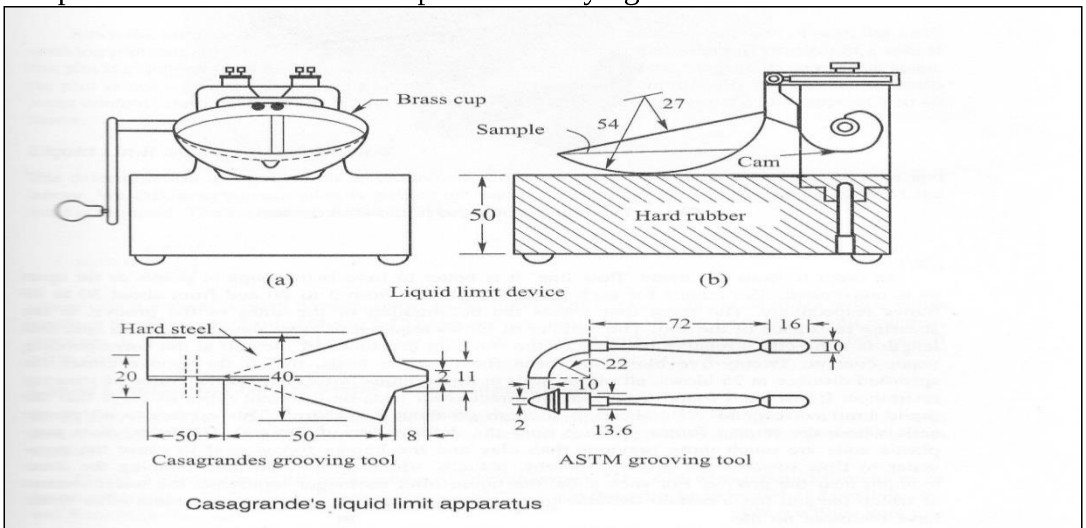
| | positive reaction.<br>5. This reaction is called quick if water appears and disappears rapidly slow if water appears and disappears slowly and no reaction if water condition does not appear to change.<br>6. The type of reaction is observed and recorded, in organic silts shows a quick reaction whereas clay shows no reaction or slow reaction. | |

| Q .NO | SOLUTION | MARKS |
|---|---|---|
| 5 | **Attempt any two of the following** | **16 M** |
| a) | **Define dry unit weight of soil (γd) :** The dry unit weight (γd) is the weight of solids (Ws) per unit of its total volume (V) (prior to drying) of the soil mass.<br>(γd) = Ws/ V<br>**Procedure for determination of dry density of field soil by core cutter method.**<br>-Measure the inside dimensions (accurate to 0.25 mm) of the core cutter and calculate its volume. Find the mass of core cutter (without dolly) accurate to 1 gm i.e. ( $W_1$)<br>-Expose the soil area, about 30 cm square to be tested and level it. Put the dolly on the top of the core cutter and drive the assembly in to the soil with the help of the rammer until the top of the dolly protrudes about 1.5 cm above the surface.<br>-Dig out the container from the surrounding soil and allow some soil to project from lower end of the cutter. With the help of straight edge, trim flat the end of the cutter.<br>-Find the mass of cutter full of soil i.e. ($W_2$)<br>-Keep some representative specimen of the soil for water content determination.<br>-Repeat the test at two or three locations nearly and get the average dry density<br>$\gamma_d = \frac{\gamma}{1+w}$<br><br> | 1 M<br><br>1 M<br><br>4 M (Procedure)<br><br>2 M (figure) |
| b) | **Liquid Limit: The** water content at which the soil changes from the liquid state to plastic state is known as liquid limit (LL, $w_L$). In other wards the liquid limit is the water content at which the soil ceases to be liquid.<br>**Procedure to determine liquid limit of soil by Casagrande's liquid limit apparatus.**<br>**Liquid limit test- I.S. 2720-(Part-5)**<br>- Sieve the sample through 425 micron I.S. sieve.<br>- Take 125 gm of soil and mix it thoroughly with 20 ml of distilled water.<br>- Put the portion of the above paste in the cup, and spread it .<br>- Level the above paste with spatula and smooth the surface off to a maximum depth of 1.25 cm.<br>- Divide the sample in the cup by grooving tool along the symmetrical axis of the cup. The tool should be held perpendicular to the cup at the point of contact.<br>- Now lift and drop the cup to fall on the rubber base with the help of a cam, operated by handle. The handle is rotated to a rate of 2 revolutions per second until the two halves | 1 M<br><br>4 M (Procedure) |

