Chapter

8

Geotechnical and Foundation Engineering

1. Residual soils are formed by
   a) glaciers
   b) wind
   c) water
   d) none of the above
2. Water content of soil can
   a) never be greater than 100%
   b) take values only from 0% to 100%
   c) be less than 0%
   d) be greater than 100%
3. Which of the following types of soil is transported by gravitational forces?
   a) loess b) talus
   c) drift d) dune sand
4. A fully saturated soil is said to be
   a) one phase system
   b) two phase system with soil and air
   c) two phase system with soil and water
   d) three phase system
5. Valid range for S, the degree of saturation of soil in percentage is
   a) $S > 0$ b) $S \le 0$
   c) $0 < S < 100$ d) $0 \le S \le 100$
6. The submerged density of soil in terms of unit weight of water γ_w, specific gravity G and voids ratio e is given by the expression
   a) $\frac{\gamma_w (G+1)}{1+e}$ b) $\frac{\gamma_w (G-1)}{1-e}$
   c) $\frac{\gamma_w (G+1)}{1-e}$ d) $\frac{\gamma_w (G-1)}{1+e}$
7. A soil has a bulk density of 22 kN/m^3 and water content 10 %. The dry density of soil is
   a) 18.6 kN/m^3
   b) 20.0 kN/m^3
   c) 22.0 kN/m^3
   d) 23.2 kN/m^3
8. 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) dehydrated soil
9. Valid range for n, the percentage voids, is
   a) $0 < n < 100$ b) $0 \le n \le 100$
   c) $n > 0$ d) $n \le 0$
10. Select the correct statement.
    a) unit weight of dry soil is greater than unit weight of wet soil.
    b) for dry soils, dry unit weight is less than total unit weight.
    c) unit weight of soil increases due to submergence in water.
    d) unit weight of soil decreases due to submergence in water.
11. Voids ratio of a soil mass can
    a) never be greater than unity
    b) be zero
    c) take any value greater than zero
    d) take values between 0 and 1 only
12. If the volume of voids is equal to the volume of solids in a soil mass, then the values of porosity and voids ratio respectively are
    a) 1.0 and 0.0
    b) 0.0 and 1.0
    c) 0.5 and 1.0
    d) 1.0 and 0.5

13. When the degree of saturation is zero, the soil mass under consideration represents
    a) one phase system
    b) two phase system with soil and air
    c) two phase system with soil and water
    d) three phase system

14. Select the correct range of density index, I_D
    a) $I_D > 0$ b) $I_D \geq 0$
    c) $0 < I_D < 1$ d) $0 \leq I_D \leq 1$

15. If the degree of saturation of a partially saturated soil is 60%, then air content of the soil is
    a) 40% b) 60%
    c) 80% d) 100%

16. If the water content of a fully saturated soil mass is 100%, then the voids ratio of the sample is
    a) less than specific gravity of soil
    b) equal to specific gravity of soil
    c) greater than specific gravity of soil
    d) independent of specific gravity of soil

17. The ratio of volume of voids to the total volume of soil mass is called
    a) air content
    b) porosity
    c) percentage air voids
    d) voids ratio

18. Relative density of a compacted dense sand is approximately equal to
    a) 0.4 b) 0.6
    c) 0.95 d) 1.20

19. If the sand *in situ* is in its densest state, then the relative density of sand is
    a) zero
    b) 1
    c) between 0 and 1
    d) greater than 1

20. Which of the following methods is most accurate for the determination of the water content of soil?
    a) oven drying method
    b) sand bath method
    c) calcium carbide method
    d) pycnometer method

21. For proper field control, which of the following methods is best suited for quick determination of water content of a soil mass?
    a) oven drying method
    b) sand bath method
    c) alcohol method
    d) calcium carbide method

22. A 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

23. Stoke's law is valid only if the size of particle is
    a) less than 0.0002 mm
    b) greater than 0.2 mm
    c) between 0.2 mm and 0.0002 mm
    d) all of the above

24. In hydrometer analysis for a soil mass
    a) both meniscus correction and dispersing agent correction are additive
    b) both meniscus correction and dispersing agent correction are subtractive
    c) meniscus correction is additive and dispersing agent correction is subtractive
    d) meniscus correction is subtractive and dispersing agent correction is additive

