Codes :

	A	B	C
(a)	4	1	3
(b)	3	2	5
(c)	4	1	5
(d)	3	2	4

60. In a flownet diagram, the length of the flow line in the last square is 2m, the total head loss is 18 m and the number of potential drops is 12. The value of exit gradient is

(a) 0.33 (b) 0.75

(c) 1.33 (d) 300

61. An initial cross-sectional area of a clay sample was 15 sq. cm. The failure strain was 25% in an unconfined compression test. The corrected area of the sample at failure would be

(a) 15 sq cm (b) 20 sq sm

(c) 25 sq cm (d) 30 sq cm

62. A fully compensated raft foundation far a building is

(a) designed as a very rigid raft.

(b) designed as a completely flexible raft.

(c) such that the weight of the excavated soil is equal to the load due to the building.

(d) supported by piles of short length.

63. For a damped vibrating system with single degree of freedom, resonance occurs at a frequency ratio of

(a) 1 (b) 0

(c) less than 1 (d) greater than 1

64. At a site having a deposit of dry sandy soil, an average soil of standard penetration resistance N equal to 6 was recorded. The compactness of the soil deposit can be described as

(a) very loose (b) dense

(c) medium (d) loose

65. Lists I and II contain respectively terms and expressions. Match the two lists and select the correct answer using the codes given below the lists:

List I

A. Activity number

B. Liquidity index

C. Sensitivity

List II

1. (Liquid limit-water contenty)/ Plasticity index
2. Plasticity index/Percent finer than 2 microns
3. (Natural moisture content-plastic limit)/ Plasticity index
4. Unconfined compressive strength of undisturbed soil sample/Unconfined compressive strength of remoulded soil sample

Codes :

	A	B	C
(a)	1	3	4
(b)	1	2	3
(c)	3	2	1
(d)	2	3	4

66. A soil has a bulk density of 1.80 g/cm^3 at a water content of 5%. If the void ratio remains constant, then its bulk density for a water content of 10% will be

(a) 1.98 g/cm^3 (b) 1.88 g/cm^3

(c) 1.80 g/cm^3 (d) 1.70 g/cm^3

67. Consider the following statements.

1. Hydraulic gradient required to initiate "quick" condition is independent of the ratio of volume of voids to volume of solids in a soil mass.
2. Initiation of piping under hydraulic structures can be prevented by increasing the length of flow path of water.
3. Seepage pressure is independent of the coefficient of permeability.

Of these statements

(a) 1, 2 and 3 are correct (b) 1 and 2 are correct

(c) 1 and 3 are correct (d) 2 and 3 are correct

68. The appropriate triaxial test to assess the long-term stability of an unloading problem, such as excavation of a clay slope, would be the

(a) unconsolidated-undrained test

(b) consolidated-undrained test

(c) consolidated-drained test

(d) unconsolidated-drained test

69. If a sample of dry sand tested in direct shear test gives failure shear stress τ_f as 1 kg/cm^2 at a normal stress τ_f of 2 kg/cm^2, then the angle of internal friction of soil is given by

(a) $\tan^{-1}(2)$ (b) $\tan^{-1}(1)$

(c) $\tan^{-1}(1/2)$ (d) $\tan^{-1}(1/4)$

70. The Factor of Safety of an infinite slope in a sand deposit is found to be 1.732. The angle of shearing resistance of the sand is 30°. The average slope of the sand deposit is given by

(a) $\sin^{-1}(0.333)$ (b) $\cos^{-1}(0.252)$

(c) $\tan^{-1}(0.333)$ (d) $\cot^{-1}(0.621)$

71. In the soil sample of a consolidometer test, pore water pressure is

(a) minimum at the centre

(b) maximum at the top

(c) maximum at the bottom

(d) maximum at the centre

72. Under load, the void ratio of a submerged saturated clay decreases from 1.00 to 0.92. What will be the ultimate settlement of the 2 m thick clay due to consolidation?

(*a*) 20 mm (*b*) 40 mm

(*c*) 80 mm (*d*) 160 mm

73. Permissible settlement is relatively higher for

(*a*) isolated footings on clays

(*b*) isolated footings on sands

(*c*) rafts on clays

(*d*) rafts on sands

74. Given :

For a damped vibrating foundation system with single degree of freedom

C = damping constant,

C_c = critical damping coefficient,

δ = logarithmic decrement,

The relationship between C, C_c and δ is given by

(*a*) $\delta^2 = 6.2832\left[\frac{C}{C_C}\right]^2$ (*b*) $\delta^2 = 6.2832\frac{(C/C_C)}{(C_C - C)^2}$

(*c*) $\delta^2 = 39.4784\frac{C^2}{C_C^2 - C^2}$ (*d*) $\delta^2 = 39.4784\frac{C_C^2 - C^2}{C^2}$

75. Match List I (different types of soils) with List II (group symbols of I.S. classification) and select the correct answer using the codes given below the Lists :

List I	List II
A. Well-graded gravel sand mixtures with little or no fines	1. ML
B. Poorly graded sands or gravelly sands with little or no fines	2. CH
C. Inorganic silts and very fine sands or clayey silts with low plasticity	3. GW
D. Inorganic clays of high plasticity	4. SP

Codes :

	A	B	C	D
(*a*)	3	1	4	2
(*b*)	3	4	1	2
(*c*)	2	4	1	3
(*d*)	2	1	4	3

76. The ratio of the energies imparted to soil sample in modified Proctor's compaction test and the standard Proctor's compaction test is about

(*a*) 10.0 (*b*) 4.5

(*c*) 2.2 (*d*) 1.8

77. Which one of the following planes is most likely to be the failure plane in sandy soils?

(*a*) Plane carrying maximum shear stress

(*b*) Plane carrying maximum normal stress

(*c*) Plane with the maximum angle of obliquity

(*d*) Principal plane

78. In which one of the following pairs of soil types would one anticipate negative pore pressure, when subjected to shearing?

