MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION
(Autonomous)

(ISO/IEC -270001 – 2005 certified)

SUMMER -2019 EXAMINATION

Subject code: 17420 **Model Answer**

<u>Important Instructions to examiners:</u>

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.

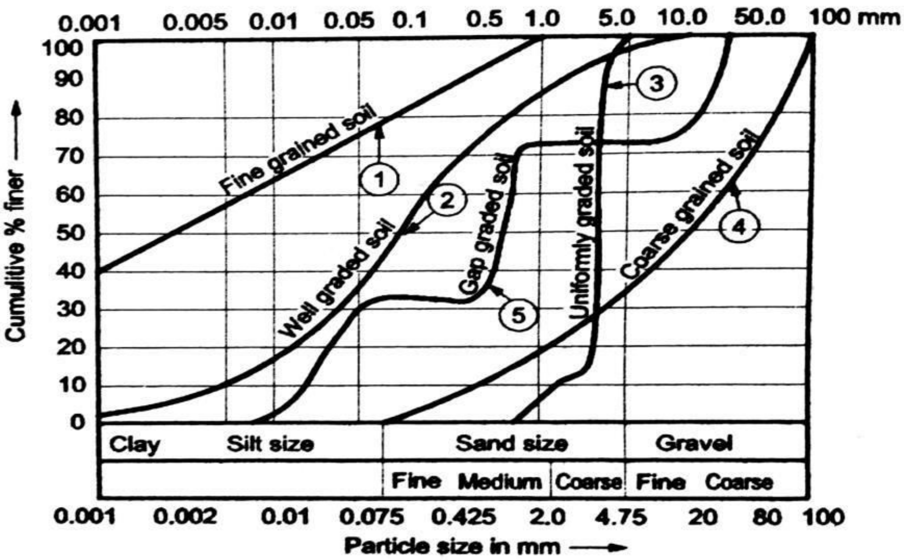
6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidates understanding

Q. No.	Question and Model Answers	Marks
Q. 1 a)	**Attempt any SIX of the following**	**12 M**
i)	**Define mineralogy and petrology.**	
	Mineralogy: It deals with study of formation, occurrence, aggregation, properties and use of minerals. **Petrology:** It deals with study of various types of rocks, their mode of occurrence, their composition, textures, structures, geological & geographical distribution.	**1 M** **1 M**
ii)	**Define the crust and write the thickness of crust for following mentioned areas:** **1) Under the ocean** **2) Under continents.**	
	Crust : The crust is earths lithosphere which is fragmented into tectonic plates that move over a rheic upper mantle (asthenosphere) via processes that are collectively refer to as plate tectonic. i) Under the ocean – 7 to 12 km. ii) Under continents – 30 to 45 km.	**1 M** **½ M** **½ M**
iii)	**What do you mean by symmetrical folds and asymmetrical folds.**	
	Symmetrical Fold: The fold in which is axial plane divides the fold equally in two parts is called as symmetrical fold. The fold may be anticline or syncline. **Asymmetrical Fold:** The fold in which is axial plane divides the fold unequally in two parts is called as asymmetrical fold.	**1 M** **1 M**

iv)	**Define:** **1) Fault** 2) **Folding**	
	1. **Fault:** Fault is fracture, along which the movement of the one block with respect to other has taken place. The movement may vary from a few centimeters to many kilometers depending upon the nature and magnitude of stresses and the resistance offered by the rock beds. 2. **Folding:** The earth's crust beds are tilted out of the horizontal plane forming a set of arches and troughs is called fold..	**1 M** **1 M**
v)	**Define:** **1) Porosity** 2) **Degree of saturation**	
	1. Porosity (n): The ratio of volume of voids (V_V) to the volume of soil (V) is called as porosity (n) $n = \frac{Vv}{V} x\ 100$ 2. Degree of saturation (s) : The degree of saturation S is defined as the ratio of volume of water V_W to the volume of voids V. $S = \frac{Vw}{Vv} = \frac{Vw}{Va+Vw} X\ 100$	**1 M** **1 M**
vi)	**Write any two objectives of geotechnical engineering.**	
	Objective of geotechnical engineering: 1. Soil as an engineering material. 2. To know bearing capacity of soil. 3. Role of soil in foundation design. 4. Earth dams, Seepage of water, ground water, stability of slope, well hydraulics.	**1 M each (any two)**
vii)	**Write any two uses of soil as construction material**	
	Uses of soil as construction material: 1. Clay the most widespread masonry material. 2. Pervious & impervious soil is used in earth dams. 3. Water bound macadam roads or WBM roads. 4. Canals & Embankments. 5. River protection works. 6. Soil cement mixture used as subgrade.	**1 M each (any two)**
viii)	**Write the formula for density index with meaning of each term in formula.**	
	Density Index (I_D): $I_D = \frac{emax - e}{emax - emin}$ Where, e_{max} = Maximum void ratio in loosest state of soil. e_{min} = Minimum void ratio in densest state of soil. e = void ratio of soil in natural state.	**1 M** **1 M**
Q.1 b)	**Attempt any <u>TWO</u> of the following**	**08**
i)	**Write any four importance of geology in Civil Engineering.**	
	Importance of geology in civil engineering. 1. It provides a systematic knowledge of construction materials, their structure and properties. 2. The knowledge of erosion, Transportation and deposition by surface water helps in soil conservation, river control, coastal and harbor works. 3. The knowledge about the nature of the rocks is very necessary in tunneling construction roads & in determining the stability of cuts & slopes. 4. The foundation problems of dams. Bridges and buildings are directly related with	**1 M EACH (any four)**

