ZONE TECH

Best Institute For Assistant & Junior Engineer

Civil Engineering

Test - 6

RSSB (JE) Diploma Test Series - 2024

Answer key & Detailed Solution

Test ID : 906 | **Date:- 27/10/2024**

Duration : 80 Minutes | **Maximum Marks : 80**

1. (d)
2. (d)
3. (c)
4. (c)
5. (c)
6. (c)
7. (a)
8. (a)
9. (a)
10. (c)
11. (b)
12. (a)
13. (b)
14. (b)
15. (b)
16. (b)
17. (b)
18. (b)
19. (a)
20. (d)
21. (b)
22. (b)
23. (c)
24. (d)
25. (b)
26. (c)
27. (d)
28. (d)
29. (c)
30. (b)
31. (c)

$$\eta_c = na_c$$

$$\eta_c = \frac{e}{1+e}(1-S)$$

$$\eta_c = \frac{e(1-S)}{1+e}$$

32. (b)

Solid volume required fill construction

$$= \frac{150000}{1+0.8} = 83333.33\ m^3$$

Volume of soil excavated from borrow pit

$= 83333.33(1 + 1.4) = 200,000\ m^3$

33. (c)

Plasticity index (%)	Soil type	Degree of plasticity	Degree of cohesiveness
0	Sand	Non-plastic	Non-cohesive
<7	Silt	Low plastic	Partly cohesive
7-17	Silt clay	Medium plastic	cohesive
>17	Clay	High plastic	cohesive

34. (d)

$$C_u = \frac{D_{60}}{D_{10}} = \frac{0.9}{0.3} = 3$$

$$C_C = \frac{D_{30}^2}{D_{60} \times D_{10}} = \frac{(0.6)^2}{0.9 \times 0.3} = 1.33$$

35. (a)

In undrained triaxial test on a saturated clay volumetric strain is zero.

However to solve the problem we take lateral strain equal to zero (although it is not there)

$$\varepsilon_3 = 0 = \frac{\sigma_3}{E} - \frac{\mu\sigma_1}{E} - \frac{\mu\sigma_2}{E}$$

and $\sigma_3 = \sigma_2$

$\Rightarrow \mu(\sigma_3 + \sigma_1) = \sigma_3$

$$\mu = \left(\frac{\sigma_3}{\sigma_3 + \sigma_1}\right)$$

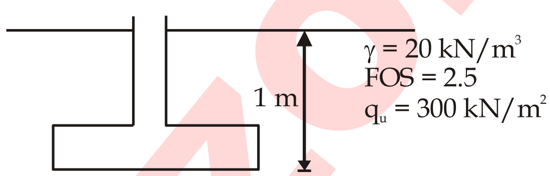
36. (a)

The size effect of footing has been considered by empirically evolving the equation.

$$\frac{S_f}{S_p} = \left(\frac{B_f (B_p + 30)}{B_p (B_f + 30)}\right)^2$$

This equation is applicable for dense sands having general shear failure.

37. (b)



Net safe bearing capacity

$$q_{ns} = \frac{q_{nu}}{FOS} = \frac{q_u - \gamma D_f}{FOS}$$

$$= \frac{300 - 20 \times 1}{2.5} = 112 \text{kN/m}^2$$

$$q_s = q_{ns} + \gamma D_f = 112 + 1 \times 20$$

$$= 132 \text{ kN/m}^2$$

38. (c)

The time required for any degree of consolidation can be obtained from Taylor's formula

$$T_v = C_v \times t/d^2$$

Where,

C_v = Coefficient of consolidation is constant for the same type of soils,

T_v = Time factor will also remain constant for the same degree fo consolidation.

Thus Time Factor depends on Coefficient of consolidation, Drainage path & Time.

39. (b)

A definite relationship is established between the **degree of dry density and soil moisture content**

The competitive effort is a moisture content of mechanical energy applied to the soil mass.