(*a*) normally consolidated clay and dense sand

(*b*) overconsolidated clay and loose sand

(*c*) losses and overconsolidated clay

(*d*) dense sand and overconsolidated clay

79. In a saturated soil deposit having a density of 22 kN/m^3, the effective normal stress on a horizontal plane at 5 m depth will be

(*a*) 22 kN/m^2 (*b*) 50 kN/m^2

(*c*) 60 kN/m^2 (*d*) 110 kN/m^2

80. A 2 m wide strip footing rests at a depth of 2 m below ground surface in a clay deposit where water table is at ground surface, c = 3 t/m^2 and γ_{sat} = t/m^3. The best estimate of the net ultimate load which the footing can carry is

(*a*) 18 t/m (*b*) 22 t/m

(*c*) 34.2 t/m (*d*) 48 t/m

81. In Newmark's influence chart for stress distribution, there are ten concentric circles and ten radial lines. The influence factor of the chart is

(*a*) 0.1 (*b*) 0.01

(*c*) 0.001 (*d*) 0.0001

82. As per Indian code of practice, the frequency ratio (ratio of operating frequency of a machine to the natural frequency of soil) should not be within the range of

(*a*) 0.5 to 1.5 (*b*) 1.0 to 2.5

(*c*) 1.5 to 3.0 (*d*) 3.0 to 6.0

83. A soil sample has a shrinkage limit of 10% and specific gravity of soil solids as 2.7. The porosity of the soil at shrinkage limit is

(*a*) 21.2% (*b*) 27%

(*c*) 73% (*d*) 78.8%

84. If during a permeability test on a soil sample with a falling head permeameter, equal time intervals are noted for drop of head from h_1 to h_2 and again from h_2 to h_3, then which one of the following relations would hold good ?

(*a*) $h_3^2 = h_1 h_2$ (*b*) $h_2^2 = h_1 h_3$

(*c*) $h_1^2 = h_2 h_3$ (*d*) $(h_1 - h_2) = (h_2 - h_3)$

85. A flownet is drawn to obtain

(*a*) seepage, coefficient of permeability and uplift pressure

(*b*) coefficient of permeability, uplift pressure and exit gradient

(*c*) exit gradient, uplift, pressure and seepage quantity

(*d*) exit gradient, seepage and coefficient of permeability

86. If the proportion of soil passing 75 micron sieve is 50% and the liquid limit and plastic limit are 40% and 20% respectively, then the group index of the soil is

(*a*) 3.8 (*b*) 6.5

(*c*) 38 (*d*) 65

87. Bearing capacity of a soil strata supporting a footing of size 3 m × 3 m will not be affected by the presence of ground water table located at a depth which is

(*a*) 1.0 m below the base of the footing

(*b*) 1.5 m below the base of the footing

(*c*) 2.5 m below the base of the footing

(*d*) 3 m below the base of the footing

88. Consider the following statements regarding negative skin friction in piles :

1. It is developed when the pile is driven through a recently deposited clay layer.
2. It is developed when the pile is driven through a layer of dense sand.
3. It is developed due to a sudden draw-down of the water table.

Of these statements

(*a*) 1 alone is correct (*b*) 2 alone is correct

(*c*) 2 and 3 are correct (*d*) 1 and 3 are correct

89. Efficiency of a pile group is defined as

(*a*) $\dfrac{\text{Load carried by the largest pile in the group}}{\text{Load carried by the smallest pile in the group}}$

(*b*) $\dfrac{\text{Maximum load carried by the pile in the group}}{\text{Minimum load carried by the pile in the group}}$

(*c*) $\dfrac{\text{Minimum load carried by the pile in the group}}{\text{Maximum load carried by the pile in the group}}$

(*d*) $\dfrac{\text{Average load carried by the pile in the group}}{\text{Load carried by the single pile}}$

90. A soil sample is having a specific gravity of 2.60 and a void ratio of 0.78. The water content in percentage required to fully saturate the soil at that void ratio would be

(*a*) 10 (*b*) 30

(*c*) 50 (*d*) 70

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

(*a*) 1.5 (*b*) 1.25

(*c*) 0.6 (*d*) 0.4

92. Sheep-foot rollers are recommended for compacting

(*a*) granular soils (*b*) cohesive soils

(*c*) hard rock (*d*) any type of soil

93. Which of the following laboratory triaxial test parameters should one specify to be carried out in connection with the initial stability of footing on saturated clay ?

1. C_{cu}, ϕ_{cu} – Consolidated undrained
2. C_{cu}, ϕ_{cu} – Undrained
3. C_{cu}, ϕ_d – Drained

Select the correct answer using the codes given below.

Codes :

(*a*) 1 alone (*b*) 2 alone

(*c*) 1 and 3 (*d*) 1, 2 and 3

94. A soil fails under an axial vertical stress of 100 kN/m² in unconfined compression test. The failure plane makes an angle of 50° with the horizontal. The shear parameters c and ϕ respectively will be

(*a*) 41.9 kN/m², 0° (*b*) 50.0 kN/m², 0°

(*c*) 41.9 kN/m²,10° (*d*) 50.0 kN/m², 10°

95. A clay layer 5 m thick in field takes 300 days to attain 50% consolidation with condition of double drainage. If the same clay layer is underlain by hard rock then the time taken to attain 50% consolidation will be

(*a*) 300 days (*b*) 600 days

(*c*) 900 days (*d*) 1200 days

96. A 30 cm diameter friction pile is embedded 10 m into a homogeneous consolidated deposit. Unit adhesion developed between clay and pile shaft is 4 t/m² and adhesion factor is 0.7. The safe load for factor of safety 2.5 will be

(*a*) 21.50 *t* (*b*) 11.57 *t*

(*c*) 10.55 *t* (*d*) 6.35 *t*

97. In case of well foundation, grip length is defined as the

(*a*) length below the top of the well cap to the cutting edge

(*b*) length between the bottom of the well cap to the cutting edge

(*c*) depth of the bottom of the well below the minimum scour level

(*d*) depth of the bottom of the well below the maximum scour level

98. In the following figures, if

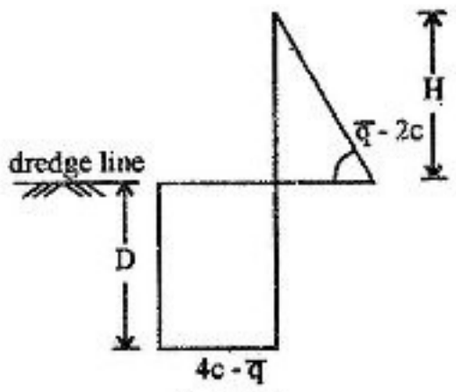
H = height of wall above dredge line,

$\bar{q}$ = effective vertical stress at any depth,

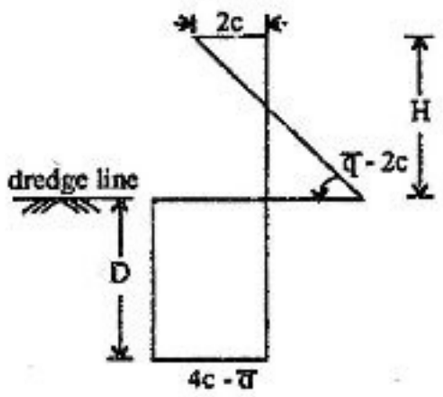
c = unit cohesion,

and passive pressure is shown hatched in the figures, then the earth pressure distribution diagram used for analysis of a cantilever sheet pile embedded to a depth D in a purely cohesive soil will be as in

