# AE/JE Foundation

## Civil Engineering

## Geotechnical Engineering

## Top 100 Most Expected Questions

1. Water content of soil is 0.15, Degree of saturation 70%, void ratio is 0.61, then specific gravity is :

A. 2.85 B. 2.13

C. 2.50 D. 2.17

Ans. A

Sol. eS = wG

0.61 x 0.7 = 0.15 x G

G = 2.85

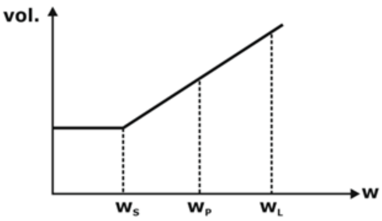
2. The numerical difference between liquid limit and plastic limit is:

A. Liquidity index B. Plasticity index

C. Consistency index D. Flow index

Ans. B

Sol.




Plasticity index, $I_p$ = liquid limit – plastic limit

$W_t$-- $W_p$

Plasticity index is the measure of the plasticity of a soil. It is the size of the range of water contents where the soil exhibits plastic properties.

3. The intensity of vertical stress at depth z below a concentrated load Q, by Boussinesq equation is:

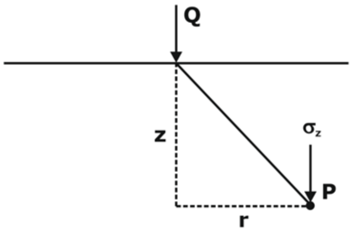
A. $\sigma_z = 0.5775 \frac{Q}{Z^2}$ B. σ = 0.4775 $QZ^2$

C. $\sigma_z = 0.4775 \frac{Q}{Z^2}$ D. σ = 0.5775 $QZ^2$

Ans. C

Sol. According to Boussinesq, vertical stress at depth z and radial distance r from a point load Q is given as

$$\sigma_z = \frac{3Q}{2\pi z^2}\left[\frac{1}{1+\left(\frac{r}{z}\right)^2}\right]^{5/2}$$




For $r = 0, \sigma_z = \frac{3Q}{2\pi z^2} = 0.4775\frac{Q}{z^2}$

4. The volumetric strain per unit increase in effective stress of soil is defined as:

A. Compression index
B. Volume compressibility
C. Coefficient of compressibility
D. Consolidation

Ans. B

Sol. Volume compressibility

$$= \frac{\frac{\Delta V}{V}}{\Delta \bar{\sigma}} = \frac{\frac{\Delta H}{H}}{\Delta \bar{\sigma}} = \frac{\frac{\Delta e}{1+e_o}}{\Delta \bar{\sigma}}$$

$$M_v = \frac{\frac{\Delta e}{\Delta \bar{\sigma}}}{1+e_O} = \left(\frac{a_v}{1+e_O}\right)$$

5. An important hydraulic failure of earth dams is

A. Piping
B. Sloughing
C. Upstream slope failure due to sudden drawdown
D. Overtopping

Ans. D

Sol. Important hydraulic failure of earth dams are:

i. Sliding ii. Overtopping

iii. Crushing

6. The collapsible soil is associated with

A. Dune sands
B. Laterite soils
C. Loess
D. Black cotton soils

Ans. D

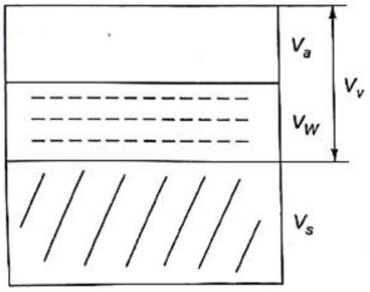
Sol. Black cotton soil has high %age of montmorillonite. Montmorillonite has high swelling and shrinking properties. Hence it is known as collapsible soil since it changes its volume to a high extent.

7. Degree of saturation (s) of a soil mass is expressed in term of value of water ($V_W$) and volume of voids ($V_V$) as

A. $S = \frac{(V_V V_W)}{100}$
B. $S = 100\left(\frac{V_W}{V_V}\right)$
C. $S = 100\left(\frac{V_V}{V_W}\right)$
D. $S = 100(V_V - V_W)$

Ans. B

Sol.




Degree of saturation is the amount of water present in the voids and is expressed as

$$S = \frac{V_w}{V_v} \times 100$$

$0\% < S < 100\%$

8. A sample of saturated soil has a water content of 29.6%. If the specific gravity of Solids is 2.7, the dry unit weight (in gr/cm$^3$) of the soil is equal to

A. 0.5
B. 0.75
C. 1
D. 1.5

Ans. D

Sol. $\gamma_d = \frac{\gamma_d}{1+W}$

$$e = \frac{WG}{S} = \frac{0.296 \times 2.7}{1} = 0.8$$

$$\gamma_d = \left(\frac{G}{1+e}\right)\gamma_W = \frac{2.7}{1+0.8} \times 1\text{g/cc}$$

$$\gamma_d = 1.5 \text{ g/cc}$$

9. Lacustrine soils according to geological classifications are

A. Transported by ice
B. Transported by wind
C. Deposited in seas
D. Deposited in lakes

Ans. D

Sol. Lacustrine soils are the soils which are deposited in lakes.

10. If two soils S1 and S2 tested in the laboratory are having liquid limits 38% and 60% and plastic limits 18% and 20% respectively. If natural moisture content for S1 and S2 is 40% and 50% respectively, which soil is a better foundation material when remoulded.

A. S1
B. S2
C. S1 and S2
D. Neither S1 nor S2

Ans. B

Sol. $I_C = \frac{W_L - W_H}{W_L - W_P}$

$$I_{C1} = \frac{38-40}{38-18} < 0$$

Soils is in liquid state not suitable for foundation.

$$I_{C2} = \frac{60-50}{60-20} = 0.25$$

Better soil for foundation

11. If H and V are initial height and volume of the soil specimen. ΔH and ΔV are corresponding changes in the values of height and volume in Triaxial Compression test. The area of cross-section A at failure or during any stage of Triaxial compression test is given

A. $A = \frac{V + \Delta V}{H - \Delta H}$ B. $A = \frac{V - \Delta V}{H + \Delta H}$

C. $A = \frac{V + \Delta V}{H + \Delta H}$ D. $A = \frac{V - \Delta V}{H - \Delta H}$

Ans. A

Sol. $\varepsilon_a$ = Axial strain = $-\frac{dh}{h_0}$

If specimen is assumed to remain cylindrical, then

$A(h_0 - dh) = V = (V_0 + dV)$

$$A = \frac{V_0 + dV}{h_0 - dh} = \frac{V + \Delta V}{H - \Delta H}$$

12. The soil which has more plasticity index is

A. Sand B. Silt

C. Gravel D. clay

Ans. D

Sol. Plasticity index: It is a measure of the plasticity of the soil and is calculated as the difference between liquid limit and plastic limit.