25. The hydrometer method of sedimentation analysis differs from the pipette analysis mainly in
    a) the principle of test
    b) the method of taking observations
    c) the method of preparation of soil suspension
    d) all of the above

26. Which of the following is a measure of particle size range?
    a) Effective size
    b) Uniformity coefficient
    c) Coefficient of curvature
    d) None of the above

27. Which of the following statements is correct?
    a) uniformity coefficient represents the shape of the particle size distribution curve.

b) for a well graded soil, both uniformity coefficient and coefficient of curvature are nearly unity.
c) a soil is said to be well graded if it has most of the particles of about the same size
d) none of the above

28. Uniformity coefficient of a soil is
a) always less than 1
b) always equal to 1
c) equal to or less than 1
d) equal to or greater than 1

29. According to Atterberg, the soil is said to be of medium plasticity if the plasticity index PI is
a) $0 < PI < 7$ b) $7 \leq PI \leq 17$
c) $17 < PI < 27$ d) $PI \geq 27$

30. If the natural water content of soil mass lies between its liquid limit and plastic limit, the soil mass is said to be in
a) liquid state b) plastic state
c) semi-solid state d) solid state

31. The ratio $\frac{Liquid\ Limit - Water\ Content}{Plasticity\ Index}$ for a soil mass is called
a) liquidity index
b) shrinkage ratio
c) consistency index
d) toughness index

32. 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) 1

33. Toughness index is defined as the ratio of
a) plasticity index to consistency index
b) plasticity index to flow index
c) liquidity index to flow index
d) consistency index to liquidity index

34. If the plasticity index of a soil mass is zero, the soil is
a) sand b) silt
c) clay d) clayey silt

35. The admixture of coarser particles like sand or silt to clay causes
a) decrease in liquid limit and increase in plasticity index
b) decrease in liquid limit and no change in plasticity index
c) decrease in both liquid limit and plasticity index
d) increase in both liquid limit and plasticity index

36. Select the correct statement.
a) a uniform soil has more strength and stability than a non-uniform soil.
b) a uniform soil has less strength and stability than a non-uniform soil.
c) uniformity coefficient does not affect strength and stability.
d) uniformity coefficient of a poorly graded soil is more than that of a well graded soil.

37. The following index properties were determined for four soils A, B, C and D.

Soil property	A	B	C	D
Liquid limit	0.50	0.49	0.43	0.47
Plastic limit	0.23	0.17	0.21	0.26

Which of these soils contains more clay particles?
a) Soil A b) Soil B
c) Soil C d) Soil D

38. The water content of soil, which represents the boundary between plastic state and liquid state, is known as
a) liquid limit b) plastic limit
c) shrinkage limit d) plasticity index

39. Which of the following soils has more plasticity index?
a) Sand b) Silt
c) Clay d) Gravel

40. At liquid limit, all soils possess
a) same shear strength of small magnitude
b) same shear strength of large magnitude
c) different shear strengths of small magnitude
d) different shear strengths of large magnitude

41. If the material of the base of the Casagrande liquid limit device on which the cup containing soil paste drops is softer than the standard hard rubber, then
    a) the liquid limit of soil always increases
    b) the liquid limit of soil always decreases
    c) the liquid limit of soil may increase
    d) the liquid limit of soil may decrease

42. According to IS classification, the range of silt size particles is
    a) 4.75 mm to 2.00 mm
    b) 2.00 mm to 0.425 mm
    c) 0.425 mm to 0.075 mm
    d) 0.075 mm to 0.002 mm

43. Highway Research Board (HRB) classification of soils is based on
    a) particle size composition
    b) plasticity characteristics
    c) both particle size composition and plasticity characteristics
    d) none of the above

44. Inorganic soils with low compressibility are represented by
    a) MH b) SL
    c) ML d) CH

45. Sand particles are made of
    a) rock minerals b) kaolinite
    c) illite d) montmorillonite

46. The clay mineral with the largest swelling and shrinkage characteristics is
    a) kaolinite
    b) illite
    c) montmorillonite
    d) none of the above

47. Dispersed type of soil structure is an arrangement comprising particles having
    a) face to face or parallel orientation
    b) edge to edge orientation
    c) edge to face orientation
    d) all of the above

48. Effective stress is
    a) the stress at particles contact
    b) a physical parameter that can be measured
    c) important because it is a function of engineering properties of soil
    d) all of the above