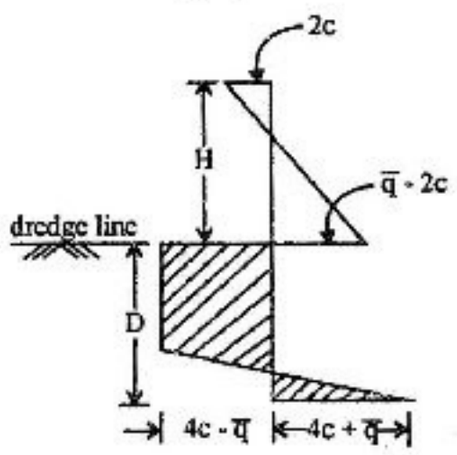
(*a*)



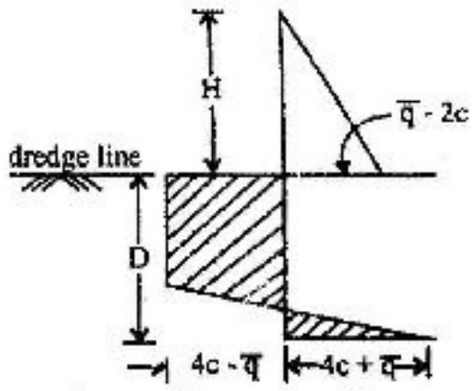
(*b*)



(*c*)



(*d*)



99. Lacustrine soils are soils

(*a*) transported by rivers and streams

(*b*) transported by glaciers

(*c*) deposited in sea beds

(*d*) deposited in lake beds

100. Consider the following statements in the context of aeolian soils :

1. The soil has low density of low compressibility.
2. The soil is deposited by wind.
3. The soil has large permeability.

Of these statements

(*a*) 1, 2 and 3 are correct (*b*) 2 and 3 are correct

(*c*) 1 and 3 are correct (*d*) 1 and 2 are correct

101. A fill having a volume of 1,50,000 cum is to be constructed at a void ratio of 0.8. The borrow pit soil has a void ratio of 1.4. The volume of soil required (in cubic metres) to be excavated from the borrow pit will be

(*a*) 1,87,500 (*b*) 2,00,000

(*c*) 2,10,000 (*d*) 2,50,000

102. Which one of the following equations correctly gives the relationship between the specific gravity of soil grains (G) and the hydraulic gradient (i) to initiate 'quick' condition in a sand having a void ratio of 0.5 ?

(*a*) $G = 0.5\,i + 1$ (*b*) $G = i + 0.5$

(*c*) $G = 1.5\,i + 1$ (*d*) $G = 1.5\,i - 1$

103. A clay soil specimen when tested in unconfined condition gave an unconfined compressive strength of 100 kN/m^2. A specimen of the same clay with the same initial condition is subjected to a UU triaxial test under a cell pressure of 100 kN/m^2. The axial stress (in kN/m^2) at failure would be

(*a*) 150 (*b*) 200

(*c*) 250 (*d*) 300

104. If s is the shear strength, c and ϕ are shear strength parameters, and σ_n is the normal stress at failure, then Coulomb's equation for shear strength of the soil can be represented by

(*a*) $c = s + \sigma_n \tan\phi$ (*b*) $c = s - \sigma_n \tan\phi$

(*c*) $s = \sigma_n + c \tan\phi$ (*d*) $s = c - \sigma_n \tan\phi$

105. In a cohesionless soil deposit having a unit weight of 1.5 t/m^3 and an angle of internal friction of 30°, the active and passive lateral earth pressure, intensities (in t/m^2) at a depth of 10 m will, respectively, be

(*a*) 15 and 5 (*b*) 5 and 45

(*c*) 10 and 20 (*d*) 20 and 10

106. Given that for a soil deposit,

K_o = earth pressure coefficient at rest,

K_a = active earth pressure coefficient,

K_p = passive earth pressure coefficient

and μ = Poisson 's ratio,

the value of $\frac{(1-\mu)}{\mu}$ is given by

(*a*) $\frac{K_a}{K_p}$ (*b*) $\frac{K_o}{K_a}$

(*c*) $\frac{K_p}{K_a}$ (*d*) $\frac{1}{K_o}$

107. A and B are Skempton's pore pressure coefficients. For saturated normally consolidated soils,

(*a*) $A > 1$ and $B > 1$ (*b*) $A > 1$ and $B < 1$

(*c*) $A < 1$ and $B > 1$ (*d*) $A < 1$ and $B = 1$

108. If the actual observed value of standard penetration resistance, N, is greater than 15 in a fine sand layer below water table, then the equivalent penetration resistance will be

(*a*) $15 + \left[\frac{(N+15)}{2}\right]$ (*b*) $15 - \left[\frac{(N+15)}{2}\right]$

(c) $15 + \left[\frac{(N-15)}{2}\right]$ (*d*) $15 + \left[\frac{(15-N)}{2}\right]$

109. Match List I (Property) with List II (Slope of the curve) and select the correct answer using the codes given below the Lists :

List I

A. Coefficient of compressibility

B. Compression index

C. Coefficient sub-grade modulus

List II

1. Stress-deformation
2. Stress-void ratio
3. Volume-pressure
4. Log stress-void ratio

Codes :