Plasticity index order: clay> silt> sand > gravel

13. If S is the shear strength, C is cohesion and φ is angel of internal friction, σ is the normal stress at failure, then coulomb's equation for shear strength of the soil can be represented by

A. C = S – σ tan φ B. S = C – σ tan φ

C. C = S + σ tan φ D. S = σ + C tan φ

Ans. A

Sol. Coulomb's equation for shear strength of the soil is given as

S = C + σ tan φ

or C = S – σ tan φ

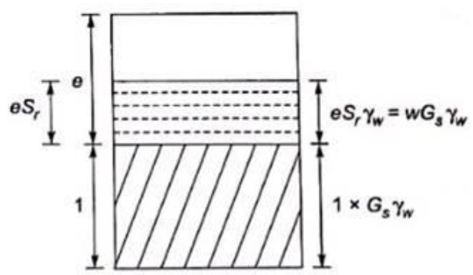
14. The relationship equation of Void ratio I, Specific gravity (G) , Water content (w) and Degree of saturation ($S_r$) is

A. $S_r$= weG B. $S_r$G = we

C. $S_r$w = eG D. $S_r$e = wG

Ans. D

Sol.



$$w = \frac{W_w}{W_s}, S_r = \frac{V_w}{V_v}$$

$$e = \frac{V_v}{V_s} = \frac{V_v}{V_w} \times \frac{V_w}{V_s} = \frac{1}{S_r} \times \frac{\frac{W_w}{\gamma_w}}{\frac{W_w}{\gamma_s}}$$

$$e = \frac{1}{S_r} \times \frac{W_w}{W_s} \times \frac{\gamma_s}{\gamma_w} = \frac{1}{S_r} wG_s$$

$$eS_r = wG_s$$

15. Compression Index on a soil helps to determine

A. total time required for consolidation

B. time required for 50% consolidation

C. total settlement of clay layer

D. pre-consolidation pressure of clay

Ans. C

Sol. Compression index

$$C_c = \left( \frac{e_1 - e_2}{\log_{10} \overline{\sigma_2} - \log_{10} \overline{\sigma_1}} \right)$$

$$= \frac{\Delta e}{\log_{10}\left( \frac{\overline{\sigma_2}}{\overline{\sigma_1}} \right)}$$

$$\Delta H = \frac{C_c H_o}{1 + e_o} \log\left( \frac{\overline{\sigma_2}}{\overline{\sigma_1}} \right)$$

ΔH = Total settlement

16. According to Boussineq's equation, the stress intensity of soil at depth 'Z' and horizontal distance V due to surface point load is given by

A. $\sigma_Z = \frac{Q}{Z^2} \frac{\frac{3}{2\pi}}{\left[1 + \left(\frac{r}{z}\right)^2\right]^{5/2}}$

B. $\sigma_Z = \frac{Q}{Z} \frac{\frac{3}{2\pi}}{\left[1 + \left(\frac{r}{z}\right)^2\right]^{5/2}}$

C. $\sigma_Z = \frac{Q}{Z^2} \frac{\frac{3}{2\pi}}{\left[1 + \left(\frac{r}{z}\right)^2\right]^{3/2}}$

D. $\sigma_Z = \frac{Q}{Z} \frac{\frac{3}{2\pi}}{\left[1 + \left(\frac{r}{z}\right)^2\right]^{3/2}}$

Ans. A

Sol. According to Boussineq's

$$\sigma_2 = \frac{3Q}{2\pi z^2} \left[ \frac{1}{1 + \left(\frac{r}{z}\right)^2} \right]^{5/2}$$

Whereas according to westergard,

$$\sigma_2 = \frac{Q}{\pi z^2} \left[ \frac{1}{1 + 2\left(\frac{r}{z}\right)^2} \right]^{3/2}$$

17. The method which is more suitable for the determination of permeability of sandy soil is

A. constant head method

B. variable head method

C. Horizontal permeability test

D. hydrometer method

Ans. A

Sol. Constant head method for the determination of permeability is more suitable for sandy soil since permeability of sandy soil is quite high whereas for clayey soil, variable head method is more suitable since permeability of clayey soil is very less and it will be difficult to maintain constant head for a very long time.

18. In sands, during earthquakes, instantaneous pore pressures are likely to develop loading to sudden and total loss of shearing strength. This phenomenon is known as

A. quicksand B. liquefaction

C. damping D. scouring

Ans. B

Sol. Loose sand has a tendency to get compressed when loaded. If rate of loading is larger and soil is saturated, +ve (positive) pre water pressure will develop. This will reduces effective stress and hence shear strength. If effective stress reduces to zero, the soil will loose all its shear strength. This phenomenon is known as liquefaction.

• Thus liquefaction occur in saturated loose sands

• It occurs during pile driving, vibration of machine, explosive blasting, earthquake shock.

• It occurs at high frequency of vibration.

• There can be cumulative increase in pore water pressure under successive cycle of loading.

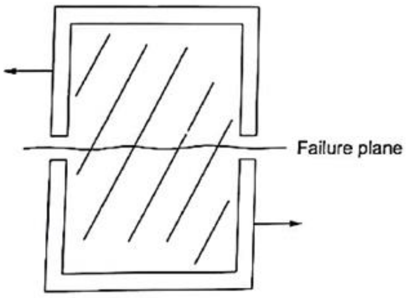
19. The failure plane in direct shear test is

A. Horizontal B. Vertical

C. Inclined at 45° to the horizontal D. Unpredictable

Ans. A

Sol. The failure in direct shear test is always horizontal.




20. Boussinesque's Solution for the stresses in soil caused by a point load at the surface is based on some assumptions. One of which is

A. Soil medium is finite medium B. Soil medium is plastic

C. Soil medium obeys Hook's law D. Soil medium is not homogenous

Ans. C

Sol. Assumptions of Boussinesque's Solution

D. Soil medium is semi infinite.

ii. It is elastic.

iii. It Obey's Hook's law.

iv. It is homogeneous and isotropic.

21. Neutral stress within a soil mass is also known as

A. Pore water pressure
B. Effective stress
C. Geostatic stress
D. Static shear stress

Ans. A

Sol. Pore water pressure is known as neutral stress since it acts in every direction with same magnitude.

22. A layer of soil having $G$ = 2.67 and $e$ = 0.67 is subjected to an upward head of 1.5 m due to seepage of water. The depth of the soil layer required to provide a factor of safety 2 against piping is

A. 1.5 m
B. 2.0 m
C. 3.0
D. 0.75 m

Ans. C

Sol. G = 2.67

e = 0.67

Critical hydraulic gradient

$$\frac{G-1}{1+e} = \frac{2.67-1}{1+0.67} = 1$$

$$\text{FOS} = \frac{i_{cr}}{i},\ i = \frac{1.5\ \text{m}}{d}$$

$$2 = \frac{1}{\left(\frac{1.5}{d}\right)}$$

$$d = 2 \times 1.5 = 3\ \text{m}$$

23. The maximum dry density and optimum moisture content of a soil is given by 1.65 gm/cc and 20.5% respectively. What is the percentage of air content of soil at OMC, if the specific gravity of particles is given by 2.65?

A. 10.4
B. 15.5
C. 26.8
D. 35.7

Ans. A

Sol. $\rho_d = \frac{(1-n_a)G\rho_w}{1+wG}$,

Hence $n_a =$ .039

$Percentage\ air\ void, n_a = n \times a_c, Here\ a_c = Air\ content$

$To\ get\ the\ value\ of\ n, \rho_d = \frac{G\rho_w}{1+e}, e = .61$

$We\ know, n = \frac{e}{1+e} = .377$

$Now, a_c = \frac{n_a}{n} \times 100 = 10.34\%$

24. If the depth of moist sand in a cylinder is 15 cm and the depth of the sand when fully inundated with water is 12 cm, then what is the bulking of the moist sand?