OMC is the moisture content at which a particular soil **attains** maximum dry density **(MDD)**

Maximum dry unit weight obtained is a function of compactive effort and methods of compaction for a particular type of soil

40. (a)

Sheep-Foot Roller:

These consist of a hollow steel drum and have projected feet or projections mounted on the surface.

It is required for compacting earthwork in embankments and canals where compaction deep into the layer of Earth is required.

The basic action is kneading of the soil sample through the projected feet. It is suitable for cohesive and impervious soil.

41. (d)

Aquifer :- An aquifer is a saturated formation of the earth. It not only stores the water but also yields it in adequate quantity. Aquifers are highly permeable formations and hence they are considered as main sources of groundwater applications.

Aquitard :- An aquitard is also a saturated formation. It permits the water through it but does not yield water in sufficient quantity as much as aquifer does. It is because of their partly permeable nature.

Aquiclude :- An aquiclude is a geological formation which is impermeable to the flow of water. It contains a large amount of water in it but it does not permit water through it and also does not yield water. It is because of its high porosity. Clay is an example of aquiclude.

Aquifuge :- An aquifuge is an impermeable geological formation which is neither porous nor permeable – which means it cannot store water in it and at the same time it cannot permit water through it. Compact rock is an example of aquifuge.

42. (d)

The liquid limit is the water content corresponding to N = 25

43. (d)

Coulomb (1776) developed a method for the determination of the earth pressure in which he considered the equilibrium of the sliding wedge which is formed when the movement of the retaining wall takes place.

44. (c)

The earth pressure for the design of bridge abutments is taken as thrust in at rest condition. At rest earth, pressure is considered to ensure that the structural elements are adequate.

Any movement in the structure caused by the at rest pressure, either through rotation or deflection will reduce the pressure on the back of the wall, a state of equilibrium is reached when the pressure reduces to the active earth pressure value.

45. (d)

Darcy's Law states that velocity of flow through porous media is directly proportional to hydraulic gradient for any given saturated soil under steady laminar flow conditions.

If the rate of flow is (Q) through the cross-sectional area (A) of the soil mass, Darcy's Law can be expressed as

$V \propto i$ or $V = K \times i$

$Q = K \times i \times A$

K = permeability of the soil

$i = dh/dl$

dh = difference in total heads

dl = length of small soil element

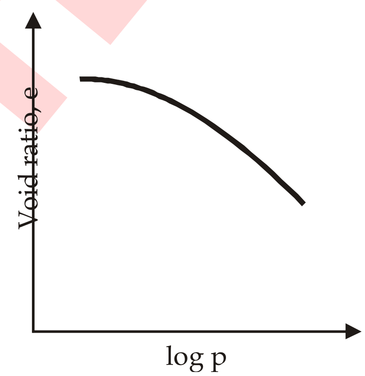
Darcy's law assumes the flow must be laminar i.e. flow of water through soil voids should have very less velocity. This only possible in case of soils having small but large no of voids. Therefore, it is applicable for soils such as fine saturated sands, clays, silts etc. It is not applicable for soils having large size voids like gravel, boulder etc because in these soils water is drained immediately due to action of gravity and hence, not possible to maintain laminar flow in these soils.

46. (d)

Since Specific yield S_Y is the volume of water drained, the drainage of water depend on grain size, shape and compaction of stratum in the soil

47. (b)

The e-log p curve shown in the figure is representative of over consolidated clay.



If a clay soil is over consolidated, then e-log p curve is not straight and pre-consolidation pressure can be derived from the curve.

The pre-consolidation pressure refers to the maximum over burden pressure to which a deposit has been subjected.

48. (a)

$U = 50\%$

$T_V = \frac{\pi}{4} \times (U)^2$

$T_V = \frac{\pi}{4} \times (0.50)^2$

$T_V = 0.196 \simeq 0.2$

49. (b)

- Quicksand is not a type of sand but a flow condition occurring within a cohesion-less soil when its effective stress is reduced to zero due to the upward flow of water.
- Quicksand occurs in nature when water is being forced upward under pressurized conditions. In this case, the pressure of the escaping water exceeds the weight of the soil and the sand grains are forced apart. The result is that the soil has no capability to support a load.