	A	B	C
(a)	4	2	2
(b)	4	3	2
(c)	2	4	1
(d)	3	4	1

110. A dry sand specimen is put through a triaxial test. The cell pressure is 50 kPa and the deviator stress at failure is 100 kPa. The angle of internal friction for the sand specimen is

(a) 15° (b) 30°

(c) 37° (d) 45°

111. The initial and final void ratios of a clay sample in a consolidation test are 1 and 0.5, respectively. If the initial thickness of the sample is 2.4 cm, then its final thickness will be

(a) 1.3 cm (b) 1.8 cm

(c) 1.9 cm (d) 2.2 cm

112. In standard penetration test, the split-spoon sampler is penetrated into the soil stratum by giving blows from a drop weight whose weight (in kg) and free fall (in cm) are, respectively,

(a) 30 and 60 (b) 60 and 30

(c) 65 and 75 (d) 75 and 65

113. Given that Plasticity Index (PI) of local soil = 15 and PI and sand = zero, for a desired PI of 6, the percentage of sand in the mix should be

(a) 70 (b) 60

(c) 40 (d) 30

114. Consider the following statements :

A well-graded sand should have

1. uniformity coefficient grater than 6.
2. coefficient of curvature between 1 and 3
3. effective size greater than 1 mm.

Of these statements

(a) 1, 2 and 3 are correct

(b) 1 and 2 are correct

(c) 2 and 3 are correct

(d) 1 and 3 are correct

115. Consider the following statements:

1. Increase in volume of a soil sample without external constraints on submergence in water is termed as the 'free swell of soil'.
2. Clay soil rich in montmorillonite exhibits very low swelling characteristic.
3. Generally, free swell of soil sample ceases when its water content reaches the plastic limit.

Of these statements

(a) 1 and 2 are correct (b) 1 and 3 are correct

(c) 2 and 3 are correct (d) 1, 2 and 3 are correct

116. The configuration of flow nets depend upon

(a) the permeability of the soil

(b) the difference in the head between upstream and downstream sides

(c) the boundary conditions of flow

(d) the amount of seepage that takes place

117. A soil has mass unit weight γ, water content w (as ratio). The specific gravity of soil solids = G, unit weight of water = γ_w, 'S', the degree of saturation of the soil is given by

(a) $S = \dfrac{1+w}{\frac{\gamma_w}{\gamma}(1+w)-\frac{1}{G}}$ (b) $S = \dfrac{w}{\frac{\gamma_w}{\gamma}(1+w)-\frac{1}{G}}$

(c) $S = \dfrac{(1+w)}{\frac{\gamma_w}{\gamma}(1+w)-\frac{1}{wG}}$ (d) $S = \dfrac{w}{\frac{\gamma_w}{\gamma}(1+w)-\frac{1}{wG}}$

118. Shear failure of soils takes place when

(a) the angle of obliquity is maximum

(b) maximum cohesion is reached in cohesive soils

(c) ϕ reaches its maximum value in cohesionless soils

(d) residual strength of the soil is exhausted.

119. In a Mohr's diagram, a point above Mohr's envelope indicates

(a) imaginary condition

(b) safe condition

(c) imminent failure condition

(d) condition of maximum obliquity

120. Minimum centre to centre spacing of friction piles of diameter (D) as per BIS code is

(a) 1.5 D (b) 2 D

(c) 2.5 D (d) 3 D

121. A good quality undisturbed soil sample is one which is obtained using a sampling tube having an area ratio of

(a) 8%

(b) 16%

(c) 24%

(d) 32%

122. Which one of the following tests cannot be done without undisturbed sampling?

(*a*) shear strength of sand

(*b*) shear strength of clay

(*c*) determination of compaction parameters

(*d*) Atterberg limits

123. If an unconfined cnmpressive strength of 4 kg/cm^2 in the natural state of clay reduces by four times in the remoulded state, then its sensitivity will be

(*a*) 1 (*b*) 2

(*c*) 4 (*d*) 8

124. In a direct shear test, the shear stress and normal stress on a dry sand sample at failure are 0.6 kg/cm^3 and 1 kg/cm^2 respectively. The angle of internal friction of the sand will be netti'y

(*a*) 25° (*b*) 31°

(*c*) 37° (*d*) 43°

125. If an infinite slope of clay at a depth 5 m has cohesion of 1 t/m^2 and unit wt. of 2 t/m^3, then the stability number will be

(*a*) 0.1 (*b*) 0.2

(*c*) 0.3 (*d*) 0.4

126. Given that c = 2 t/m^2, $\phi = 0°$ and γ = 2t/m^3, the depth of tension crack developing in a cohesive soil backfill would be

(*a*) 1 m (*b*) 2 m

(*c*) 3 m (*d*) 4 m

127. Which one of the following pairs of parameters and expressions is not correctly matched ?

(*a*) Coefficient of consolidation ... $\frac{T_v H^2}{t}$

(*b*) Coeff. of volume compressibility ...

$$\frac{e_0 - e}{(1+e_0)(p - p_0)}$$

(*c*) Over consolidation ratio ...

$$\sqrt{\frac{\text{Maximum previous effective pressure}}{\text{Existing effective pressure}}}$$

(*d*) Modulus of volume change .... $\frac{a_v}{1+e_0}$

128. Consider the following

1. Initial consolidation
2. Primary consolidation
3. Secondary consolidation
4. Final consolidation

The three stages which would be relevant to consolidation of a solid deposit includes

(*a*) 1, 2 and 3 (*b*) 2, 3 and 4

(*c*) 1, 3 and 4 (*d*) 1, 2 and 4

129. As per Terzaghi's equation, the bearing capacity of strip footing resting on cohesive soil (c =10 kN/m^2) for unit depth and unit width (assume N_c as 5.7) is

(*a*) 47 kN/m^2 (*b*) 57 kN/m^2

(*c*) 67 kN/m^2 (*d*) 77 kN/m^2

130. With a vertical point load on the surface when considering the vertical plane passing through the load, the stress gets reduced by 52.3% at a depth of

(*a*) 0.25 of unit length (*b*) 0.5 of unit length

(*c*) 0.75 of unit length (*d*) 1 of unit length

131. Ratio of bearing capacity of double Under Reamed (U.R.) pile to that of single U.R. pile is nearly

(*a*) 2 (*b*) 1.5

(*c*) 1.2 (*d*) 1.7

132. A raft of 6 m × 9 m is founded at a depth of 3 m in a cohesive soil having c = 120 kN/m^2. The ultimate net bearing capacity of the soil using Terzaghi's theory will be nearly