49. Rise of water table above the ground surface causes
    a) equal increase in pore water pressure and total stress
    b) equal decrease in pore water pressure and total stress
    c) increase in pore water pressure but decrease in total stress
    d) decrease in pore water pressure but increase in total stress

50. The total and effective stresses at a depth of 5 m below the top level of water in a swimming pool are respectively
    a) zero and zero
    b) 0.5 kg/cm^2 and zero
    c) 0.5 kg/cm^2 and 0.5 kg/cm^2
    d) 1.0 kg/cm^2 and 0.5 kg/cm^2

51. If the water table rises upto ground surface, then the
    a) effective stress is reduced due to decrease in total stress only but pore water pressure does not change
    b) effective stress is reduced due to increase in pore water pressure only but total stress does not change
    c) total stress is reduced due to increase in pore water pressure only but effective stress does not change
    d) total stress is increased due to decrease in pore water pressure but effective stress does not change

52. The critical hydraulic gradient i_c of a soil mass of specific gravity G and voids ratio e is given by
    a) $i_c = \dfrac{G+1}{1-e}$ b) $i_c = \dfrac{G-1}{1+e}$
    c) $i_c = \dfrac{G+1}{1+e}$ d) $i_c = \dfrac{G-1}{1-e}$

    [CS 96]

53. Quick sand is a
    a) type of sand
    b) flow condition occurring in cohesive soils

c) flow condition occurring in cohesionless soils
d) flow condition occurring in both cohesive and cohesionless soils

54. The hydraulic head that would produce a quick condition in a sand stratum of thickness 1.5 m, specific gravity 2.67 and voids ratio 0.67 is equal to
a) 1.0 m b) 1.5 m
c) 2.0 m d) 3 m

55. Physical properties of a permeant which influence permeability are
a) viscosity only
b) unit weight only
c) both viscosity and unit weight
d) none of the above

56. Select the correct statement.
a) the greater the viscosity, the greater is the permeability.
b) the greater the unit weight of fluid, the greater is the permeability.
c) the greater the unit weight, the smaller is the permeability.
d) unit weight does not affect permeability.

57. Effective stress on soil
a) increases voids ratio and decreases permeability
b) increases both voids ratio and permeability
c) decreases both voids ratio and permeability
d) decreases voids ratio and increases permeability

58. If the permeability of a soil is 0.8 mm/sec, the type of soil is
a) gravel b) sand
c) silt d) clay [CS 96]

59. Which of the following methods is more suitable for the determination of permeability of clayey soil?
a) constant head method
b) falling head method
c) horizontal permeability test
d) none of the above

60. Which of the following methods is best suited for determination of permeability of coarse-grained soils?
a) constant head method
b) falling head method
c) both the above
d) none of the above

61. Due to a rise in temperature, the viscosity and the unit weight of the percolating fluid are reduced to 60% and 90% respectively. If other things remain constant, the coefficient of permeability
a) increases by 25%
b) increases by 50%
c) increases by 33.3%
d) decreases by 33.3%

62. Coefficient of permeability of soil
a) does not depend upon temperature
b) increases with the increase in temperature
c) increases with the decrease in temperature
d) none of the above

63. The average coefficient of permeability of natural deposits
a) parallel to stratification is always greater than that perpendicular to stratification
b) parallel to stratification is always less than that perpendicular to stratification
c) is always same in both directions
d) parallel to stratification may or may not be greater than that perpendicular to stratification

64. The total discharge from two wells situated near to each other is
a) sum of the discharges from individual wells
b) less than the sum of the discharges from individual wells
c) greater than the sum of the discharges from individual wells
d) equal to larger of the two discharges from individual wells

65. The flownet for an earthen dam with 30 m water depth consists of 25 potential drops and 5 flow channels. The coefficient of permeability of dam material is 0.03 mm/sec. The discharge per metre length of dam is

a) 0.00018 m^3/sec
b) 0.0045 m^3/sec
c) 0.18 m^3/sec
d) 0.1125 m^3/sec

66. The most suitable method for drainage of fine grained cohesive soils is
a) well point system
b) vacuum method
c) deep well system
d) electro-osmosis method