	geology of the area where they are. 5. The knowledge of ground water is necessary in connection with excavation works, water supply, irrigation and many other purposes. 6. Geological maps &sections helos considerably in planning many engineering projects. 7. If the geological features like faults, joints, beds, folds, solution channel are found they have to be suitably treated. Hence the stability of the structure is greatly increased. 8. Pre-geological survey of the area concerned reduces the cost of engineering works.	
ii)	**Explain different types of faults occurs in rocks.**	
	Types of Faults: 1. Normal Faults a. Horst & Graben b. Half- Grabens 2. Reverse Faults a. Thrust Faults b. Overthrust Faults c. Underthrust Faults 3. Strike Fault 4. Dip Fault 5. Strike slip Faults 6. Dip slip Faults 7. Step Faults 8. Parallel Faults 9. Hinge Faults 10. Emergent Faults 11. Radial Faults 12. Peripheral Faults 13. Enechelon Faults 14. Transform Faults 15. Ring Faults 16. Listric Faults 17. Oblique Faults **Note : Student should explain any one with sketch**	**½ M Each (any four)** **2 M**
iii)	**Enlist field application of geotechnical engineering and explain any one.**	
	Field Application of geotechnical engineering: 1. In foundation design 2. In pavement design 3. In earth retaining structure 4. In design of earthen dams. 5. In design of embankments. 6. In design of underground structures. **In design of underground structures:** While designing the underground structures such as tunnels conducts power houses. The role of soil is important as load is transferred through the soil, therefore stress distribution should be taken into account.	**½ M each (any four)** **2 M**

Q. 2	Attempt any <u>FOUR</u> of the following:	16 M
a)	**Define weathering and write the factors affecting weathering.**	
	Weathering: The process by which the rocks is decayed, disintegrated & de-composited with the action of the physical agent of atmosphere like wind, water & ice is called as weathering. **Factors affecting weathering:** 1. Rock type & structure. 2. Slope a. Steep slope b. Gentle slope. 3. Climate 4. Vegetation cover & organisms. 5. Time	**2 M** **2 M**
b)	**Enlist the physical properties of soil and explain any one of them.**	
	Physical properties of soil: 1. Void ratio (e) 2. Porosity (n) 3. Degree of saturation (s) 4. Density index (I_D) 5. Density (p) **Void ratio (e):** The ratio of volume of voids ($V_V = V_a + V_W$) to the total volume (V) of solids is called as void ratio. $e = \frac{Va+Vw}{Vs}$ $e = \frac{Vv}{V}$	**1/2 M each (any four)** **2 M**
c)	**Explain the formation process of soil.**	
	Formation process of soil: Soil formation mainly takes place due to mechanical disintegration or chemical decomposition of rocks whenever rock get exposed to atmosphere, It is acted by various weathering agencies & it gets disintegrates or decomposed into small particles & then it is converted into soil.	**4 M**
d)	**Define earthquake and classify it on the basis of origin.**	
	Earthquake: An earthquake is the result from the sudden release of stored energy due to abrupt dislocation and disturbances within its interior causes the sudden vibrations (shaking) of the earth's crust that creates seismic waves. Its result is displacement of ground, destruction of property, causes tsunamis. **Classification of Earth Quake based on origin:** 1. Techtonic Earth Quake: Earth Quake originated due to relative movement of crustal block or faulting. 2. Non-techtonic Earth Quake: Earth Quake originated due to volcanic eruption, atomic explosions, Landslides, avalanches.	**2 M** **1 M** **1 M**
e)	**Write any two causes and effect of earthquakes.**	
	Causes of earthquake: 1. Movement of tectonic plates. 2. Volcanic eruptions. 3. Anthropogenic Sources. 4. Dams. 5. Use of explosives. 6. Sport games. 7. Injection & extrusion of fluids. 8. Removal of natural gases. 9. Landslide. 10. Avalanches.	**½ M each (any four)**