50. (a)

$$\tau = C + \sigma \tan\phi$$

$$C = 0 \rightarrow \text{cohesionless soils}$$

$$\tan\phi = \tan 38° = 0.781$$

So, $$\tau = \sigma \times 0.781 \Rightarrow \frac{\tau}{\sigma} = 0.781$$

51. (c)

Effective stress is the ratio of force at contact of particles of soil to the total area. It cannot be obtained practically but we can calculate the effective stress by measuring total stress and pore water pressure as:

Total stress (σ) = effective stress (σ') + pore water pressure (u)

Lower permeability of soil means that water is not able to drain out from soil quickly and hence, excess pore water pressure will be build up inside the soil and less is the effective stress.

52. (c)

We know that

$$(T_V)_{90} = \frac{C_{v_1} t_1}{H_1^2}$$

$$(T_V)_{90} = \frac{C_{v_1} \times 15}{H_1^2}$$

Again, $K = C_V m_V \gamma_w$

$$\frac{K_1}{K_2} = \frac{C_{V_1}}{C_{V2}} \times \frac{m_{v_1}}{m_{v2}} \times \frac{\gamma_{w_1}}{\gamma_{w_2}}$$

$$\frac{K}{3K} = \frac{C_{V_1}}{C_{V2}} \times \frac{m_v}{4m_v}$$

$$C_{V_2} = \frac{3}{4} C_{V_1}$$

Time required to achieve 90% consolidation

$$(T_V)_{90} = \frac{C_{V_1} t_2}{(H_2)^2}$$

Form (i)

$$\frac{C_{V_1} \times 15}{H_1^2} = \frac{3}{4} C_{V_1} \times \frac{t_2}{(2H_1)^2}$$

$$t_2 = 80 \text{ years}$$

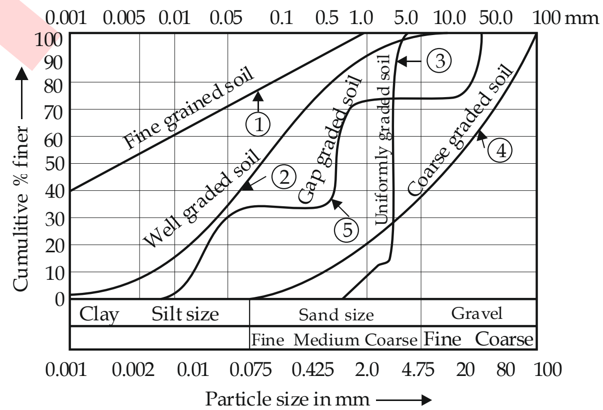
53. (a)

Stationary Piston Sampler: It is used to obtain an undisturbed sample of soft and sensitive clays.

Split Spoon Sampler: It is commonly used to obtain a disturbed soil sample.

54. (c)

Steep slope in particle size distribution curve indicates a uniform graded/uniform size soil as shown is graph of following figure.



55. (a)

As we know that -

$q_u = 1.3CN_C + \gamma D_f N_q + 0.4B\gamma N_\gamma$ (For square footing)

$q_u = 1.3CN_C + \gamma D_f N_q + 0.3B\gamma N_\gamma$ (For circular footing)

As both footings mention in question is on cohesionless soil and are founded on a surface so, c = 0 and D_f = 0 for both footings.

So, q_u for square footing = 0.4 $B\gamma N_\gamma$

Hence, $$\frac{q_{u\ circular}}{q_{u\ square}} = \frac{3}{4}$$

56. (c)

In General, shear strength of soil is governed by the following factors:

1. Interlocking between the particles e.g. Gravel and Dense Sand.
2. Friction between the particles due to sliding or rolling between them e.g. Sand, Silt, Gravel.
3. Intermolecular force of attraction called cohesion e.g. Silt and clay.