67. Total number of stress components at a point within a soil mass loaded at its boundary is
a) 3 b) 6
c) 9 d) 16

68. Boussinesq's influence factor for vertical pressure at depth z and at the centre of a circular area of diameter 'a' carrying uniformly distributed load is

a) $\left[1-\frac{1}{1+\left(\frac{a}{z}\right)^2}\right]^{3/2}$

b) $\frac{3}{2\pi}\left[\frac{1}{1+\left(\frac{a}{z}\right)^2}\right]^{5/2}$

c) $1-\left[\frac{1}{1+\left(\frac{a}{z}\right)^2}\right]^{3/2}$

d) $1-\left[\frac{1}{1+\left(\frac{a}{2z}\right)^2}\right]^{3/2}$

69. The intensity of vertical pressure directly below a concentrated load of 3/2π tonnes at a depth of 3/2π metres is given by
a) 1 t/m^2 b) $\frac{1}{2}$ t/m^2
c) $\frac{3}{2}$ t/m^2 d) $\left(\frac{3}{2\pi}\right)^{3/2}$ t/m^2

70. Vertical stress on a vertical line at a constant radial distance from the axis of a vertical load
a) is same at all depths
b) increases with depth
c) first increases, attains a maximum value and then decreases
d) first decreases, attains a minimum value and then increases

71. Phreatic line in an earthen dam is
a) straight line b) parabolic
c) circular d) elliptical

72. The hydrostatic pressure on the phreatic line within a dam section is
a) less than atmospheric pressure
b) equal to atmospheric pressure
c) greater than atmospheric pressure
d) none of the above

73. Rate of consolidation
a) increases with decrease in temperature
b) increases with increase in temperature
c) is independent of temperature
d) is unaffected by permeability of soil

74. The unit of the coefficient of consolidation is
a) cm^2/gm b) cm^2/sec
c) gm/cm^2/sec d) gm-cm/sec

75. Terzaghi's basic differential equation for one-dimensional consolidation of clayey soils is
a) $\frac{\partial \bar{u}}{\partial t} = C_v \frac{\partial \bar{u}}{\partial z}$ b) $\frac{\partial \bar{u}}{\partial z} = C_v \frac{\partial^2 \bar{u}}{\partial t^2}$
c) $\frac{\partial^2 \bar{u}}{\partial t^2} = C_v \frac{\partial \bar{u}}{\partial z}$ d) $\frac{\partial \bar{u}}{\partial t} = C_v \frac{\partial^2 \bar{u}}{\partial z^2}$

76. The slope of isochrone at any point at a given time indicates the rate of change of
a) effective stress with time
b) effective stress with depth

c) pore water pressure with depth
d) pore water pressure with time

77. Within the consolidation process of a saturated clay
a) a gradual increase in neutral pressure and a gradual decrease in effective pressure takes place and sum of the two is constant
b) a gradual decrease in neutral pressure and a gradual increase in effective pressure takes place and sum of the two is constant
c) both neutral pressure and effective pressure decrease
d) both neutral pressure and effective pressure increase

78. The value of compression index for a remoulded sample whose liquid limit is 50% is
a) 0.028 b) 0.287
c) 0.36 d) 0.036

79. Which one of the following clays behaves like a dense sand?
a) Over-consolidated clay with a high over-consolidation ratio
b) Over-consolidated clay with a low over-consolidation ratio
c) Normally consolidated clay
d) Under-consolidated clay [ES 98]

80. Coefficient of consolidation of a soil is affected by
a) compressibility
b) permeability
c) both compressibility and permeability
d) none of the above

81. Degree of consolidation is
a) directly proportional to time and inversely proportional to drainage path
b) directly proportional to time and inversely proportional to square of drainage path
c) directly proportional to drainage path and inversely proportional to time
d) directly proportional to square of drainage path and inversely proportional to time

82. Time factor for a clay layer is
a) a dimensional parameter
b) directly proportional to permeability of soil
c) inversely proportional to drainage path
d) independent of thickness of clay layer

83. If the time required for 50% consolidation of a remoulded sample of clay with single drainage is t, then the time required to consolidate the same sample of clay with same degree of consolidation but with double drainage is
a) $t/4$ b) $t/2$
c) $2t$ d) $4t$

84. Clay layer A with single drainage and coefficient of consolidation C_v takes 6 months to achieve 50% consolidation. The time taken by clay layer B of the same thickness with double drainage and coefficient of consolidation $C_v/2$ to achieve the same degree of consolidation is
a) 3 months b) 6 months
c) 12 months d) 24 months