	Effect of Earthquake : 1. Shaking & ground rupture. 2. Landslide & avalanches. 3. Fires. 4. Soil Liquefaction. 5. Tsunamis. 6. Human impacts. 7. Changing in the course of streams.	**½ M each (any four)**
f)	**Define:** **(i) Consistency limit** **(ii) Liquid limit** **(iii) Plastic limit** (iv) **Shrinkage limit**	
	1. **Consistency Limit:** The water content at which the soil passes from one state to the another state is called as consistency limit. 2. **Liquid Limit:** It is defined as the maximum water content up to which the soil will remain in liquid state & tend to flow. 3. **Plastic Limit (W_P):** It is minimum water content at which the soil mass can still be deformed (rolled into 3 mm diameter threads) without surface cracking (crumbling). 4. **Shrinkage Limit (W_S):** It is maximum water content at which further reduction in water content will not cause decrease in volume of soil mass.	**1 M each**
Q.3	**Attempt any FOUR of the following:**	**16**
a)	**Write any four uses of particle size distribution curve.**	
	Particle size distribution curve (PSDC) is the semi log graph drawn as sieve size versus % finer of given soil sample. The PSDC is useful for grading of soil i.e. classification of soil based on its particle sizes available. Thus the outcome of sieve analysis is PSDC gives following types of soil as shown in figure above.  OR	**4 M**
	From above graph soil is classified based on grading curves as follows. 1. **Fine grained soil:** When line cuts Y-axis indicate more amount of fine articles. 2. **Well graded soil:** When PSDC is S-shaped indicates soil contains all particle sizes.	**1 M each (any four)**

	3. **Uniformly graded soil:** When line is almost vertical indicates particles of same sizes. 4. **Coarse grained soil:** When line cuts X-axis indicates more amount coarse particles available. 5. **Gap graded soil:** When graph is of wavy nature indicating particles of only specific size and deficiency of other sizes.	
b)	**State Darcy's Law of permeability and Define Permeability and Coefficient of Permeability.**	
	Darcy's Law of permeability:- It states that for laminar flow, the rate of flow or discharge per unit time is directly proportional to hydraulic gradient. q= KiA or V= q/A = Ki **Permeability** : It is the property of soil by virtue of which the soil mass allows water to flow through it. **Coefficient of Permeability**: **-** It is defined as the velocity of flow under a unit hydraulic gradient through a soil. **Mathematically: -** K = V/i Where q= discharge per unit time. , A= total cross-sectional area of soil mass perpendicular to the direction of flow, i= hydraulic gradient = h/L, K = Darcy's coefficient in permeability, v= velocity of flow, h= differential head of water = h1-h2, L= length of soil sample.	**1M** **1M** **1M** **1M**
c)	**A soil sample having 10 cm diameter and 15 cm long was tested under variable head permeameter. Initial water head was 45 cm and it was observed to dropped to 30 cm in 195 sec. The burette diameter was found to be 1.9 cm. Calculate the coefficient of permeability in m/day**	
	Given: D = 10 cm , L = 15 cm , h1 = 45 cm , h2 = 30 cm , t = 195 sec, d=1.9 cm A = (π/4) x d^2 = (π/4) x 10^2 = 78.54 cm2 a = (π/4) x d^2 = (π/4) x 1.9^2 = 2.834 cm2 $K = 2.3 \frac{a}{A} . \frac{L}{t} . \log_{10} [h1/h2]$ $K = 2.3 \frac{2.384}{78.54} . \frac{15}{195} . \log_{10} [45/30]$ K= 9.457 x 10^{-4} cm/ sec $K = \frac{9.457 \times 10^{-4} \times (1/100)}{(1/60) \times (1/60) \times (1/24)}$ = **0.817 m / day**	**1M** **1M** **1M** **1M**

d)	**Differentiate between Cohsionless soil and purely cohesive soil**	

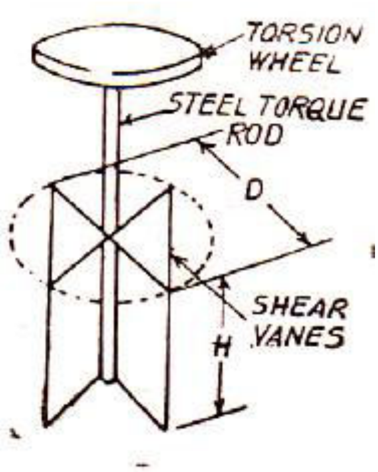
Cohsionless soil	**Purely cohesive soil**
1) Interaction or bond between soil particles is absent.	1) Interaction or bond between soil particles is perfect.
2) Shearing resistance is only the function of angle of friction.	2) Shearing resistance is only the function of cohesion.
3) Bearing capacity of soil is high.	3) Bearing capacity of soil is low.
4) Permeability of soil is more.	4) Permeability of soil is less.
5) Type of soil is coarse, gravel, sand, silt etc	5) Type of soil is soft shale, clay etc

1M each (any four)

e)	**Explain vane shear test carried on given soil sample.**	

i) The undrained shear strength of soft clays can be determined in a laboratory by a vane shear test

ii) Apparatus –



1M

A) Consist of a vertical steel rod having four thin stainless steel blades fixed at bottom end

B) Height (H) of vane equals twice the overall diameter (D)
(D = 2.5 mm and H = 60 mm)(Length of rod = 24 mm) recommended values

C) Container having d = 38 mm and ht = 75 mm is fixed securely to the base plate.

D) Vane is gradually lowered into container having soil mass at a depth of 10 to 20 mm below the top of specimen

E) Torque is applied at rate of 6^oper minute till the specimen fails is shear, Torque applied is measured.