come in contact. The cam lifts the brass cup through a specified height of 1 cm.

- Record the number of blows required to close the groove in the soil for a distance of 1.25 cm. Groove should not be closed by slippage between the cup and the soil but it should be closed by the flow of the soil.
- If groove closes by slippage, then mix the soil immediately in the cup, and repeat the above procedure. Calculate the moisture content of the sample by taking sample from near the closed groove when the number of blows lies between 10 to 40.
- Repeat the test with 4 or 5 samples with varying moisture contents.

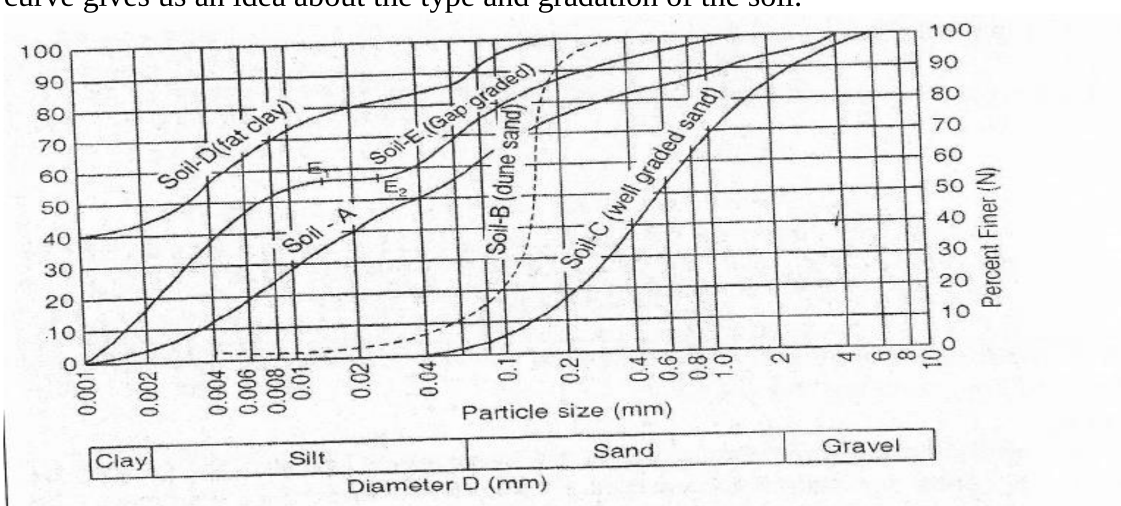



Casagrande's liquid limit apparatus

3 M (figure)

c) **Particle Size Distribution Curve :** 2 M

The results of the mechanical sieve analysis are plotted to get a particle size distribution curve with the percentage finer N, as the ordinate and the particle diameter as the abscissa, the diameter being plotted on a logarithmic scale.A particle size distribution curve gives us an idea about the type and gradation of the soil.




PARTICLE SIZE DISTRIBUTION CURVE

**Procedure for mechanical sieve analysis for grading of soil**

**Materials and Equipment:**

Balance accurate to 1 gm, set of sieves 4.75 mm, 2.36 mm, 1.18mm, 600 micron, 300 micron, 150 micron, 75micron, receiver, metal trays, mechanical sieve shaker etc.