A. 0.1
B. 0.2
C. 0.15
D. 0.25

Ans. D

Sol. Bulking of moist sand = (depth of moist sand – depth of sand fully inundated with water) / depth of sand fully inundated with water × 100

= (15 – 12 / 12) × 100 = (3 / 12) × 100

= 25% = 0.25

25. Capillary water in soils

A. Causes negative pore water pressure. B. Reduces effective pressure.

C. Reduces bearing capacity D. All of the above.

Ans. A

Sol. In the same way that water moves upwards through a tube against the force of gravity; water moves upwards through soil pores, or the spaces between soil particles. The height to which the water rises is dependent upon pore size. As a result, the smaller the soil pores, the higher the capillary rise. Capillary water in soils Reduces bearing capacity.

26. When applying Darcy's law to soils, it is assumed that the

A. Soil is compressible. B. Soil is homogenous and isotropic.

C. Flow conditions are laminar D. All of these.

Ans. D

Sol. Darcy's Law is an empirical relationship for liquid flow through a porous medium. A common application is groundwater flow through an aquifer. Darcy's Law gives the relationship among the flow rate of the groundwater, the cross-sectional area of the aquifer perpendicular to the flow, the hydraulic gradient, and the hydraulic conductivity of the aquifer. Darcy's Law is valid only for laminar flow, which occurs for Reynold's number less than 1. Soil is compressible. Soil is homogenous and isotropic.

27. The quantity of seepage of water in a soil medium is

A. Directly proportional to the head of water at upstream.

B. Inversely proportional to the head of water at upstream.

C. Directly proportional to the coefficient of permeability.

D. Inversely proportional to the coefficient of permeability.

Ans. C

Sol. The pressure exerted by water on the soil through which it percolates, is known as seepage pressure. The quantity of seepage of water in a soil medium is directly proportional to the coefficient of permeability.

Coefficient of permeability, $k = \frac{Q}{Ah}$

Where Q is discharge quantity

28. A stratum of clay draining both at top and bottom undergoes 30% consolidation under a load in 9 years. If an additional drainage layer were present at the mid height of this clay stratum, what would be the time taken for 30% consolidation under the same load?

A. 3 years B. 4 years and 6 months

C. 2 years and 3 months D. 9 years

Ans. C

Sol. Additional drainage layer at mid height will reduce the drainage path by half.

Therefore $\frac{t_1}{d_1^2} = \frac{t_2}{d_2^2}$

So the time taken for same degree of consolidation will reduce to one fourth.

$t_2 = \frac{t_1}{4} = \frac{9}{4} = 2.25$ years

$t_2 = 2$ years 3 months

29. Which one of the following represents the correct relationship between seepage pressure ($p_s$), unit weight of water ($\gamma_w$) and hydraulic gradient (i) inside an earth dam?

A. $p_s = i/\gamma_w$

B. $p_s = i\,\gamma_w$

C. $p_s = i^2\,\gamma_w$

D. $p_s = \gamma_w/i$

Ans. B

Sol. The seepage pressure increases effective stress on the upstream side and decreases it on the downstream side in an earth dam. Therefore, downstream slopes are critical $p_s = i\,\gamma_w$

30. Given that for a sample

Critical void ratio = 0.50

Initial void ratio = 0.60

If the sand sample is subjected to continued shear, its volume will:

A. Increase

B. Decrease

C. Not change

D. Initially increase and then decrease

Ans. B

Sol. As the initial void ratio is more than critical void ratio, so sand is in loose state. During shearing the loose particles will rearrange themselves to a dense state and so volume will decrease.

31. When does a quick sand condition is developed in soil?

A. Head causing upward flow is decreased

B. Head causing upward flow is increased

C. Head causing downward flow is decreased

D. Head causing downward flow is increased

Ans. B

Sol. The quick condition of soil is the condition when the upward water pressure gradient and water flow reduce the effective stress, i.e., cohesiveness of the soil. This is generally takes place when Head causing upward flow is increased.

Due to thissandy soils may lose their shear strength, and the soilmay behave as a fluid. Cohesive soils may produce cracks with water seepage.

32. Compressibility is the reciprocal of

A. Bulk modulus of elasticity

B. Young's modulus of elasticity

C. Shear modulus of elasticity

D. Rigidity Modulus of elasticity

Ans. A

Sol. Compressibility is a measure of the relative volume change of a fluid or solid as a response to a pressure (or mean stress) change. While Bulk modulus is the measure of the decrease in volume with an increase in pressure. So we can say that compressibility is reciprocal of bulk modulus.

33. The water in the soil which is in excess of the hygroscopic and capillary water and which can move freely downwards when the soil is porous and drainage available is called

A. Hygrosopic water
B. Firing water
C. Free water
D. Capillary water

Ans. C

Sol. Gravitational or free water – This form of water is loosely held in the soil and could be easily lost by gravitational force. Hygroscopic water – is a form of soil water that is present not only in the pores but also on the surface of the soil particle.

34. Which of the following is the appropriate triaxial test to assess the immediate stability of an unloading problem, such as an excavation of a clay slope?

A. CU test
B. CD test
C. UU test
D. Unconsolidated drained test

Ans. C

Sol. The standard unconsolidated undrained test is compression test, in which the soil specimen is subjected under isotropic all round pressure in the triaxial cell before failure is brought about by increasing the major principal stress.It is performed without measurement of pore pressure.

In a 'consolidated drained' test the sample is consolidated and sheared in compression slowly to allow pore pressures built up by the shearing to dissipate. ... The idea is that the test allows the sample and the pore pressures to fully consolidate (i.e., adjust) to the surrounding stresses.

The standard consolidated undrained test is compression test, in which the soil specimen is first consolidated under all round pressure in the triaxial cell before failure is brought about by increasing the major principal stress.

35. Terzaghi's bearing capacity factors depend on

A. Coefficient of curvature of soil and bulk density of soil
B. Angle of internal friction of soil and depth of foundation
C. Uniformity coefficient of soil and dry
D. Angle of internal friction of soil density of soil

Ans. D

Sol. Terzaghi's Bearing capacity equations:

Strip footings:

Qu = c Nc + g D Nq + 0.5 g B Ng

Square footings:

Qu = 1.3 c Nc + g D Nq + 0.4 g B Ng

Circular footings:

Qu = 1.3 c Nc + g D Nq + 0.3 g B Ng

Where:

C: Cohesion of soil (apparent cohesion intercept);

g: unit weight of soil;

D: depth of footing (depth of embedment);

B: width/breadth of footing;

Nc, Nq, Nr: Terzaghi's bearing capacity factors depend on soil friction angle, f:

36. Soil at a site consists of two layers. The top layer has permeability k units and bottom layer has permeability 5k units. If the thickness of both the layers is equal, then what is the average permeability in the vertical direction?