For plastic undrained clays, angle of internal friction is zero, therefore shear strength is the function of cohesion only.

57. (b)

For routine consolidation test in laboratory the thickness of the specimen is 20 mm.

58. (b)

Given:

We know that, $w_L > w_P > w_S$

Atterberg limit of clay are

Liquid limit, LL = 38%

Plastic limit, PL = 27%

Shrinkage limit, SL = 24.5%

Natural water content of clay = w_n = 30%

Hence, the clay is in plastic state

Method 2

With the help of consistency and liquidity index, we can find out the state of soil.

Consistency index,

$$I_C = \frac{w_L - w_n}{w_L - w_p} = \frac{38-30}{38-27} = 0.727$$

Liquidity index,

$$I_L = \frac{w_n - w_p}{w_L - w_p} = \frac{30-27}{28-27} = 0.272$$

∴ From the above values, the clay is in plastic state.

I_C	Water content	Consistency
$I_C > 1$	$W_n < w_p$	Semi – solid or solid
$0 < I_C < 1$	$w_P < w_n < w_L$	Plastic
$I_C < 0$	$w_n > w_L$	Liquid

I_L	Water content	Consistency
$I_L < 0$	$W_n < w_p$	Semi – solid or solid
$0 < I_L < 1$	$w_P < w_n < w_L$	Plastic
$I_L > 1$	$w_n > w_L$	Liquid

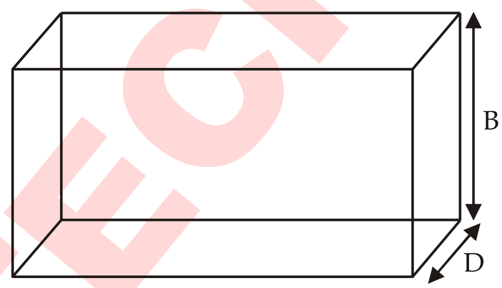
Hence, the clay is in plastic state

59. (a)

The term consistency of a soil is a measure of its resistance to flow. It can also be defined as the strength with which soil materials are held together or resistance of soils to deformation and rupture. The consistency of a saturated cohesive soil is affected by water content.

60. (c)

Coefficient of transmissibility (T): The rate of flow of water per unit width under unit hydraulic gradient is termed as the coefficient of transmissibility (T)



∵ $T = Q/D$

Where, $Q = KiA$

& $A = B \times D$

& $i = 1$

Hence $T = K.B.D/D$

$T = K.B$

61. (c)

The specific Surface area is inversely proportional to grain size. Out of sand, silt, clay and colloids.

Sand has the highest grain size while colloids have the least grain size.

For coarse sand → 2 mm < d ≤ 4.75 mm

For fine sand → 0.075 mm < d ≤ 0.425 mm

For silt → 0.002 mm < d ≤ 0.075 mm

For clay → < 0.002 mm

Colloids are basically finer clay particles whose surface area is so high that its behaviour is controlled by specific energy rather than mass-energy.

∴ Increasing order of surface area ⇒ sand < silt < clay < colloids

62. (b)

A proving ring is used in the direct shear test to measure the shear load applied to the soil sample. The deformation of the proving ring is proportional to the shear load applied, and this deformation is measured by a dial gauge. By measuring the shear load applied to the sample, the shear strength of the soil can be determined.

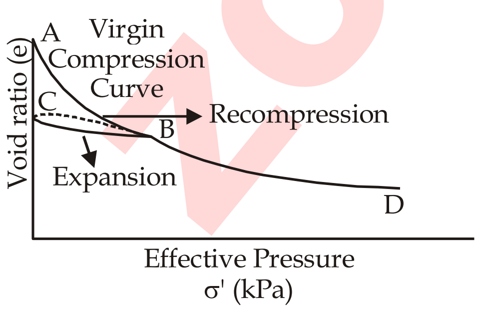
63. (c)

Virgin Compression Curve: A soil that has been deposited from suspension and consolidated to some stress, clearly the maximum stress to which the soil has ever been subjected, is said to be normally consolidated, and the associated - relationship is termed the virgin compression curve.