4 M (Procedure)

## Procedure:

-Take a representative sample of soil received from the field and dry it in the oven. Break the

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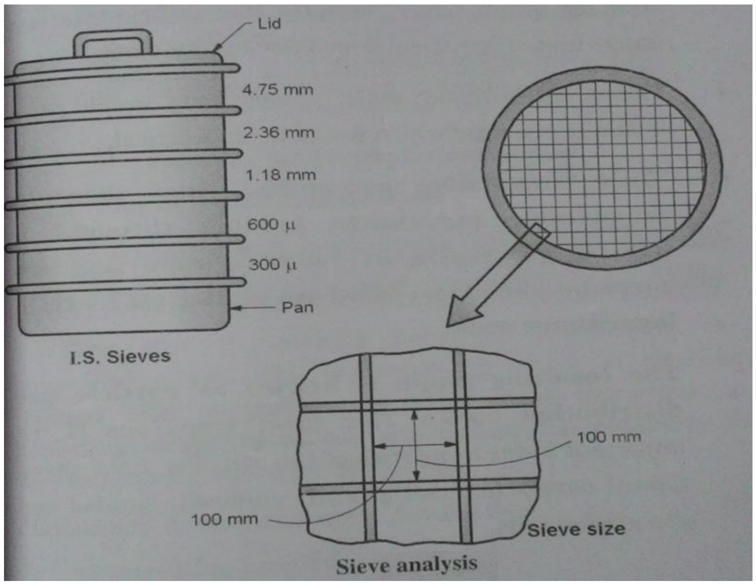
| | clods of the sample by means of hand.<br>-Weigh the required amount of sample for testing say 5 kg.<br>- The sample is sieved through the set of sieves arranged in descending order of their sieves.<br>- The portion retained on 4.75 mm sieve is gravel fraction.<br>- The portion passed through 4.75 mm and retained on 75 micron sieve is sand fraction.<br>These fractions are expressed by weight of original sample to give gravel content and sand content in percentage.<br>-The weight of the soil portion retained on each sieve and pan is obtained to the nearest 0.1 gm.<br>- The weight of the retained soil is checked against the original weight.<br>**Note:** If the soil contains appreciable fine (75%) aggregates and hard to break in to elementary particles soak the sample for 24 hours and wash through 75 microns sieve. The residue on the sieve is weighed.<br><br> | 2 M (figure) |
| 6b | **Attempt any two of the following** | **16** |
| a) | D = 10 cm , L = 15 cm , $h_1$ = 45 cm , $h_2$ = 25 cm , t = 12 minutes i.e. =720sec, d=0.5 cm<br>**Find K in m/day** | 1M |
| | $A = (\pi/4) \times d^2 = (\pi/4) \times 10^2 = 78.54\ cm^2$ | 1M |
| | $a = (\pi/4) \times d^2 = (\pi/4) \times 0.5^2 = 0.196\ cm^2$ | 1M |
| | $K = 2.3 \frac{a}{A} \cdot \frac{L}{t} \cdot \log_{10} [h_1/h_2]$ | 1 M |
| | $K = 2.3 \frac{0.196}{78.54} \cdot \frac{15}{720} \cdot \log_{10} [45/25]$ | 1M |
| | $K = 3.05 \times 10^{-5}$ cm/ sec | 1M |
| | $K = \frac{3.05 \times 10^{-5} \times (1/100)}{} = 0.026$ m / day | 2 M |