A. (5/6)k units

B. (5/3)k units

C. 3k units

D. (6/5)k units

Ans. B

Sol. $$k_{eqv} = \frac{H_1 + H_2}{\frac{H_1}{k_1} + \frac{H_2}{k_2}}$$

Here H1 = H2= let us assume H (given in question)

$$k_{eqv} = \frac{H + H}{\frac{H}{5K} + \frac{H}{K}}$$

$$k_{eqv} = \frac{5}{3}K$$

37. The property of the soil due to which a decrease in volume occurs under compressive force is known as -

A. Compression strength of soil

B. Compressibility of soil

C. Consolidation of soil

D. Initial consolidation of soil

Ans. B

Sol. Soil compressibility is the capability of a soil to decrease in volume when subjected to a mechanical load. The process that describes the decrease in soil volume (soil densification) under an externally applied load is called compression.

While consolidation is natural phenomena.

38. A phreatic line is defined as the line within a dam section below which there is/are

A. Positive hydrostatic pressure

B. Negative hydrostatic pressure

C. Negative equipotential lines

D. Positive equipotential lines

Ans. A

Sol. It is defined as an imaginary line within the dam section, belowwhich there is positive hydrostatic pressure, and above there is negative hydrostatic pressure in the dam section. The hydrostatic pressure represents the atmospheric pressure, which is equal to zero at the face of phreatic line.

39. If two individual footings are too close as per design, then they should be converted as

A. Strap footing B. Combined footing

C. Strip raft D. Mat raft

Ans. B

Sol. If two individual footings are too close as per design, then they should be converted as Combined footing.

40. A soil sample is partially saturated. Its natural moisture content was found to be 22% and bulk density 2 gms/c.c. If the specific gravity of the solid particles is 2.65 and the density of water is I gm/c.c, the void ratio of the sample is

A. 0.3825 B. 0.6165

C. 0.8188 D. 0.9122

Ans. B

Sol. w= 0.22

$p_b$= 2g/cc G=2.65 $p_w$ = 1g/cc

$p_b = \left(\frac{G+Se}{1+e}\right) p_w$

since, Se = wG = 0.22*2.65 = 0.583

1+e = (2.65+0.583)/2 * 1

Therefore **e = 0.6165**

41. A clay layer of thickness 10 cm and initial void ratio 0.5 undergoes settlement so that the final void ratio is 0.2. The settlement of the layer in cm is:

A. 1.0 B. 1.5

C. 2.0 D. 2.5

Ans. C

Sol. $\frac{\Delta H}{h} = \frac{\Delta e}{1+e_0}$

$\Delta H = 10 \text{ x } \frac{(0.5-0.2)}{1+0.5}$

$\Delta H = 2 \text{ cm}$

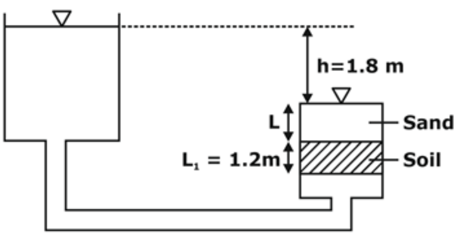
42. A 1.2 m layer of soil is subjected to an upward seepage head of 1.8 m. A layer of coarse sand is laid above the soil layer to attain a factor of safety of 2.0 against piping. Both the soil and coarse sand have the same values of G = 2.67 and e = 0.678. The required depth of the coarse sand layer is:

A. 0.9 m B. 1.2 m

C. 2.4 m D. 3.6 m

Ans. C

Sol.



Factor of safety against piping

F.S. = $\frac{Submerged\ weight\ at\ the\ base\ of\ soil}{Total\ uplift\ force}$

F.S. = $\frac{\gamma_b(L_1+L)}{h\gamma_w}$ = 2.0

$\frac{\gamma_b}{\gamma_w} = (\frac{G-1}{1+e})$ = 1

$L_1$ + L = 2 x 1.8 = 3.6 m

L = 3.6 – 1.2 = 2.4 m

43. In a three-layered soil, water flows parallel to stratification. The thickness of the middle layer is twice that of top and bottom layer. The coefficient of permeability of middle layer (2k) is twice that of top and bottom layer (k). What is the average coefficient of permeability for this flow?

A. k
B. 1.33 k
C. 1.5 k
D. 0.66 k

Ans. C

Sol. For flow parallel to the stratification

$K_eH = k_1h_1 + k_2h_2 + k_3h_3$

Let $h_1$ = h, $h_2$ = 2h, $h_3$ = h

$K_1$ = k, $k_2$ = 2k, $k_3$ = k

$K_e = \frac{k+4k+k}{4}$ = 1.5 k

44. If the pores of a soil are completely full of air only, the soil is said to be

A. Dry soil
B. Wet Soil.
C. Fully Saturated soil
D. Partially Saturated soil

Ans. A

Sol. When voids are completely filled with air, water content is equal to zero. This type of soil is known as dry soil. Presence of water content in voids of soil make the soil partially saturated and wet soil. When voids are completely filled with water, this type of soil is known as saturated soil.

45. The water content of a soil remains unchanged during the entire test in

A. Drained test
B. Consolidated undrained test
C. Unconsolidated undrained test
D. None of the above.

Ans. C

Sol. For the UU test, the specimens (assumed to be saturated prior to test) are subjected to a confining fluid pressure in a triaxial chamber. Once the specimen is inside the triaxial cell, the cell pressure is increased to a predetermined value by rotating the knob of the constant pressure unit, and the specimen is brought to failure by increasing the vertical stress by applying a constant rate of axial strain. Since saturation and consolidation do not exist in this method, original structure and water content of sample is untouched. Pore and back pressures are not measured during this test and therefore the results can only be interpreted in terms of total stress over a confinement pressure (stress). The water content of a soil remains unchanged during the entire test in unconsolidated undrained test.

46. The void ratio of a soil is defined as the ratio of the

A. Weight of water to the weight of solids.

B. Volume of water to the volume of voids in the soil mass.

C. Total volume of voids to the total volume of soil solids.

D. Total volume of voids to the total volume of soil.

Ans. C

Sol. The void ratio of a mixture is the ratio of the volume of voids to volume of solids.

$$void\ ratio, e = \frac{Volume\ of\ voids\ (V_v)}{Volume\ of\ solids\ (V_s)}$$

47. The fine grained soil

A. Has low permeability

B. Has high compressibility

C. May or may not be plastic

D. All of the above

Ans. D

Sol. Fine grained soils are identified on the basis of its plasticity. Individual particles are not visible by naked eye. Fine grained soils are also divided in two groups, Silt & Clay. Particles having diameter in between 75 micron to 2 micron are called Silt and particles having diameter smaller than 2 micron is called Clay. Verbal description of fine grained soil is done on the basis of its dry strength, dilatancy, dispersion and plasticity. Fine grained soil exhibit a poor load bearing capacity. Fine grained soil is practically impermeable in nature because of its small particles size. Volume change occurs with change in moisture content. Strength changes with change in moisture condition. Fine grained soil is susceptible to frost action. Engineering properties are controlled by mineralogical factors. When touched by hand it feels smooth, greasy and sticky.

48. A unit volume of a mass of saturated soil is subjected to horizontal seepage. The saturated unit weight is 22 kN/$m^3$ and the hydraulic gradient is 0.5. The resultant body force on the soil mass is

A. 13 kN

B. 10 kN

C. 9 kN

D. 5 kN

Ans. A

Sol. Body force is equal to vector summation of effective buoyant weight and seepage force.