(*a*) 820 kN/m^2 (*b*) 920 kN/m^2

(*c*) 1036 kN/m^2 (*d*) 1067 kN/m^2

EXERCISE - II

(Questions From Previous SSC CPWD Exams)

2008

1. A footing is resting on fully saturated clayey strata for checking the initial stability shear parameter are used from

(*a*) Consolidated undrained test

(*b*) Unconsolidated drained test

(*c*) Unconsolidated undrained test

(*d*) Unconsolidated undrained test with pore pressure measurement

2. Coefficient of active earth pressure for cohesion less soil is given by

(*a*) $\frac{1+\sin\theta}{1-\sin\theta}$ (*b*) $\frac{1-\sin\theta}{1+\sin\theta}$

(*c*) $\frac{1+\tan\theta}{1-\tan\theta}$ (*d*) $\frac{1+\cos\theta}{1-\cos\theta}$

3. For routine consolidation test in laboratory, the thickness of the specimen is

(*a*) 10 mm (*b*) 20 mm

(*c*) 40 mm (*d*) 60 mm

4. Coefficient of permeability of soil varies approximately as

(*a*) D_{10}^2 (*b*) $\sqrt{D_{10}}$

(*c*) D_{10}^3 (*d*) $D_{10}^{3/2}$

5. For a granular soil, with increasing void ratio the critical hydraulic gradient

(*a*) Decreases (*b*) Increases

(*c*) Remains constant (*d*) Is zero

6. For cohesive soil, with increasing compactive effort, the optimum moisture content

(*a*) Increase (*b*) Decrease

(*c*) Remains constant (*d*) Is zero

7. A sample of saturated clay has a porosity of 0.562, the void ratio of the clay is

(*a*) 1.283 (*b*) 0.438

(*c*) 1.779 (*d*) 0.360

2009

8. The rate of consolidation.

(*a*) Increases with decrease in temperature.

(*b*) Increases with increase in temperature.

(*c*) Is independent of temperature.

(*d*) All the above.

9. Cohesionless soil is

(*a*) Silt (*b*) Sand

(*c*) Clay (*d*) None of the above

10. Physical properties which influence permeability are

(*a*) Viscosity only

(*b*) Unit weight only

(*c*) Both viscosity and unit weight

(*d*) None of the above

11. If the voids of a soil mass are full of air only, the soil is termed as

(*a*) Air entrained soil

(*b*) Partially saturated soil

(*c*) Dry soil

(*d*) None of the above

12. The ratio of volume of voids to the total volume of the soil mass is called

(*a*) Air content (*b*) Porosity

(*c*) Voids ratio (*d*) All the above

13. Pycnometer is used to determine

(*a*) Water content and voids ratio

(*b*) Specific gravity and dry density

(*c*) Water content and specific gravity

(*d*) None of the above

14. When the plastic limit of a soil is greater than the liquid limit, then the plasticity index is reported as:

(*a*) Negative (*b*) Zero

(*c*) Non-plastic (NP) (*d*) None of the above

15. The pH value of fresh sewage is usually:

(*a*) Less than 7 (*b*) more than 7

(*c*) Equal to 7 (*d*) Equal to zero.

16. A septic tank is:

(*a*) settling tank. (*b*) A digestion tank.

(*c*) Both (*a*) and (*b*). (*d*) None of the above.

17. A sand deposit has a porosity of 1/3 and its specific gravity is 2.5. The critical hydraulic gradient to cause sand boiling in the stratum will be

(*a*) 1.5 (*b*) 1.25

(*c*) 1.0 (*d*) 0.75

18. The % of chlorine in fresh bleaching powder is about.

(*a*) 10 to 20 (*b*) 20 to 25

(*c*) 30 to 35 (*d*) 40 to 50

19. Sewage treatment units are normally designed for:

(*a*) 5-10 years. (*b*) 15-20 years.

(*c*) 30-40 years. (*d*) 40-50 years.

2010

20. The shearing strength of a cohesion less soil depends on

(*a*) Dry density (*b*) Rate of loading

(*c*) Confining pressure (*d*) All the above

21. The relation between coefficient of consolidation Cv, time factor Tv, drainage path d and time t, is given by:

(*a*) $C_v = \frac{d^2 T_v}{t}$ (*b*) $C_v = \frac{d^2 t}{T_v}$

(*c*) $C_v = \frac{t T_v}{d^2}$ (*d*) $C_v = \frac{T_v}{t d^2}$

22. The ratio of liquid limit to plasticity index for a soil mass is called

(*a*) Liquidity index (*b*) Shrinkage ratio

(*c*) Consistency index (*d*) None of the above

23. The coefficient of curvature for a well graded soil must be in the gauge

(*a*) 0.5 – 1.0 (*b*) 3.0 – 4.0

(*c*) 4.0 – 5.0 (*d*) None of the above

24. Coefficient of earth pressure at rest is given by

(*a*) $\frac{\mu^2}{1-\mu^2}$ (*b*) $\frac{\mu}{1-\mu}$

(*c*) $\frac{1-\mu}{\mu}$ (*d*) $\frac{1-\mu^2}{\mu^2}$

2011

25. The correction in elevations due to the curvature and refraction is proportional to

(*a*) D/R (*b*) D^2/R

(*c*) R/D^2 (*d*) R/D

where R is the radius of curvature of Earth and D is the horizontal distance.