2M

iii) Measurement of shear strength

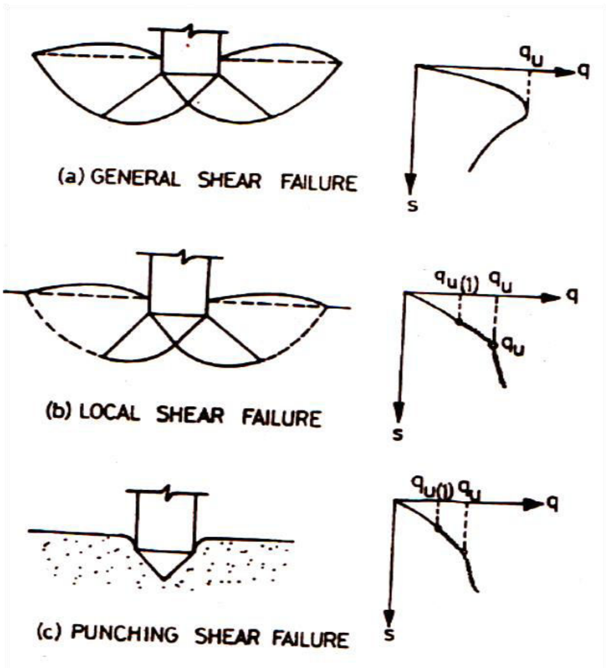
The shear strength of soil is measured using

$$\tau = \frac{T}{\pi D^2 \left[-\frac{H}{2} + \frac{D}{6} \right]}$$

Both top & bottom end partakes in shearing and

$$\tau = \frac{T}{\pi D^2 \left[\frac{H}{2} + \frac{D}{12} \right]}$$

1M

	Only bottom end partakes in shearing where τ is in N / mm^2 and T is in N – mm	
f)	**Write any four assumptions of Rankine's theory made for non-cohesive soils.**	
	Assumption of Rankines Theory for non-cohesive soils : i. The soil is semi-infinite, homogenous, dry and cohesion less. ii. The soil element is in the state of plastic equilibrium. iii. The ground surface is plane which may be horizontal or inclined. iv. The back of is vertical and smooth. v. The wall yield about the base thus satisfies deformation condition for plastic equilibrium.	**1M each (any four)**
Q.4	**Attempt any FOUR of the following:**	**16**
a)	**State and explain the failure of soil on the basis of Terzaghi's analysis**	
	On the basis of Terzaghi's analysis the three types of shear failure occurs; i. General shear failure: When footing is rested on dense sand or stiff clay, the settlement increases suddenly at particular loading is called as General shear failure. ii. Local shear failure : When footing is rested on medium dense sand or clay of medium consistency, the gradual settlement increases at particular loading is called as Local shear failure. iii. Punching shear failure : When footing is rested on loose sand or soft clay, the settlement increases vertical diraction at particular loading is called as Punching shear failure. 	**1M** **1M** **1M** **1M**
b)	**Write any four methods of improving bearing capacity.**	
	Methods of improving bearing capacity of soil. i. By increasing depth of foundation: At deeper depths the over burden pressure on soil is higher hence soil is more compacted at deeper depth. As a result it shows higher bearing capacity.	**1M each (any**

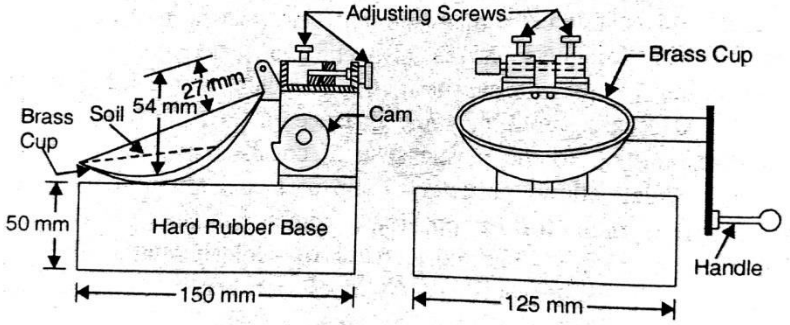
	ii. <u>By draining sub soil water</u>: With reduction in percentage of water content of soil the bearing capacity increases. iii. <u>By compacting soil</u>: If we compact soil using appropriate method then there will be increase in its density and shear strength. As a result bearing capacity also increases. iv. <u>By increasing width of foundation</u>: By increasing width of foundation, the intensity of load is decreased and on the same soil can take more loads. v. <u>By confining soil</u>: In this method soils are enclosed with the help of sheet piles. This confined soil is further compacted to get more strength. vi. <u>By replacing poor soil</u>: In this method poor soil first removed and then the gap is filled up by superior material such as sand, stone, gravel or any other hard material. vii. <u>By using grouting material</u>: In this method poor soil bearing strata is hardened by injecting the cement grout under pressure.	**four)**
c)	**Define compaction and write any three rollers used for compaction with their suitability.**	
	Compaction: Instant compression of soil under dynamic load is called compaction. <u>Rollers with their suitability</u> a) Smooth wheel rollers: Suitability: These rollers best suitable for subgrade or base coarse compaction of cohesion less soils. b) Pneumatic tyred rollers: Suitability: Pneumatic tyred rollers are effective for compacting cohesive as well as cohesion less soils. Light rollers are effective for compacting soil layers of small thickness. c) Sheep foot roller: Suitability: Suitable only for fine grained soil.	**1M** **1M** **1M** **1M**
d)	**Define CBR and write the significance of CBR .**	
	i) **Definition** : The California Bearing Ratio abbreviated as CBR is defined as the ratio of test load to the standard load, expressed as percentage for a given penetration of plunger $CBR = \frac{\text{Test load}}{\text{Standard load}} \times 100$ ii) **Significance :** a) It is most widely used method for design of flexible pavement. b) For a given CBR, appropriate thickness of construction required above a material for different wheel load and traffic conditions can be determined. c) It is used for evaluating the suitability of subgrade, sub – base and base course materials.	**1M** **1 each (any three)**