$\gamma_{saturated} = 22\ kN/m^3$

Seepage force, $F_{seepage} = i\gamma_w = 0.5 \times 10 = 5$

Effective buoyant force of 1 $m^3$ = $\gamma_{saturated} - \gamma_w = 22 - 12 = 10\ kN$

Resultant Body force, $F_r = \sqrt{12^2 + 5^2} = 13\ kN$

49. Which one of the following statements provides the best argument that direct shear tests are not suited for determining shear parameters of clay soil?

A. Failure plane is not the weakest plane

B. Pore pressures developed cannot be measured

C. Satisfactory strain levels cannot be maintained

D. Adequate consolidation cannot be ensured

Ans. A

Sol. The predetermined failure plane may not be the weakest plane. This is the most important limitation of direct shear test.

50. Which one of the following is the appropriate field test for assessing the angle of shearing resistance $\varphi$ of a deep seated sand deposit?

A. Vane shear test  B. Plate load test

C. Standard penetration test  D. Static cone penetration test

Ans. C

Sol. i) Vane shear test is suitable for soft clays. Plate load test will give the ultimate failure load only.

ii) Standard Penetration test is suitable for obtaining $\varphi$ value of san deposit based on the correlation of shearing resistance.

51. Which one of the following is the best method for the stabilization of the clayey subgrade in water logged area?

A. Cement stabilization  B. Lime stabilization

C. Bitumen stabilization  D. Stabilization by grouting

Ans. B

Sol. By adding lime the optimum water content of clay increases while the maximum dry density decreases. In water logged area, the water content is above the optimum so addition of lime will help in drying of soil.

52. The natural void ratio of a saturated clay strata, 3 m thick is 0.9. The final void ratio of clay at the end of consolidation is expected to be 0.71. The total consolidation settlement of clay strata is

A. 30 cm  B. 25 cm

C. 20 cm  D. 15 cm

Ans. A

Sol. Let the total consolidation = $\Delta H$

Thickness of strata, H = 3 m

Final void ratio, $e_f = 0.71$

Initial void ratio, $e_0 = 0.9$

$$\frac{\Delta H}{H} = \frac{\Delta e}{1 + e_0}$$

$$\frac{\Delta H}{3} = \frac{0.9 - 0.71}{1 + 0.9}$$

$$\Delta H = 0.3 \text{ m} = 30 \text{ cm}$$

53. Given that coefficient of curvature = 1.5, $D_{30} = 3\text{mm}, D_{10} = 0.6\text{ mm}$. Based on this information of particle size distribution for use as subgrade, this soil will to be

A. Uniformly Graded sand  B. Well graded sand

C. Very fine sand  D. Poorly graded sand

Ans. B

Sol. Coefficient of curvature, $C_c = 1.5$

$$D_{30} = 3\text{mm}$$

$$D_{10} = 0.6\text{ mm}$$

$$C_c = \frac{(D_{30})^2}{D_{10}.D_{60}}$$

$$1.5 = \frac{3^2}{0.6 \text{ x } D_{60}}$$

$$D_{60} = 10$$

$$C_u = \frac{D_{60}}{D_{10}} = \frac{10}{0.6} = 16.6$$

$$\text{Since}, C_u \geq 6\ ;\ C_c = 1 - 3$$

Hence, well graded

54. Which of the following bonding is responsible to combine the silica-gibsite sheet in kaolinite clay mineral?

A. Covalent bond

B. Hydrogen bond

C. Ionic bond

D. Polar covalent bond

Ans. B

Sol. The basic units of kaolinite mineral are held together by hydrogen bonds. The strong bonding does not permit water to enter the lattice. Thus kaolinite minerals are stable and shows lesser swelling and shrinkage properties.

55. If void ratio is 0.65 and specific gravity is 2.65 then the critical hydraulic gradient is

A. 2

B. 1

C. 2.2

D. 3.3

Ans. B

Sol. $i_c = \frac{G-1}{1+e}$

$$= \frac{2.65-1}{1+0.65} = 1$$

56. The changes that take place during the process Of consolidation of a saturated clay would include

A. an increase in pore water pressure and an increase in effective pressure

B. an increase in pore water pressure and a decrease in effective pressure

C. a decrease in pore water pressure and a decrease in effective pressure

D. a decrease in pore water pressure and an increase in effective pressure

Ans. D

Sol. The excess hydrostatic pressure developed after the application of the load sets up a hydraulic gradient, and the water starts escaping from the voids. As the water escapes, the applied pressure is transformed from the water to the solids. Eventually, the whole of the pressure is transferred to the soil solids as the effective stress, and the excess water pressure becomes zero. As the effective stress increases, the Volume of the soil decreases.

57. If the void ratio and discharge velocity for soil is 0.5 and 6 x$10^{-7}$ m/s respectively, what is the value of seepage velocity (m/s)?

A. 3 x$10^{-7}$

B. 6 x$10^{-7}$

C. 12 x$10^{-7}$

D. 18 x$10^{-7}$

Ans. D

Sol. $Seepage\ velocity(V_s) = \frac{V}{n}$

Here V= discharge velocity

n=Porosity,

$n = \frac{e}{1+e} = \frac{1}{3}$

Therefore, $V_s = 18 \times 10^{-7}$

58. Bulking of sand occurs when water content is,

A. 18—20%

B. 10—12%

C. 7—8%

D. 4—5%

Ans. D

Sol. The increase in volume due to bulking is Between 20 to 30% for most sands at a water content of 4— 5%.

| Moisture Content % | Bulking Percentage by Volume |
|---|---|
| 2% | 15% |
| 3% | 20% |
| 4% | 25% |
| 5% | 30% |

59. Which one in the following list does not possess plasticity?

A. Bentonite

B. Kaolinite

C. Rock flour

D. Fat clay

Ans. C

Sol. Rock flour, or glacial flour, consists of fine grained, silt sized particles of rock, generated by mechanical grinding of bedrock by glacial erosion or by artificial grinding to a similar size. Kaolinite, bentonite and fat clay are all types of clay and possess plasticity.

60. Average flow parallel to the plane of stratification is governed by :

A. most permeable layer

B. most impermeable layer

C. least permeable layer

D. None of these

Ans. A

Sol. Average permeability parallel to the plane of stratification depends mainly on the permeability of the most permeable layer and its value is close to the permeability of that layer.

61. Sum of the specific yield and specific retention is:

A. porosity B. void ratio

C. volume of voids D. none of the above

Ans. A

Sol.

- **Specific Yield** is the volume of water yielded from the soil against gravity per unit volume of soil.
- **Specific retention** Volume of water retained in the voids against gravity per unit volume of soil.

Specific yield + specific retention = porosity

$$S_y + S_r = n$$

62. A soil has liquid limit of 60%, plastic limit of 35%, shrinkage limit of 20% and it has a natural moisture content of 50%. What is the liquidity index of the soil?

A. 0.4 B. 0.6

C. 1.5 D. 1.3

Ans. B

Sol. liquidity index, $I_L = (W_N-W_P)/(W_L-W_P)$

Where, $W_L$, $W_p$ & $W_N$= liquid limit, plastic limit & moisture content.

So, $I_L = (50-35)/(60-35) = 0.6$

other given data has no use.