26. Relative density of a compacted dense sand is approximately equal to

(*a*) 0.4 (*b*) 0.6

(*c*) 0.95 (*d*) 1.20

27. Relationship between dry density γ_{d+} percentage air voids n_a, water content w and specific gravity G of any soil is

(*a*) $\gamma_d = \dfrac{(1+n_a)G\gamma_w}{1+wG}$ (*b*) $\gamma_d = \dfrac{(1+n_a)G\gamma_w}{1-wG}$

(*c*) $\gamma_d = \dfrac{(1-n_a)G\gamma_w}{1+wG}$ (*d*) $\gamma_d = \dfrac{(1-n_a)G\gamma_w}{1-wG}$

28. A shallow foundation is defined as a foundation which

(*a*) has low bearing capacity

(*b*) has a depth of embedment less than its width

(*c*) is resting on the ground surface

(*d*) causes less settlement

2012

29. Water content of soil can

(*a*) Be less than 0%

(*b*) Be greater than 100%

(*c*) Never be greater than 100%

(*d*) Take values only from 0% to 100%

30. The coefficient of active earth pressure for a loose sand having an angle of internal friction 'ϕ' is

(*a*) $\dfrac{1-\sin\frac{\phi}{2}}{1+\sin\frac{\phi}{2}}$ (*b*) $\dfrac{1+\sin\frac{\phi}{2}}{1-\sin\frac{\phi}{2}}$

(*c*) $\dfrac{1-\sin\phi}{1+\sin\phi}$ (*d*) $\dfrac{1+\sin\phi}{1-\sin\phi}$

31. A plate load test is useful to estimate

(*a*) Both bearing capacity and settlement of foundation

(*b*) Consolidation of soil

(*c*) Bearing capacity of foundation

(*d*) Settlement of foundation

32. The unit of the coefficient of consolidation is

(*a*) $gm/cm^2/sec$ (*b*) gm–cm/sec

(*c*) cm^2/sec (*d*) cm^3/sec

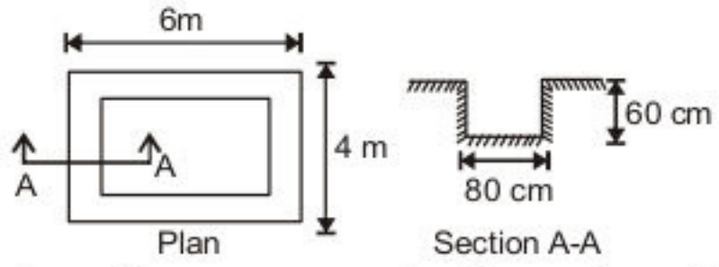
2013

33. Anti-siphonage pipe is connected to

(*a*) Main soil pipe (*b*) Bottom of P trap W.C.

(*c*) Top of P trap W.C. (*d*) Side of Water Closet

34.



The above figure represents plan and section of an excavation layout. The volume of earthwork in excavation of foundation trench is

(*a*) 6.528 cu.m. (*b*) 8.064 cu.m.

(*c*) 8.832 cu. m. (*d*) 9.600 cu. m.

35. A shallow foundation is defined as a foundation which

(*a*) has low bearing capacity

(*b*) has a depth of embedment less than its width

(*c*) is resting on the ground surface

(*d*) causes less settlement

36. If the volume of voids is equal to the volume of solids in a soil mass, than the values of porosity and voids ratio respectively are

(*a*) 1.0 and 0.0 (*b*) 0.0 and 1.0

(*c*) 1.5 and 1.0 (*d*) 1.0 and 0.5

37. The lime stabilization is very effective in treating

(*a*) Sandy soils (*b*) Silty soils

(*c*) Non-plastic soils (*d*) Plastic clayey soils

38. A 300 mm square bearing plate settles by 15 mm in a plate load test on a cohesive soil when the intensity of loading is $0.2\ N/mm^2$. The settlement of a prototype shallow footing 1 m square under the same intensity of loading is

(*a*) 15 mm (*b*) 30 mm

(*c*) 50 mm (*d*) 167 mm

2014

39. Specific gravity has a unit :

(*a*) g/cc (*b*) kg/m^3

(*c*) N/m^3 (*d*) No unit-dimensionless

40. The relationship between void ratio '*e*' and porosity '*n*' is :

(*a*) $n = \dfrac{1+e}{1-e}$ (*b*) $e = n(1+e)$

(*c*) $n = \dfrac{e}{1-e}$ (*d*) $e = \dfrac{1+n}{1-e}$

41. When the plastic limit of a soil is greater than the liquid limit, then the plasticity index is reported as :

(*a*) 1 (*b*) Negative

(*c*) Zero (*d*) Non-Plastic (NP)

42. Compression members always tend to buckle in the direction of the :

(*a*) Least radius of gyration

(*b*) Axis of load

(*c*) Perpendicular to the axis of load

(*d*) Minimum cross-section

2015

43. Black cotton soil is not suitable for foundation because of its

(*a*) low bearing capacity

(*b*) cohesive particles

(*c*) swelling and shrinkage

(*d*) black colour

44. Optimum moisture content is obtained from

(*a*) triaxial test (*b*) standard proctor test

(*c*) consolidation test (*d*) hydrometer test

45. The effective size of particles of soil is denoted by

(*a*) D_{10} (*b*) D_{20}

(*c*) D_{30} (*d*) D_{60}

46. When the plasticity index of a soil is zero, the soil is

(*a*) Clay (*b*) Silt

(*c*) Sand (*d*) Silty sand

47. The depth of foundation is usually calculated from

(*a*) Rankine's formula

(*b*) Newton's formula

(*c*) De Almbert's formula

(*d*) Gutter's formula

48. Pollution potential of domestic sewage generated in a town and its industrial sewage can be compared with reference to