85. Coefficient of consolidation for clays normally
a) decreases with increase in liquid limit
b) increases with increase in liquid limit
c) first increases and then decreases with increase in liquid limit
d) remains constant at all liquid limits

86. Direct measurement of permeability of the specimen at any stage of loading can be made
a) only in fixed ring type consolidometer
b) only in floating ring type consolidometer
c) both (a) and (b)
d) none of the above

87. 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 the above

88. Select the correct statement.
    a) coefficient of compressibility of an over-consolidated clay is less than that of a normally consolidated clay
    b) coefficient of compressibility of an over-consolidated clay is greater than that of a normally consolidated clay
    c) coefficient of compressibility is constant for any clay
    d) none of the above

89. Coefficient of compressibility is
    a) constant for any type of soil
    b) different for different types of soils and also different for a soil under different states of consolidation
    c) different for different types of soils but same for a soil under different states of consolidation
    d) independent of type of soil but depends on the stress history of soil

90. The ultimate consolidation settlement of a structure resting on a soil
    a) decreases with the increase in the initial voids ratio
    b) decreases with the decrease in the plastic limit
    c) increases with the increase in the initial voids ratio
    d) increases with the decrease in the porosity of the soil

91. The ultimate consolidation settlement of a soil is
    a) directly proportional to the voids ratio
    b) directly proportional to the compression index
    c) inversely proportional to the compression index
    d) none of the above

92. A normally consolidated clay settled 10 mm when effective stress was increased from 100 kN/m^2 to 200 kN/m^2. If the effective stress is further increased from 200 kN/m^2 to 400 kN/m^2, then the settlement of the same clay is
    a) 10 mm
    b) 20 mm
    c) 40 mm
    d) none of the above

93. Coarse grained soils are best compacted by a
    a) drum roller
    b) rubber tyred roller
    c) sheep's foot roller
    d) vibratory roller

94. With the increase in the amount of compaction energy
    a) optimum water content increases but maximum dry density decreases
    b) optimum water content decreases but maximum dry density increases
    c) both optimum water content and maximum dry density increase
    d) both optimum water content and maximum dry density decrease

[ES 93]

95. The maximum dry density upto which any soil can be compacted depends upon
    a) moisture content only
    b) amount of compaction energy only
    c) both moisture content and amount of compaction energy
    d) none of the above

96. Relationship between dry density T_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) $\gamma_d = \dfrac{(1-n_a)G\gamma_w}{1-wG}$

97. For better strength and stability, the fine grained soils and coarse grained soils are compacted respectively as
    a) dry of OMC and wet of OMC
    b) wet of OMC and dry of OMC

c) wet of OMC and wet of OMC
d) dry of OMC and dry of OMC

where OMC is optimum moisture content

98. Select the incorrect statement.
a) effective cohesion of a soil can never have a negative value.
b) effective angle of internal friction for coarse grained soils is rarely below 30°.
c) effective angle of internal friction for a soil increases as state of compactness increases.
d) effective angle of internal friction is a complicated function of mineralogy and clay size content.

99. For a loose sand sample and a dense sand sample consolidated to the same effective stress
a) ultimate strength is same and also peak strength is same
b) ultimate strength is different but peak strength is same
c) ultimate strength is same but peak strength of dense sand is greater than that of loose sand
d) ultimate strength is same but peak strength of loose sand is greater than that of dense sand.

100. The shear strength of a soil
a) is directly proportional to the angle of internal friction of the soil
b) is inversely proportional to the angle of internal friction of the soil
c) decreases with increase in normal stress
d) decreases with decrease in normal stress

101. In a consolidated drained test on a normally consolidated clay, the volume of the soil sample during shear
a) decreases
b) increases
c) remains unchanged
d) first increases and then decreases

102. Skempton's pore pressure coefficient B for saturated soil is
a) 1
b) zero
c) between 0 and 1
d) greater than 1 [CS 95]

103. Shear strength of a soil is a unique function of
a) effective stress only
b) total stress only
c) both effective stress and total stress
d) none of the above

104. In a deposit of normally consolidated clay
a) effective stress increases with depth but water content of soil and undrained strength decrease with depth
b) effective stress and water content increase with depth but undrained strength decreases with depth
c) effective stress and undrained strength increase with depth but water content decreases with depth
d) effective stress, water content and undrained strength decreases with depth

105. Select the incorrect statement.
Effective angle of shearing resistance
a) increases as the size of particles increases
b) increases as the soil gradation improves
c) is limited to a maximum value of 45°
d) is rarely more than 30° for fine grained soil