63. Which of the following statement is CORRECT about the stream lines and equipotential lines?

A. Both ca n be drawn graphically for viscous flow around any boundary.

B. Meshes formed by them are alwayssquares.

C. They always meet orthogonally.

D. They can be calculated for all boundary conditions.

Ans. C

Sol. In flow field it is seen that the stream lines are defined as lines of constant which are same as gradient lines and perpendicular to lines of constant.

So, the equipotential lines and stream lines are mutually perpendicular in a flow field.

64. The coefficient of gradation and the coefficient of uniformity of a given soil sample is 1.0 and 4.0 respectively. The ratio of effective size to the diameter through which 30% of the total mass is passed is _______.

A. 2 B. 4

C. 1.5 D. 0.5

Ans. D

Sol. Given,

Coefficient of gradation, $C_c = 1$

And coefficient of uniformity, $C_u = 4$

We know that

$C_u = D_{60} / D_{10} = 4$

$D_{60} = 4D_{10}$

And $C_c = (D_{30})^2 / D_{60}.D_{10}$

From first equation,

$4 = (D_{30})^2 / (D_{10})^2$

So $D_{30} / D_{10} = 2$.

So $D_{10} / D_{30} = 0.5$

Where $D_{10}$ is effective size and $D_{30}$ is effective size through which 30% of total mass is passed.

65. The angle of repose of a soil is the maximum angle which the outer face of the soil mass makes

A. with the horizontal

B. with the vertical

C. with the perpendicular to the inclined plane of the soil

D. None of these

Ans. A

Sol. The angle of repose, or critical angle of repose, of a granular material is steepest angle of descent or dip relative to the horizontal plane to which a material can be be piled without slumping. At this angle, the material on the slope face is on the verge of sliding. The angle of repose can range from 0° to 90°.

66. The height of a retaining wall is 5.5 m. It is to be designed as:

A. Cantilever type | B. Counterfort type

C. Cantilever or counterfort type | D. None of the above

Ans. A

Sol. For height less than 8 m and greater than 4.5 m, cantilever type retaining walls are best and for heights greater than 8m, counterfort type walls are best.

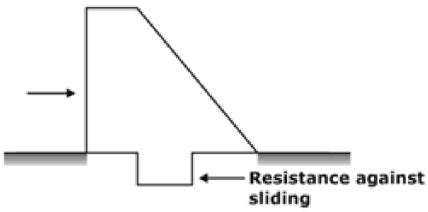
67. A shear key is provided in a retaining wall to avoid

A. Sliding | B. Overturning

C. Buckling | D. Bending

Ans. A

Sol. A shear key in retaining walls acts as a restraining force against sliding hence, avoids sliding.




68. Which is an example of cased cast-in-situ concrete pile?

A. Raymond pile | B. Watson pile

C. Reynold pile | D. Boston pile

Ans. C

Sol. Type of cast-in-situ piles Simpler pile, Franbi pile, Vibro pile, Raymond pile, Mac Arthor pile.

69. For a rectangular foundation of width b, eccentricity of load should not exceed

A. b/2
B. b/3
C. b/5
D. b/6

Ans. D

Sol. Maximum and minimum stresses on the foundation with eccentric leads are given as

$$= \frac{P}{b}\left(1 \pm \frac{6e}{b}\right)$$

We have to ensure that no tension is developed anywhere in the foundation. For that $\sigma_{\min} > 0$

$$\frac{p}{b}\left(1 - \frac{6e}{b}\right) = 0, 1 - \frac{6e}{b} > 0$$

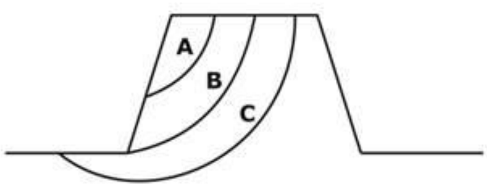
$$e < \left(\frac{b}{6}\right)$$

70. Failure of a finite slope along a surface that intersects the slope above the toe:

A. Compound failure
B. Base failure
C. Slope failure
D. Toe failure

Ans. C

Sol.




A → Slope failure

B → Toe failure

C → Base failure

71. Pycnometer is used to determine.

A. water content and voids ratio
B. specific gravity and dry density
C. water content and specific gravity
D. voids ratio and dry density

Ans. C

Sol. **TEST FOR Water content**

**a) Oven drying method**

**b) Sand Bath Method**

**c) Alcohol Method**

**d) Calcium Carbide Method**

**e) Pycnometer Method**

Specific gravity of the sample can be determined by the use of 50 ml density bottle, 500 ml flask or by the use of pycnometer

72. Which one of the following gives the correct decreasing order of the densities of a soil sample?

A. Saturated, submerged, wet and dry
B. Saturated, wet, submerged and dry
C. Saturated, wet, dry and submerged
D. Wet, saturated, submerged and dry

Ans. C

Sol. Decreasing order of density is

$\gamma_{sat} > \gamma > \gamma_d > \gamma_{sub}$

73. A soil sample has properties: Liquid limit = 45%, Plastic limit = 25%, Shrinkage limit = 17%, Natural moisture content = 30%. The consistency index of soil is

A. 5/20
B. 8/20
C. 13/20
D. 15/20

Ans. D

Sol. **Consistency Index:**

$$I_C = \frac{W_L - W}{I_P} = \frac{W_L - W}{W_L - W_P} = \frac{45 - 30}{45 - 25} = \frac{15}{20}$$

74. A soil has a discharge velocity of 6 × $10^{-7}$ m/s and a void ratio of 0.5, its seepage velocity is

A. 18 × $10^{-7}$ m/s
B. 12 × $10^{-7}$ m/s
C. 6 × $10^{-7}$ m/s
D. 3 × $10^{-7}$ m/s

Ans. A

Sol. $V_s = \frac{V}{n} = \left(\frac{1+e}{e}\right) \times V = \left(\frac{1+0.5}{0.5}\right) \times 6 \times 10^{-7} = 18 \times 10^{-7} m/sec$

75. Degree of consolidation is directly proportional to

A. time and inversely proportional to drainage path
B. time and inversely proportional to square of drainage path
C. drainage path and inversely proportional to time
D. square of drainage path and inversely proportional to time

Ans. B

Sol.

$$\boxed{T_v = \frac{C_v t}{d^2}}$$

$T_v = \frac{\pi}{4} U^2$, when $U \le 0.6$

$T_v = 0.9332\, log_{10}(1 - U) - 0.0851$, when U > 0.6

So U directly depends on time and inversely to square to drainage path.

76. Coarse grained soils are best compacted using

A. drum roller
B. rubber tyre roller
C. sheep’s foot roller
D. vibratory roller

Ans. B

Sol. Pneumatic tyre rollers are also called as rubber tyre roller are used for compaction of coarse grained soils.

77. Below the shrinkage limit soil

A. Remains fully saturated
B. Does not remain fully saturated
C. Remains fully dry
D. Remains submerged

Ans. B

Sol. As shrinkage limit is define as the lowest water content at which soil is just saturated. Below shrinkage limit the soil doesn't remain Fully saturated.