(*a*) their BOD value

(*b*) population equivalent

(*c*) their volume

(*d*) the relative density

ANSWERS

EXERCISE - I

1. (*c*)	**2.** (*b*)	**3.** (*b*)	**4.** (*d*)	**5.** (*d*)	**6.** (*b*)	**7.** (*b*)	**8.** (*c*)	**9.** (*c*)	**10.** (*a*)
11. (*d*)	**12.** (*c*)	**13.** (*c*)	**14.** (*c*)	**15.** (*c*)	**16.** (*d*)	**17.** (*c*)	**18.** (*a*)	**19.** (*b*)	**20.** (*d*)
21. (*d*)	**22.** (*a*)	**23.** (*b*)	**24.** (*a*)	**25.** (*c*)	**26.** (*a*)	**27.** (*c*)	**28.** (*c*)	**29.** (*a*)	**30.** (*b*)
31. (*c*)	**32.** (*b*)	**33.** (*c*)	**34.** (*c*)	**35.** (*d*)	**36.** (*b*)	**37.** (*b*)	**38.** (*c*)	**39.** (*b*)	**40.** (*b*)
41. (*b*)	**42.** (*b*)	**43.** (*d*)	**44.** (*d*)	**45.** (*b*)	**46.** (*c*)	**47.** (*c*)	**48.** (*d*)	**49.** (*d*)	**50.** (*d*)
51. (*d*)	**52.** (*a*)	**53.** (*a*)	**54.** (*b*)	**55.** (*c*)	**56.** (*c*)	**57.** (*c*)	**58.** (*a*)	**59.** (*b*)	**60.** (*b*)
61. (*b*)	**62.** (*c*)	**63.** (*a*)	**64.** (*d*)	**65.** (*d*)	**66.** (*b*)	**67.** (*c*)	**68.** (*c*)	**69.** (*c*)	**70.** (*c*)
71. (*d*)	**72.** (*c*)	**73.** (*c*)	**74.** (*c*)	**75.** (*b*)	**76.** (*b*)	**77.** (*b*)	**78.** (*d*)	**79.** (*c*)	**80.** (*a*)
81. (*b*)	**82.** (*a*)	**83.** (*a*)	**84.** (*b*)	**85.** (*c*)	**86.** (*b*)	**87.** (*d*)	**88.** (*d*)	**89.** (*d*)	**90.** (*b*)
91. (*c*)	**92.** (*b*)	**93.** (*b*)	**94.** (*d*)	**95.** (*d*)	**96.** (*c*)	**97.** (*d*)	**98.** (*c*)	**99.** (*d*)	**100.** (*b*)
101. (*b*)	**102.** (*c*)	**103.** (*b*)	**104.** (*c*)	**105.** (*b*)	**106.** (*d*)	**107.** (*c*)	**108.** (*c*)	**109.** (*c*)	**110.** (*b*)
111. (*b*)	**112.** (*c*)	**113.** (*b*)	**114.** (*b*)	**115.** (*b*)	**116.** (*c*)	**117.** (*a*)	**118.** (*a*)	**119.** (*a*)	**120.** (*d*)
121. (*a*)	**122.** (*b*)	**123.** (*c*)	**124.** (*b*)	**125.** (*a*)	**126.** (*b*)	**127.** (*c*)	**128.** (*a*)	**129.** (*b*)	**130.** (*d*)
131. (*b*)	**132.** (*a*)								

EXERCISE - II

1. (*c*)	**2.** (*b*)	**3.** (*d*)	**4.** (*a*)	**5.** (*a*)	**6.** (*b*)	**7.** (*a*)	**8.** (*b*)	**9.** (*b*)	**10.** (*c*)
11. (*c*)	**12.** (*b*)	**13.** (*c*)	**14.** (*b*)	**15.** (*b*)	**16.** (*c*)	**17.** (*a*)	**18.** (*c*)	**19.** (*b*)	**20.** (*d*)
21. (*a*)	**22.** (*d*)	**23.** (*d*)	**24.** (*b*)	**25.** (*b*)	**26.** (*c*)	**27.** (*c*)	**28.** (*b*)	**29.** (*b*)	**30.** (*c*)
31. (*a*)	**32.** (*c*)	**33.** (*c*)	**34.** (*b*)	**35.** (*b*)	**36.** (*d*)	**37.** (*d*)	**38.** (*c*)	**39.** (*d*)	**40.** (*b*)
41. (*c*)	**42.** (*a*)	**43.** (*c*)	**44.** (*c*)	**45.** (*a*)	**46.** (*c*)	**47.** (*a*)	**48.** (*b*)		

EXPLANATIONS

EXERCISE-II

1. A footing is resting on fully saturated clayey strata for checking the initial stability, shear parameter are used from Unconsolidated undrained test.

2. Coefficient of active earth pressure (K_a)

$$K_a = \frac{1-\sin\theta}{1+\sin\theta} = \tan^2\left(45-\frac{\theta}{2}\right)$$

Where, θ = angle of internal friction

3. For performing consolidation the test, a soil sample of **60 mm dia** is taken as per ISI standards. Samples of 50, 70 and 100 mm dia may also be used in special cases. The sample thickness should not be less than 10 times the maximum dia of the soil grains, and the dia to thickness ratio of the sample should be minimum of 3.

4. Factors affecting permeability (K)-

1. Grain size- $K \propto D_{10}^2$
2. Properties of water- $K \propto \frac{\gamma_w}{\mu}$

   → With increases temperature, viscosity (μ) decreases; and hence K increases
3. Void ratio of soil- $K \propto e^2$
4. Degree of saturation- $K \propto S$
5. Shape of particles- $K \propto \frac{1}{s^2}$

   (Specific surface area s = Surface Area/Volume)
6. Temperature- $K \propto$ Temp
7. Impurities present in water block the voids and hence permeability reduces
8. Adsorbed water hinders the flow under gravity. Hence K is reduces.

5. Critical hydraulic gradient $i_c = \frac{G-1}{1+e}$

Where,

G = Specific gravity and e = void ratio

Hence increasing void ratio, the critical hydraulic gradient will decrease.

6. In a compaction test, as the compaction effort is increased, the optimum moisture content decreases.

7. Relationship between void ratio 'e' and porosity 'n' is given by

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

$$n(1+e) = e$$

$$n + ne = e$$

$$n = e - ne$$

$$n = e(1-n)$$

$$\therefore\ e = \frac{n}{1-n} = \frac{0.562}{1-0.562} = 1.283 \text{ (since } n = 0.562)$$

8. Factors affecting rate of consolidation-

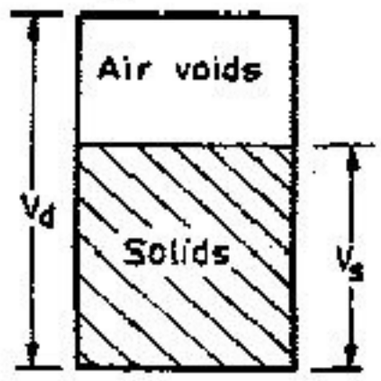
- The rate of consolidation increases with increase in temperature.
- Decreases with increase of liquid limit.
- Changes with increase in effective stress etc.

9. Cohesionless soil-Lacking cohesion among particles, such as in the case of sand a Cohesionless soil.

Any free-running type of soil, such as sand or gravel, whose strength depends on friction between particles is called Cohesionless soil. Also called frictional.

Cohesive soil-It is hard to break up when dry, and exhibits significant cohesion when submerged. Cohesive soils include clayey silt, sandy clay, silty clay, clay and organic clay. "Dry soil" means soil that does not exhibit visible signs of moisture content.