e)	**Write any four uses of Soil Stabilization.**	
	Uses of Soil Stabilization is as follows, 1. To increase the shear strength of soil. 2. To reduce construction cost by use of locally available material. 3. To improve stability of slopes. 4. To increase strength against displacement and deformation. 5. To reduce settlement of structures. 6. To increase the density of soil. 7. To reduce permeability of soil.	**1M each (any four)**
f)	**Enlist field identification test on soil and explain dilatency test.**	
	Field Identification test on soil:- 1) Dry Strength Test 2) Dilatency Test 3) Toughness Test 4) Organic content and colour test 5) Visual examination. 6) Other identification test.	**2M**
	Dilatency test : i) This is simple test for fine fractions of soil ii) Dilatency means reaction to shaking. About 5 cc soil sample is taken and enough water is added to nearly saturate it. 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. 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 disappears rapidly, slow if water appears and disappears slowly and no reaction if water condition does not appear to change. v) The type of reaction is observed and recorded. Inorganic silts show a quick reaction where as clays shows no reaction or slow reaction.	**2M**
Q.5	**Attempt any TWO of the following**	**16**
a)	**A soil sample of volume 160cc, weight 310 gms, when partially saturated. It weight 269.28 gms when fully dry, specific gravity of soil is 2.67. Determine porosity, voids ratio, water content and degree of saturation.**	
	Given- V = 160 cm^3, W = 310 gms, W_d = 269.26 gm, G=2.67, $\gamma_w = 1$ gm/cm^3 Find - w, V_v, S_r, η 1. Calculate Bulk Density $\gamma = \frac{W}{V} = \frac{310}{160}$ = 1.937 gm/cm^3 2. Calculate dry density $\gamma_d = \frac{W_d}{V} = \frac{269.26}{160}$ = 1.683 gm/cm^3	**1M** **1M** **1M**

	3. Calculate water content (w) $w = \frac{W - W_d}{W_d} x100$ dry density $\gamma_d = \frac{\gamma}{1+w}$ **OR** = $\frac{310-269.26}{269.26} x100$ 1.683 (1+w) = 1.937 1 + w =1.1509 **w = 15.12 %** w = 0.1509 **w = 15.092%** 4. Calculate void's Ratio (e) $\gamma_d = \frac{G\gamma_w}{1+e}$ 1+e = $\frac{G\gamma_w}{\gamma_d} = \frac{2.67x1}{1.683}$ 1+e =1.586 **e = 0.586** 5. Calculate Porosity $\eta = \frac{e}{1+e} = \frac{0.586}{1+0.586}$ η **= 0.3697** 6. Calculate Degree of Saturation S_r $S_r = \frac{wG}{e} = \frac{0.1509x2.67}{0.586}$ S_r = 0.6875 x100 **S_r = 68.75%**	1M 1M 1M 1M 1M
b)	**Write the laboratory procedure to determine liquid limit by Casagrande's method with neat sketch.**	
	Procedure of liquid limit- 1. Take about 120 gm of air dried soil sample passing through 425 micron IS Sieve in metal tray. 2. Add 20% distilled water to form uniform soil paste. 3. Put this soil paste in the brass cup of Casagrande's apparatus and spread horizontally into portion with few strokes of spatula. 4. Trim the soil upto a depth of 1 cm maximum thickness and remove excess soil if any. 5. divide the soil sample in two parts by the firm strokes of the grooving tool along the diameter through the centre of brass cup so that clean sharp groove of proper dimension is formed. 6. Rotate the handle of casagrande's apparatus at a rate of 2 revolutions per second until two parts of the soil will come in contact with each other for a length of 12mm by flow only. 7. Count the number of blows required to close the groove for about 12mm. it is recorded as N. 8. Take representative portion of soil for water content determination as w%. 9. Repeat all above steps by changing water in soil sample to get number of blows between 10 to 50. Record the number of blows and corresponding water content for various trials. 10. Draw the flow curve i.e. Number of blows required as abscissa (log scale)	4M

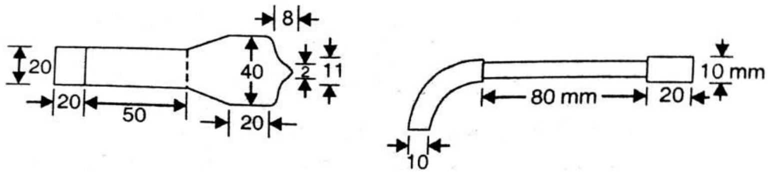
versus water content determined as ordinate (natural scale) on semi logarithmic graph paper.