78. Which of the following soil has max surface area

A. Colloidal
B. Clay
C. Silt
D. Sand

Ans. A

Sol. Colloidal has max surface area

Colloidal > Clay > Silt > Sand

79. Average permeability ($K_Z$) for flow perpendicular to the bedding planes in a layered soil is

Where $K_1$, $K_2$,….$K_n$- are co-efficient of permeability of respective layer

$H_1$, $H_2$, …. $H_n$- are thickness of respective layer.

A. $K_z = \frac{K_1 + K_2 + .... + K_n}{n}$

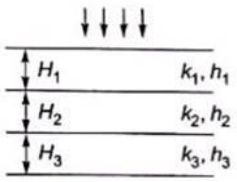
B. $K_z = \frac{K_1H_1 + K_2H_2 + .... + K_nH_n}{H_1 + H_2 + ... + H_n}$

C. $K_z = \frac{H_1 + H_2 + .... + H_n}{\frac{H_1}{K_1} + \frac{H_2}{K_2} + ... + \frac{H_n}{K_n}}$

D. $K_z = \frac{H_1 + H_2 + .... + H_n}{\frac{K_1}{H_1} + \frac{K_2}{H_2} + ... + \frac{K_n}{H_n}}$

Ans. C

Sol.




$H_1$, $H_2$, $H_3$ = thickness

$H_1$, $h_2$, $h_3$ = head loss

$K_1$, $k_2$, $k_3$ = permeability

$h_1 = h_1 + h_2 + h_3$

and $H = H_1 + H_2 + H_3$

*

$$Q = k_1 i_1 = k_v \frac{h}{H} = k_1 i_1 = k_2 i_2 = k_3 i_3$$

$$Q = k_1 i_1 A = k_2 i_2 A = k_3 i_3 A$$

$$Q = ki = k_1 i_1 = k_2 i_2 = k_3 i_3$$

$$\frac{kh}{H} = \frac{k_1 h_1}{H_1} = \frac{k_2 h_2}{H_2} = \frac{k_3 h_3}{H_3}$$

$$h_1 + h_2 + h_3 = h$$

$$h\left(\frac{k_v H_1}{Hk_1} + \frac{k_v H_2}{Hk_2} + \frac{k_v H_3}{H k_3}\right) = h$$

$$k_v = \left(\frac{H}{\frac{H_1}{K_1} + \frac{H_2}{K_2} + \frac{H_3}{K_3}}\right)$$

80. Which one of the following statement provides the best argument that direct shear tests are not suited for determining shear parameters of a clay soil?

A. Failure plane is not the weakest plane

B. Pore pressures developed cannot be measured

C. satisfactory strain levels cannot be maintained

D. Adequate consolidated cannot be ensured

Ans. B

Sol. Since pore water pressure measurement is not possible in direct shear test, effective analysis cannot be done and hence triaxial test has to be done to determine shear parameter of clay soil.

81. The specific gravity of a soil having dry unit weight 18.5 kN/m$^3$ and porosity 0.35 is

A. 2 .45
B. 2 .62
C. 2 .83
D. 2 .90

Ans. D

Sol. Porosity = 0.35

Void ratio, $e = \frac{n}{1-n} = \frac{0.35}{1-0.35}$ = 0.54

Dry unit weight ($\gamma_d$) = $\frac{G\gamma_w}{1+e}$

$$18.5 = \frac{G \times 9.81}{1 + 0.54}$$

G = 2.90

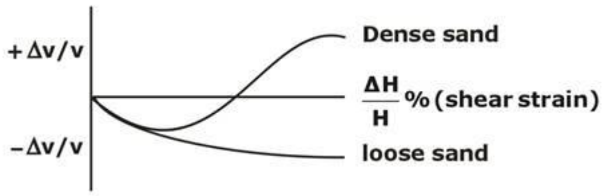
82. Which of the following soil will be subjected to dilation on the application of load?

(i) Loose sand
(ii) Over consolidated clays
(iii) Dense sand
(iv) Normally consolidated clays

A. (i) and (ii)
B. (ii) and (iii)
C. (i) and (iv)
D. (ii) and (iv)

Ans. B

Sol.




In case of dense sand or over consolidated clay, the volume first decreases but then increases with further increase in strain. This increase in volume is known as dilation.

83. To determine water content using pycnometer method, following readings were taken

Mass of empty pycnometer – 26 g

Mass of pycnometer + Soil – 45 g

Mass of pycnometer + soil + water – 55 g

Mass of pycnometer + water – 47 g

Specific gravity of soil – 2.65

The water content is

A. 23.45%
B. 35.43%
C. 47.88%
D. 54.36%

Ans. C

Sol. Water content using pycnometer is given by

$$w = \left[\frac{(M_2 - M_1)}{(M_3 - M_4)}\left(\frac{G-1}{G}\right) - 1\right] \times 100$$

Here,

$M_1$ = 26 g

$M_2$ = 45 g

$M_3$ = 55 g

$M_4$ = 47 g

G = 2.65

$$w = \left[\frac{(45 - 26)}{(55 - 47)}\left(\frac{2.65-1}{2.65}\right) - 1\right] \times 100 = 47.88\%$$

84. Which of the following is not an organic soil?

A. Peat B. Humus

C. Moorum D. Muck

Ans. C

Sol. Moorum is formed from the disintegration of rock and shells.

85. The ultimate bearing capacity of a strip footing resting on clayey soil having c value 28.5 $kN/m^2$ as per Terzaghi's theory is

A. 145.85 $kN/m^2$ B. 162.45 $kN/m^2$

C. 186.25 $kN/m^2$ D. 200.30 $kN/m^2$

Ans. B

Sol. For a purely cohesive soil,

$N_c$ = 5.7, $N_q$ = 1 and $N_\gamma$ = 0

Since the footing is resting on the soil, $D_f$ = 0

As per Terzaghi theory,

$q_u = cN_c + \gamma D_f + 0.5\gamma BN_\gamma$

So,

$q_u = 5.7 \times 28.5 = 162.45$ $kN/m^2$

86. Which type of shear failure is generally observed in soft clays?

A. General shear failure B. Local shear failure

C. Punching shear failure D. none of the above

Ans. C

Sol. General shear failure – Dense sand or stiff clay

Local shear failure – Medium dense sand or clay with medium consistence

Punching shear failure – Loose sand and soft clay

87. Coulomb wedge theory is NOT based on which of the following assumptions?

A. The slip surface passes through the toe of wall

B. The wall surface is rough

C. The slip surface is plane.

D. The backfill is dry and cohesionless

Ans. A

Sol. As per Coulomb theory, the slip surface passes through the heel of wall.