11. If the voids of a soil mass are full of air only, the soil is termed as Dry soil.



12. Air content- The ratio of volume of air voids to the total volume of the voids, i.e. $a_c = \frac{V_a}{V_V}$

Porosity- The ratio of volume of voids to the total volume of the soil mass. i.e. $n = \frac{V_V}{V}$

Voids ratio- The ratio of volume of voids to the volume of the solids, i.e. $e = \frac{V_V}{V_S}$

13. Pycnometer- is a glass jar of about 1 litre capacity and fitted with a brass conical cap by means of a screw-type cover. The cap has a small hole of 6 mm diameter at its apex.

Pycnometer is used to determine water content and specific gravity.

14. Plasticity index $I_p = \omega_L - \omega_P$

When the plastic limit of a soil is greater than the liquid limit, then the plasticity index is reported as zero soil will be non-plastic.

16. A septic tank combines the function of a sedimentation tank, a sludge digestion tank and a sludge storage tank.

18. The bleaching powder is a white powder and it contains about 30 to 35 per cent of available chlorine

19. Sewage treatment units are normally designed for 15-20 years.

20. Factors Affecting Shear strength of Cohesionless Soil-

- Shear strength of cohesionless soils is only developed with the presence of effective stress.
- Shear strength increases with increasing effective stress.
- The increase of shear strength of cohesionless soil depends upon the internal friction angle of the soil.
- The type of soil most susceptible to liquefaction is one in which the resistance to deformation is mobilized by friction between particles. If other factors such as grain shape, uniformity coefficient and relative density are equal, the frictional resistance of cohesion less soil decreases as the grain size of soils becomes smaller.

21. Time factor $T_V = \dfrac{C_V t}{d^2} \Rightarrow C_V = \dfrac{d^2 T_V}{t}$

22. Liquidity index $I_L = \dfrac{w - w_P}{w_L - w_P} = \dfrac{w - w_P}{I_P}$

Shrinkage ratio - It is defined as the ratio of a given volume change in a soil expressed as a percentage of dry volume to the corresponding change in water content above the shrinkage limit.

$$R = \frac{\dfrac{V_1 - V_2}{V_d} \times 100}{w_1 - w_2}$$

Consistency index-

$$I_C = \frac{w_L - w}{w_L - w_P} = \frac{w_L - w}{I_P}$$

23. Coefficient of curvature or coefficient of gradation or coefficient of concavity (C_C)

$$C_C = \frac{D_{30}^2}{D_{60} \times D_{10}}$$

For well graded soil C_c should be between 1 to 3.

i.e. $1 \le C_C \le 3$

24. Coefficient Of Earth Pressure at Rest (K_0)-

$$K_0 = \frac{\mu}{(1 - \mu)}$$

- For a perfectly cohesion-less soil (C = 0)

$$K_0 = (1 - \sin\phi)$$

- If the soil normally consolidated (N.C. soil)

$$K_0 = 0.19 + 0.2331 \log_{10}(I_P)$$

- For over consolidated soil (OC soil)

$$K_{0_{(OC)}} = K_{0_{(NC)}} \sqrt{O.C.R.}$$

Where, μ = poission's ratio

ϕ = friction angle

I_P = plasticity index

O.C.R. = over consolidated ratio

26. Relative density / density index or degree of density (I_D) (its range 0 to 1)

$$I_D = \frac{l_{max} - l}{l_{max} - l_{min}}$$

Where,

l_{max} = maximum void ratio,

l_{min} = minimum void ratio

l = natural void ratio

(when the soil is undisturbed)

In dense condition,

$$l = l_{min}$$

$$\because \quad I_D = \frac{l_{max} - l_{min}}{l_{max} - l_{min}} = 1.0$$

But 1.0 is not availabe in choices, so we take the nearest value of 1.0 i.e. 0.95.

So answer is (*c*).

28. A foundation is shallow if its depth is equal to less then its width.

34. Volume of excavation at section A-A

$\Rightarrow$ 80 cm × 60 cm

$\Rightarrow$ 4800 cm^2

Perimeter of excavation

$\Rightarrow$ 4 + 4 + 2 (6 – (2 × .8 m))

$\Rightarrow$ 4 + 4 + 8.8

$\Rightarrow$ 16.8 m

Volume of whole excavation

$\Rightarrow \dfrac{4800}{(100)^2} \times 16.8$ m

$\Rightarrow$ 8.064 m^3

or = 8.064 cu.m

35. Shallow foundation (D < B)

Deep foundation (D > B)

36. According to question $Vv = Vs$

$$\text{(Void Ratio) } e \Rightarrow \frac{Vv}{Vs} \Rightarrow 1.0$$

$$\text{(Porosity) } n = \frac{e}{1+e} \Rightarrow \frac{1}{1+1} \Rightarrow 0.5$$

37. Hydrated lime (or slaked) lime is very effective in treating heavy, plastic clayey soil.

38. For clayey soil (cohessive soil)

$$\rho_P = \rho_F \cdot \frac{B_P}{B}$$

$$\because \quad \rho_F = \rho_P \cdot \frac{B}{B_P}$$

$$\rho_F = 15 \times \frac{1000}{300} = 50 \text{ mm}$$

where ρ_F = Settlement of footing

ρ_P = Settlement of plate

B = Breadth of footing

B_P = Breadth of Plate

40. Relationship between void ratio 'e' and porosity 'n'-

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

$$\therefore \quad n = e(1-n)$$

$$\therefore \quad 1-n = \frac{1}{1+e}$$

42. Compression members always tend to buckle in the direction of the Least radius of gyration. The radius of gyration (r) of a section is given by

$$r = \sqrt{I/A}$$

Where I = moment of inertia

A = area of the section

43. Because black soil has high plasticity index.

44. Optimum moisture content is obtained from standrd proctor test because it contains the density of maximum dryness.

45. $D_{10} \rightarrow 10\%$ of sample finer in weight on Grain Size Distribution Curve.

46. Because clay contains high plasticity index and sand contains zero plasticity index.

47. Depth of foundation is calculated from Ramekin formula.

48. Population equivalent

$$= \frac{\text{B.O.D. Industrial (5 days)}}{\text{B.O.D. domestic sewage/person/day}}$$

■■