Compression of soil causes largely irreversible movements between particles, so if the soil is unloaded, the resulting rebound curve, or swelling curve, has a flatter slope than the virgin curve and the recompression curve (also called the reloading curve) forms a hysteresis loop with the rebound curve.

Soils now existing under effective stresses smaller than the maximum effective stress at some time in the past are said to be over consolidated.

If the soil is undergoing consolidation down the virgin curve, it is under-consolidated. Obviously, this is a transient condition unless the deposition of sediment is occurring at a fast enough rate that the excess pore water pressures cannot be dissipated.



64. (d)

This test is valid for cohesionless soil because it measures the immediate settlement only which can be achieved in a short duration. Hence, It is called short duration test.

Limitations of plate load test (PLT):

It is essentially a test of short duration. For clayey soil, it does not give an ultimate settlement. The load-settlement curve is not truly representative.

The test on a plate of size larger than 0.6 m width is difficult.

The test should be placed at the water table level if it is within 1m below the footing. If the water table is above the footing, it has to be lowered by pumping.

The ultimate bearing capacity of clays is independent of the size of the plate, while for cohesionless soil it increases with the size of the plate.

The plate load test does not truly represent the actual conditions if the soil is not homogenous and isotropic to a large depth.

65. (a)

In standard penetration test, the first 15 cm of drive may be considered to be a seating drive. The total blows required for the second and third 15 cm of penetration is termed as the penetration resistance N.

66. (c)

Since the shearing strain is made to increase at a constant rate in a direct shear test, and hence the test is called the Strain controlled shear box test.

67. (c)

There are two main types of a soil sample that is collected for the study of the properties of soils:

1. **Disturbed Soil Samples:**

   During the sampling process of the soil sample If the natural structure of the soil gets disturbed, then this type of soil sample is called a Disturbed Soil Sample.

   The disturbed Soil Samples can be used for the determination of the grain size, plasticity characteristics, and specific gravity of the soil.

   These samples are collected by different methods such as Auger Boring, Wash Boring, Rotary Drilling, and Percussion Drilling.

2. **Undisturbed Soil Samples:**
During the sampling process of the soil sample, if the natural structure of the soil and water content does not disturb, that means the soil retained its natural structure and water content, then these types of soil samples are called undisturbed soil samples.
The undisturbed soil samples are used for the determination of engineering properties of soils such as shear strength, consolidation test, permeability, and compressibility.
The undisturbed soil samples are collected by Thin-walled samplers.

68. (c)
Residual soil can be defined as a soil material which is the result of weathering and decomposition of rocks that has not been transported from its original place.
Alluvial soil has the highest productivity with respect to other soils. It is present mostly along rivers and is carried by its streams during weathering of rocks.
Eolian (or aeolian) sediments are wind deposited materials that consist primarily of sand or silt-sized particles
Glacial soil is found in high Himalayan regions having rocky terrain with ice blocks. They are covered with snow for most of the year. The soil is much less exposed to the air due to snow cover.

69. (b)
It is always convenient to show the constituents occupying separate spaces as blocks. In the phase diagram, the soil occupies the bottom position. Water and air occupy the middle and top positions.

70. (d)
Fine grained soil are subdivided into 3 types
i. Inorganic silts and very fine sands
ii. Inorganic clays
iii. Organic silts and clay and organic matter.