88. The pile which is used to resist lateral loads is known as

A. Fender Pile
B. Tension Pile
C. Batter Pile
D. Compaction Pile

Ans. C

Sol. Fender pile – Used to protect water front structures

Tension pile – Used to resist hydrostatic uplift forces

Batter Pile – Inclined pile used to resist lateral loads

Compaction pile – Are driven into loose granular soil to improve permeability

89. A two layered soil having depth of different layers 2m and 3m have coefficient of permeability 5 mm/sec and 2.5 mm/sec respectively. The equivalent coefficient of permeability in horizontal direction is

A. 1.25 mm/s
B. 2.35 mm/s
C. 3.50 mm/s
D. 3.75 mm/s

Ans. C

Sol. Coefficient of horizontal permeability = $\frac{K_1H_1 + K_2H_2}{H_1 + H_2}$

$= \frac{5 \times 2 + 2.5 \times 3}{2 + 3} = 3.5$ mm/s

90. Activity of soil is ratio of the plasticity index to:

A. liquidity index
B. percentage of compressive strength
C. percentage of sensitivity
D. percentage by weight of clay fraction

Ans. D

Sol. Formula for activity

Activity = $\frac{I_P}{\% C}$

$I_P$ = plasticity Index

% C = Percentage (by weight) of clay fraction

91. Following results are obtained from particle size analysis:

Uniformity coefficient = 8

Coefficient of curvature = 2.8

Percentage of soil passing through 75μ IS sieve = 10%

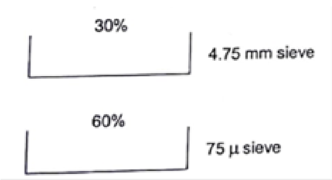
Percentage of soil passing through 4.75 mm IS sieve = 70%

If liquid limit and plastic limit for the soil are 38% and 34.2% respectively, the soil can be classified as per IS soil classification system as

A. SP-SM
B. SW-SM
C. SP-SC
D. SW-SC

Ans. B

Sol.



% fines (<75μ size) = 10% $\rightarrow$ between 5 and 12%

Hence, we will use dual symbols

Sand>Gravel,

$C_u$ = 8>6

and $C_c$ = 2.8-between 1 and 3

Hence, sand is well graded

Equation of A line

$I_p = 0.73(W_L-20)$

$= 0.73(38-20) = 13.14$

$I_p = 38-3.42 = 3.8<13.14$

Point lies below A line, hence silt.

Therefore, the soil will be classified as SW-SM.

92. Bentonite clay is an example for

A. Kaolinite
B. Montmorillonite
C. Vermiculite
D. Illite

Ans. B

Sol. Bentonite clay is a mud like substance derived from volcanic ash. It is an example of montmorillonite.

93. Ratio of unconfined compressive strength of an undisturbed sample of soil to that of a remoulded sample at the same water content is known as

A. Plasticity index
B. Thixotropy
C. Sensitivity
D. Activity

Ans. C

Sol. Sensitivity = $\frac{UCS \ in \ undisturbed \ state}{UCS \ in \ \text{remoulded} \ state}$

Generally it is greater than 1, but in case of fissured clay it can be less than 1.

94. In soil consolidation, what is the correct sequence of processes which take place after loading?

A) Decrease in excess pore pressure

B) Increase in total stress

C) Development of excess pore pressure

D) Increase in effective stress

Select the code for the correct answer from the options given below:

A. C,B,A,D
B. B,C,D,A
C. B,C,A,D
D. C,B,D,A

Ans. C

Sol. Correct sequence of processes taking place after loading is as follows:

B. Increase in total stress.

C. Development of excess pore pressure.

A. Decrease in excess pore pressure.

D. Increase in effective stress.

95. A 1 m thick layer of saturated clay, drained at both faces, settles by 10 cm in one year. If a thin layer of pervious soil is introduced in the middle of this layer, then what will be the period during which the settlement of 10 cm will be compacted?

A. 2 years

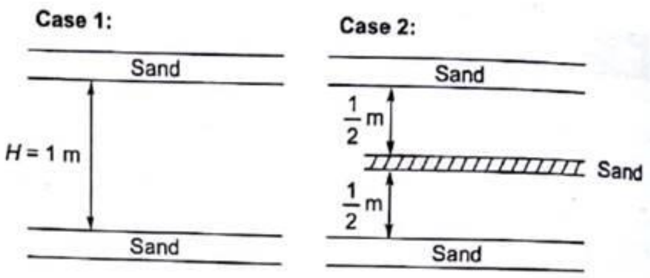
B. 0.75 years

C. 0.25 years

D. 3 years

Ans. C

Sol.




$\therefore d = \frac{H}{2} = \frac{1}{2}m, T_v = \frac{C_v t}{d^2} d = \frac{1}{2}\times\left(\frac{1}{2}\right) = \frac{1}{4}m, t_2 = ?$

$t_1 = 1yr \ and \ t \ \alpha \ d^2$

$\frac{t_2}{t_1} = \left(\frac{d_1}{d_2}\right)^2$

$\frac{t_2}{t_1} = \left(\frac{\frac{1}{2}}{\frac{1}{4}}\right)^2 = 4$

$t_2 = \frac{t_1}{4} = \frac{1}{4} = 0.25yr$

$t_2 = 0.25yr$

96. If the void ratio and discharge velocity for soil is 0.5 and $5 \times 10^{-7}$ m/s respectively, what will be the seepage velocity in m/s?

A. $6 \times 10^{-7}$

B. $15 \times 10^{-7}$

C. $12 \times 10^{-7}$

D. $3 \times 10^{-7}$

Ans. B

Sol. seepage velocity= Discharge velocity/ porosity

Porosity n=e/(1+e) = 0.5/(1+0.5)= 1/3.

Thus,

Seepage velocity = $5\times10^{-7}\times3 = 15\times10^{-7}$.

97. An undisturbed sample of clay 20 mm thick consolidated 50% in 30 minutes when tested in laboratory with drainage allowed top and bottom. The clay layer from which the sample is taken form the 6.0 mal thick layer in the field. How much time will it take to consolidate 50% with single drainage?

A. 3860 days B. 7500 days

C. 1500 days D. 3000 days

Ans. B

Sol. $T_v=C_vt/H^2$

Since % consolidation conditions are same and drainage conditions are different,

$4t_1/H_1^2= t_2/H_2^2$

$t_2 =4*30*6000^2/(60*24* 20^2)=7500$ days

98. Compressibility of sandy soils is:

A. almost equal to that of clayey soils. B. much greater than that of clayey soils.

C. much less than that of clayey soils. D. None of these

Ans. C

Sol. Compressibility of sandy soils is much less than that of clayey soil due to presence of pore water.

99. The water table in the deposit of sand 8.0 metre thick is at depth of 3 metre below the surface. Above the water table sand is saturated by capillary water. The bulk density of sand is 19.620 kN/m$^3$. Calculate the effective pressure at 3.0 metre below the surface.

A. 58.86 kN/m$^2$ B. 60 kN/m$^2$

C. 70.5 kN/m$^2$ D. 108.5 kN/m$^2$

Ans. A

Sol. At 3m level from top effective stress= 19.62*3=58.86KN/m$^2$

100. An undisturbed sample of clay 24 mm thick consolidated 50% in 20 minutes when tested in laboratory with drainage allowed top and bottom. The clay layer from which the sample is taken form the 4.0 m thick layer in the field. How much time will it take to consolidate 20% with double drainage?

A. 63 days B. 400 days

C. 150 days D. 300 days

Ans. A

Sol. $T_{v1}=\pi*U^2/4=0.197$, $T_{v2}=\pi*U^2/4 =\pi*0.20^2/4=0.03142$

$T_{v1}=4C_vt_1/H_1^2$ , $T_{v2}=4C_vt_2/H_2^2$

$t_1=20$ min$=20/(60*24)=0.0138$ days , $t_2=?$

$H_1=24$mm, $H_2= 4000$mm

Solving we get $t_2=63$ days

****