11. Find out the water content corresponding to 25 blows from the graph as liquid limit (w_L) of given soil sample.

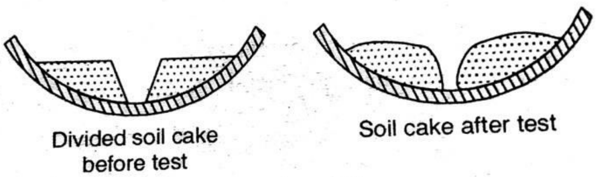


(i) Liquid Limit Apparatus

4M



(ii) Grooving Toos



(iii) Closing of Groove

c) **Classify the soil according to IS Classification and explain the meaning of following terms i) GW ii) SP iii) ML iv) SM-ML**

As per IS classification soil is broadly divided into three divisions:

1. **Coarse grained soil:** In these soils, more than half the total material by mass is larger than 75 micron IS sieve size. Coarse grained soils are divided into two sub divisions:

a) **Gravels (G)** - In these soils, more than half the coarse fraction (+ 75 micron) is larger than 4.75mm IS sieve size. The sub division includes gravels and gravelly soil, and is designated by symbol G. **1M**

b) **Sands (S)** - In these soils, more than half the coarse fraction (+ 75 micron) is smaller than 4.75mm IS sieve size. The sub division includes sands and sandy soils. Each of the above sub divisions are further sub divided into four groups: **2M**

i) Well graded, clean(W)
ii) Well graded with excellent clay binder (C)
iii) Poorly graded, fairly clean (P)
iv) Not covered in other groups (M)

These symbols are used in combination and designate the type of coarse grained soil e.g GC means clayey gravels.

2. **Fine grained soils:** In these soils, more than half the total material by mass is smaller than 75 micron IS sieve size. Fine grained soils are further divided into three sub divisions. **2M**

a) Inorganic silt and very fine sands (M)
b) Inorganic clay (C)
c) Organic silt and clays (O)

The fine grained soils further sub divided into following groups on the basis of liquid limit which is a good index of compressibility.

i) Silt and clays of low compressibility, having liquid limit less than 35% (L)

ii) Silt and clays of medium compressibility, having liquid limit greater than 35% and less than 50% (I)

iii) Silt and clays of high compressibility, having liquid limit greater than 50% (H)

Laboratory classification of fine grained soil is done with the help of plasticity chart.

Note: if the classification of fine grained soil is explained with the help of plasticity then appropriate marks should be given to the students.

3. **Highly organic soils and other miscellaneous soil materials:** These soils contain large percentages of fibrous organic matter such as peat, and the particles of decomposed vegetation. In addition, certain soils containg shells, concretions, cinders and other non-soil material in sufficient quantities are also grouped in this division. **1M**

Meaning of Terms:

i) GW – well graded Gravel

ii) SP – Poorly graded sands or gravelly sands

iii) ML – inorganic silt with low to medium compressibility.

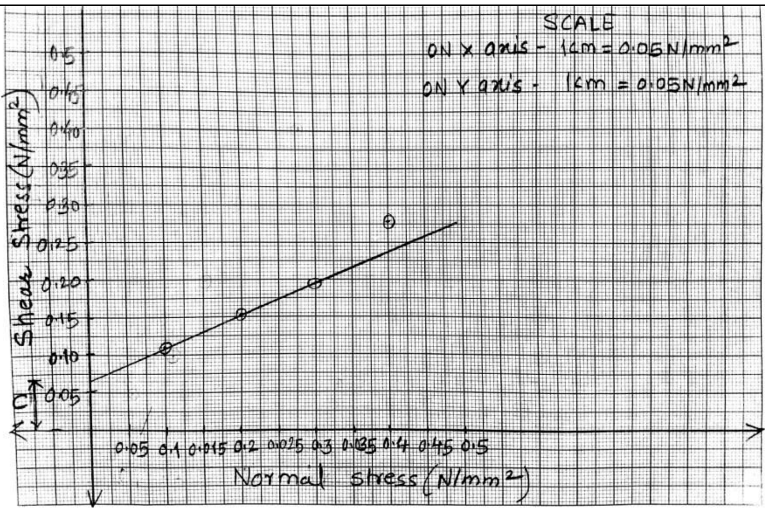
iv) SM-ML - boundary classification between coarse grained and fine grained soils.