71. (c)
In situ Vane shear test is conducted to determine the shear strength of a cohesive soil in its natural condition.
It consists of four blades , 100mm(or 150mm or 200mm) long , attached at right angles to a steel rod.
The height - diameter ratio (H/D) of the apparatus is generally equal to 2

72. (c)
Dilatancy correction is to be applied when (N') obtained after overburden correction, exceeds 15 in saturated fine sands and silts.
N" = 15 + 0.5 (N' – 15)
Where N" = final corrected value to be used in design charts.
Standard Penetration Test (SPT) gave an average count of 35 in fine sand below the water table.
N" = 15 + 0.5 (N' – 15)
N" = 15 + 0.5 (35 - 15) = 25

73. (c)

For sand, $\dfrac{q_{uf}}{q_{up}} = \dfrac{B_f}{B_p}$

Where,
q_{up}, q_{uf} = Ultimate load of plate and footing respectively,
B_f, B_p = Width of footing and plate respectively.
Given:
q_{up} = 200 kN/m², B_f = 1.5 m, B_p = 0.3 m

$$\frac{q_{uf}}{200} = \frac{1.5}{0.3} \Rightarrow q_{uf} = 200 \times 5 = 1000\,\text{kN/m}^2$$

74. (a)
The Specific Gravity of soil solids is given as:

$$G = \frac{W_2 - W_1}{(W_2 - W_1) - (W_3 - W_4)}$$

Where,
W_1 = Mass of empty Pycnometer
W_2 = Mass of the Pycnometer with dry soil
W_3 = Mass of the Pycnometer and soil and water
W_4 = Mass of the Pycnometer filled with water only
G = Specific gravity of soils.
W_1 = 0.498 kg
W_2 = (0.498 + 0.198) kg
W_3 = 1.653 kg
W_4 = 1.528 kg

$$G = \frac{(0.498 + 0.198)\text{kg} - (0.498)\text{kg}}{\left[(0.498 + 0.198)\text{kg} - (0.498)\text{kg}\right] - (1.653 - 1.528)\text{kg}}$$

$$G = 2.71$$

75. (d)
Calcium carbide method of the determination of water content makes use of the fact that water reacts with calcium carbide(CaC_2), acetylene gas (C_2H_2) is produced.
$CaC_2 + 2H_2O = \mathbf{C_2H_2} + Ca(OH)_2$

76. (a)

CONSISTENCY INDEX (I_C) - it is define as

$$I_C = \frac{(\text{Liquid limit}) - (\text{Water Content})}{\text{Plasticity Index}} \times 100$$

$$= \frac{45\% - 30\%}{(45\% - 25\%)} \times 100 = 75\%$$

77. (b)

This method is also based on total stress analysis in which shearing angle of ϕ is used to analyse the stability of finite slope.

The principle of the method is that the inter granular forces are in an obliquity of ϕ to the circular surface at failure, where ϕ is the angle of the internal friction of the soil.

When the length of the arc is divided into small elements, the line of action of the inter granular forces acting on these elements can be defined by a tangent to the friction circle drawn around the centre of the sliding circle.

The radius of this friction circle is given by R $\sin\phi$

where, R is the radius of the sliding circle.

78. (c)

IS code specification for permissible settlement:

(i) Total Permissible settlement:

For isolated footing on clay = 65 mm

For isolated footing on sand = 40 mm

For raft footing on clay = 65-100 mm

For raft footing on sand = 40-65 mm

(ii) Permissible Differential settlement:

For isolated footing on clay = 40 mm

For isolated footing on sand = 25 mm

(iii) Permissible angular settlement:

For high framed structure < 1/500

To prevent all type of minor damage < 1/1000

79. (b)

If the foundation is rigid , such as a heavy beam and slab raft , the settlement is about 0.8 times the settlement at the centre of the corresponding flexible foundation.

80. (c)

The pressure exerted by the water in the pores on the soil is called a pour of water pressure. The negative and positive values are based upon the atmospheric pressure.

The soil below the groundwater table is fully saturated and hence the value off for pressure is greater than atmospheric pressure called a positive for water pressure.

The soil above the groundwater table is unsaturated and hence the pore pressure is less than the atmospheric pressure. Thus, the pore water pressure is negative.