| | | |
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| | (1/60) x (1/60) x (1/24) | |
| b) | **Ultimate bearing capacity ($q_u$)**: It is the gross pressure at the base of the foundation at which the soil fails in shear is called as ultimate bearing capacity.<br>**Safe bearing capacity ($q_s$)** : It is the maximum pressure which the soil can carry without risk of failure is called as safe bearing capacity<br>OR<br>**Ultimate Bearing Capacity ($q_u$):-** The Ultimate bearing capacity of soil is defined as the minimum gross pressure intensity at the base of the foundation at which the soil fails in shear.<br>**Safe Bearing Capacity ($q_s$):-** The maximum pressure the soil can carry safely without risk of shear failure is called the safe bearing capacity. It is equal to the net safe bearing capacity plus the original overburden pressure. Sometimes the safe bearing capacity is also referred to as the ultimate bearing capacity $\mathbf{q_u}$ divided by factor of safety **F.**<br>**Effect of water table on bearing capacity of soil:-**<br>1. The rise in water table from below the foundation results in decrease in bearing capacity in granular soil.<br>2. When the water table reaches the ground where the depth is greater of equal to width of footing the bearing capacity is reduced by 50% or more.<br>3. The bearing capacity is not affected for purely cohesive soil.<br>4. The bearing capacity for non-granular soil decreases with presence of water table.<br>5. Presence of water table for shallow depth give poor bearing capacity as compared for larger depth foundation. | 2 M<br><br>2 M<br><br><br><br><br><br><br><br><br><br><br><br><br>4 M |
| c) | **CBR Definition** : CBR is define as the ratio of test load to the standard load, express in percentage, for a given penetration ofthe plunger.<br>**Procedure :**<br>1. The CBR test may be conducted on a prepared specimen in a mould or on the soil in –situ condition. The laboratory CBR apparatus consists of a mould 150 mm diameter and 175 mm height, having a separate base plate and collar. The load applied by a loading frame through a plunger of 50 mm diameter. Dial gauges are used for measurement of the expansion of the specimen on soaking and for measurement of penetration.<br>2. It may be noted that with the displacer disc inside the mould, the effective height of the mould is only 125 mm. the test consist of causing the plunger to penetrate the specimen at the rate of 1.25 mm per minute.<br>3. The load required for the penetration of 2.5 mm and 5.00 mm are recorded by proving ring attached to the plunger. The load is expressed as a percentage of the standard load at the respective deformation level, and is known as CBR value.<br>4. The CBR values are usually calculated for penetration of 2.5mm and 5mm. Generally the CBR value at 2.5mm penetration will be greater than5mm penetration and in such a case former value is taken as the CBR value for Design purpose.<br>$CBR = \frac{P_T}{P_s} x\ 100$<br>$P_T$ = Corrected test load corresponding to the chosen penetration from the load penetration curve.<br>$P_S$ = Standard Load for the same penetration | 1 M<br><br><br><br>3 M<br>(Procedure) |

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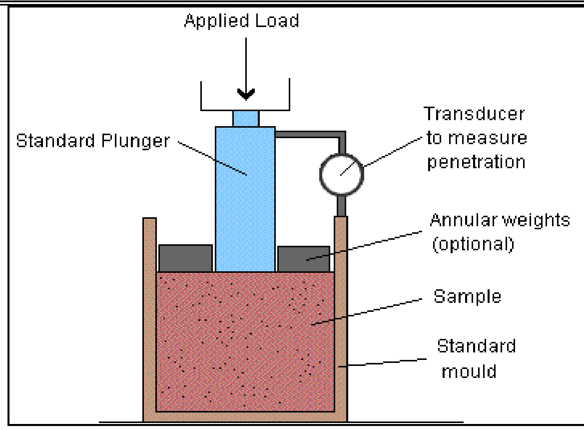
| |   | 2 M (Figure) |
| | **Application of CBR Test :**<br>1. CBR test is considered to be one of the most commonly used and widely accepted tests.<br>2. This test is use for the analysis of existing pavements, layers by layer in respect of their strength and load carrying capacity. It also helps in identifying the courses of failure of road pavements.<br>3. The CBR values are usually calculated for penetration of 2.5mm and 5mm. Generally the CBR value at 2.5mm penetration will be greater than5mm penetration and in such a case former value is taken as the CBR value for Design purpose.<br>4. If the CBR value corresponding to a penetration of 5 mm exceeds that for 2.5mm the test is repeated. | 2M |