½ M for Each meaning

Q.6	**Attempt any TWO of the following**	**16**
a)	**Following readings were taken in a direct shear test:**	

Normal stress in N/mm^2	**0.1**	**0.2**	**0.3**	**0.4**
Shear stress in N/mm^2	**0.110**	**0.152**	**0.193**	**0.285**

Determine the values of C and ø

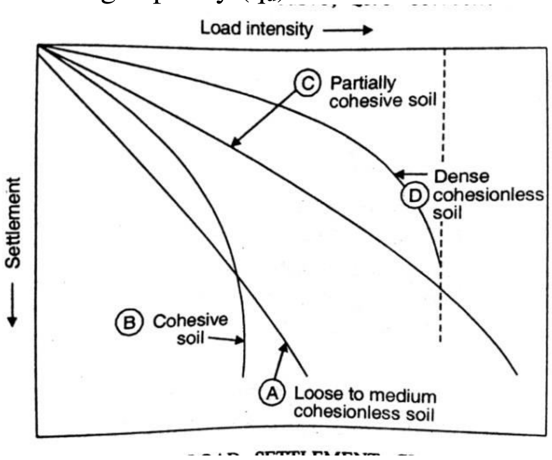


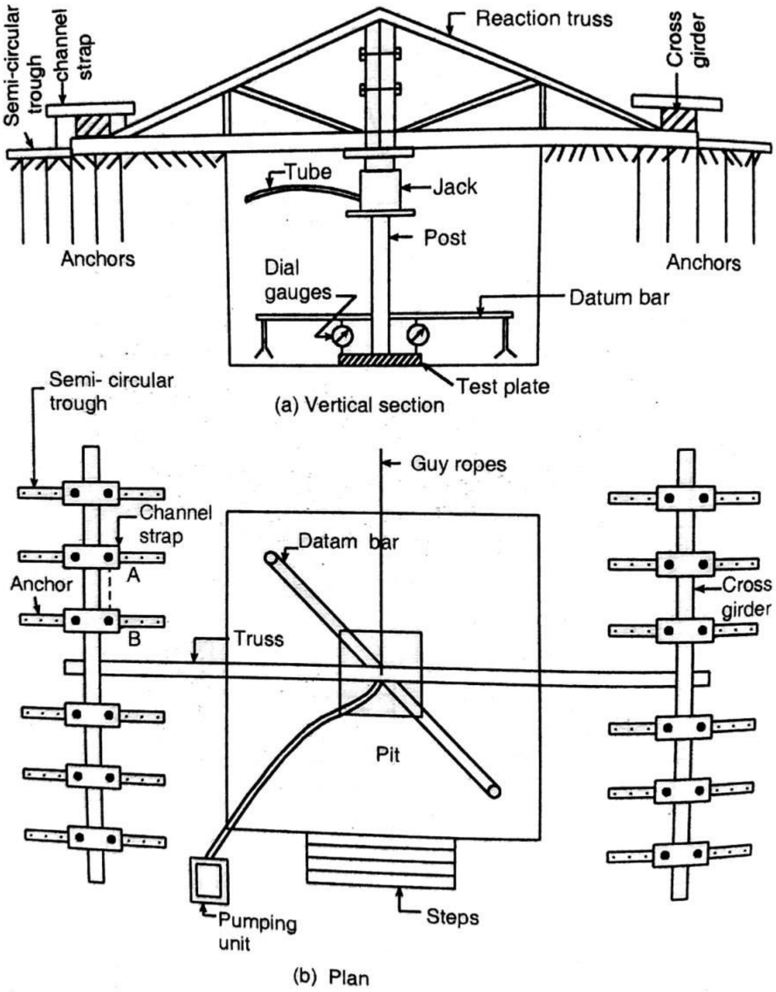
4M for Graph

Slope M = $\frac{y_2 - y_1}{x_2 - x_1} = \frac{0.193 - 0.11}{0.3 - 0.1}$ **= 0.415** **1M**

Angle of Repose ϕ **= tan^{-1} M = tan^{-1} (0.415)**

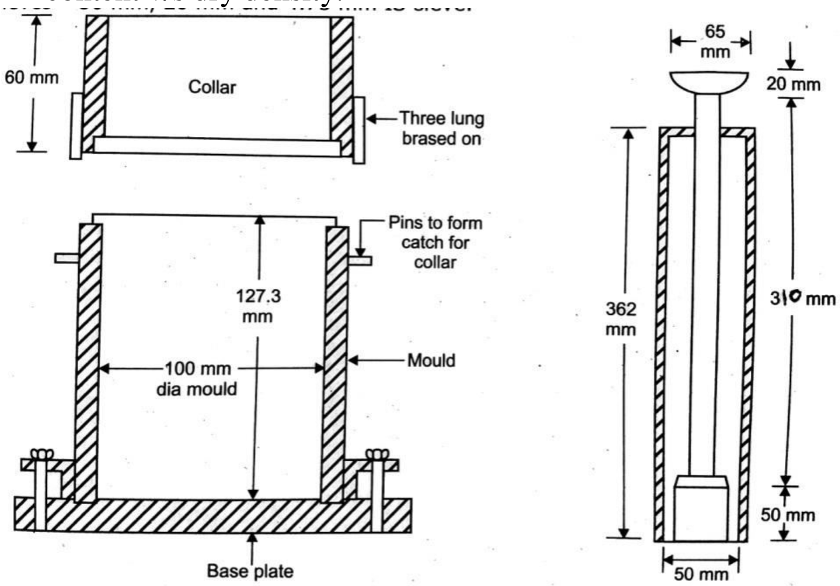
ϕ **= 22.538^0**

	Y intercept C $S = C + \sigma_n \tan\phi$ $0.11 = C + 0.1 \times \tan 22.538$ $0.11 = C + 0.04149$ $\mathbf{C = 0.0685}$ **OR C** values can be determined by using graph. The value may be in range of (0.06-0.075) appropriate marks can be given.	**1M** **2M**
b)	**Explain the plate load test with sketch of reaction truss method.**	
	i) Plate load test is field test to determine the ultimate bearing capacity of soil and probable settlement under given loading. ii) The test essentially consist in loading a rigid plate, called bearing plate at the foundation level and determining the settlement corresponding to each load increment. iii) The ultimate bearing capacity is taken as the load at which plate starts sinking at a rapid rate. iv) The test pit having width equal to 5 times the width of bearing plate is dug upto a depth of proposed foundation. Plate size may vary in width from 300mm to 750mm and 25mm thick. v) The loading to the test plate may be applied with the help of hydraulic jack. The reaction of hydraulic jack may be borne by reaction truss method. vi) The truss is held to the ground through soil anchors. These anchors are firmly driven in the soil with the help of hammers. The reaction truss is usually made up of mild steel sections. Guy ropes are used for the lateral stability of the truss. vii) When the load is applied is applied to the plate, it sinks or settles. The settlement of plate is measured with the help of sensitive dial gauge and for square plate two dial gauge. viii) The dial gauges are mounted on independently supported datum bar. As the plate settles, the ram of the dial gauge moves down and settlement is recorded. The load is indicated on the load gauge of the hydraulic jack. The load is applied in increment of $1/10^{th}$ of estimated failure load. ix) Settlement readings are made at regular interval of 1, 2, 5,10,20,40 and 60 minutes, until the rate of settlement becomes the less than about 0.02 mm/hr. x) The results of test are plotted between settlement and load intensity and ultimate bearing capacity (q_u) of soil is found out.	**4M for procedure**
	 **Note:** If any one curve of above is drawn by student appropriate marks can be given.	**1M**

	 **Plate load test using Reaction Truss Method**	**3M for sketch**
c)	**State the step by step procedure for determination of OMC and MDD using standard proctor test and explain compaction curve.**	
	Procedure: 1. Take about 5 Kg. of de-aired soil passing through sieve 20mm in tray. 2. Add about 4% water (approximately 120ml) to the soil and mixed thoroughly with trowel and cover it with moist cloth for 24 hrs to ensure thorough mixing of water with soil. 3. Note the dimension of proctor mould, collar and base plate. 4. Take the empty weight of the mould (without collar and base plate) 5. Apply a thin film of grease on inside of the mould. 6. Fix the mould with base plate with the help of wing nuts, place collar on the mould. 7. To determine the proctor density till the soil in mould in three equal layers and give 25 blows to each layer using standard hammer. Scrap the top surface of compacted layer before placing the next layer of a soil. Ensure that after compaction of the third layer, the level of compacted soil slightly above the top of the mould. 8. Remove the collar trim the soil with a straight edge, disconnect the mould from base plate and weigh it. 9. Extract the compacted soil from the mould. 10. Collect sample from middle of the mould for water content determination. 11. Repeat step 5 to 10 taking fresh sample of same soil with addition of 3 to 4%	**4M for procedure**

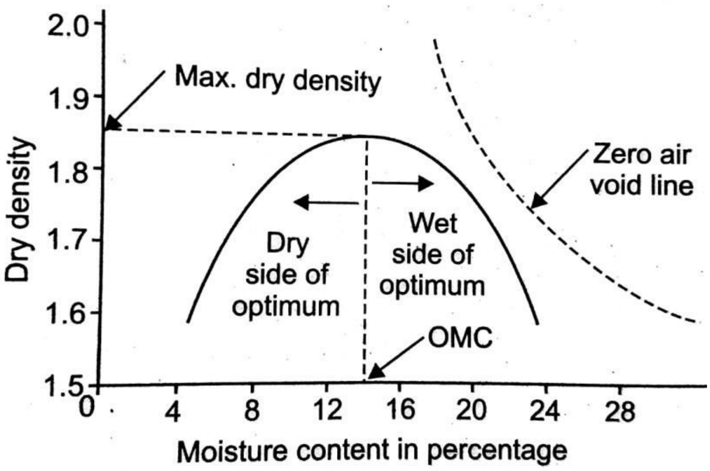
more water than previously added water. Repeat these steps for no. of times till a decrease in the weight of a soil is observed for at least two successive reading.

12. Calculate bulk density of compacted soil for each test.
13. Determine the maximum dry density and Optimum moisture content corresponding to the standard proctor compaction by plotting graph water content v/s dry density.



1M for sketch

Compaction Curve:



2M

Compaction curve is plotted between the water content as abscissa and the corresponding dry density as ordinate as shown in figure. It is observed that the dry density initially increases with an increase in water content since the soil particles gets lubricated and slips over each other and moved into densely packed position and dry density is increased, till the maximum density is attained. With further increase in water content the dry density decreases. Since there is formation of double layer of water around soil particles in the same volume.

1M