106. Unconfined compressive strength test is
a) undrained test
b) drained test
c) consolidated undrained test
d) consolidated drained test

107. A cylindrical specimen of saturated soil failed under an axial vertical stress of 100 kN/m^2 when it was laterally unconfined. The failure plane was inclined to the horizontal plane at an angle of 45°. The values of cohesion and angle of internal friction for the soil are respectively:

a) 0.5 N/mm^2 and 30°
b) 0.05 N/mm^2 and 0°
c) 0.2 N/mm^2 and 0°
d) 0.05 N/mm^2 and 45°

108. In an unconfined compression test on a clay specimen of initial volume V and length L, the area of cross-section at failure is taken as

a) $\frac{V}{L-\Delta L}$ b) $\frac{V+\Delta V}{L-\Delta L}$

c) $\frac{V-\Delta V}{L-\Delta L}$ d) $\frac{V}{L+\Delta L}$

where ΔL is the change in length and ΔV is change in volume

109. The angle that Coulomb's failure envelope makes with the horizontal is called
a) cohesion
b) angle of internal friction
c) angle of repose
d) none of the above

110. In a triaxial compression test on a soil specimen, the intermediate principal stress is equal to
a) major principal stress
b) minor principal stress
c) difference between major and minor principal stresses
d) none of the above

111. If a cohesive soil specimen is subjected to a vertical compressive load, the inclination of the cracks to the horizontal is
a) 90° b) 45°
c) 22.5° d) 0°

112. Select the incorrect statement.
a) in a direct shear box test, the plane of shear failure is predetermined.
b) better control is achieved on the drainage of the soil in a triaxial compression test.
c) stress distribution on the failure plane in the case of triaxial compression test is uniform.
d) unconfined compression test can be carried out on all types of soils.

113. If the shearing stress is zero on two planes, then the angle between the two planes is
a) 45° b) 90°
c) 135° d) 225°

114. In the triaxial compression test, the application of additional axial stress (i.e. deviator stress) on the soil specimen produces shear stress on
a) horizontal plane only
b) vertical plane only
c) both horizontal and vertical planes
d) all planes except horizontal and vertical planes

115. The state of stress on a plane inclined at an angle of 45° to the horizontal plane is represented on the Mohr's circle by a point at which
a) normal stress is $\frac{\sigma_1+\sigma_3}{2}$ and shear stress is $\frac{\sigma-\sigma_3}{2}$
b) normal stress is $\frac{\sigma_1-\sigma_3}{2}$ and shear stress is $\frac{\sigma_1+\sigma_3}{2}$
c) normal stress is $\frac{\sigma_1+\sigma_3}{2}$ and shear stress is zero
d) both normal stress and shear stress are equal

where σ_1 and σ_3 are major and minor principal stresses respectively

116. In a triaxial compression test when drainage is allowed during the first stage (i.e. application of cell pressure) only and not during the second stage (i.e. application of deviator stress at constant cell pressure), the test is known as
a) consolidated drained test
b) consolidated undrained test
c) unconsolidated drained test
d) unconsolidated undrained test

117. When a soil sample is subjected to a uniformly distributed fluid pressure only, in a triaxial compression test, the Mohr's representation of the state of stress on sample is

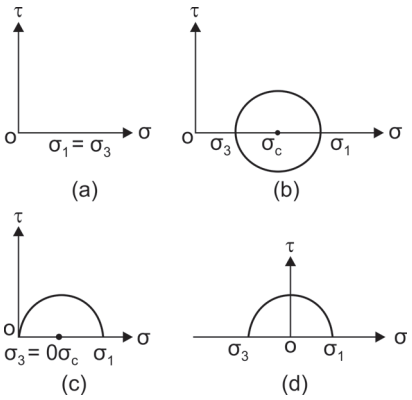


Fig. 8.1.

118. When a sample of sand is sheared under undrained condition, then
   a) volume of dense sand increases and that of loose sand decreases
   b) volume of dense sand decreases and that of loose sand increases
   c) volume of both dense sand and loose sand decreases
   d) volume does not change

119. The ratio of the undisturbed shear strength to the remoulded shear strength in cohesive soils under undrained conditions is
   a) zero
   b) 1
   c) greater than 1
   d) between 0 and 1

120. During the first stage of biaxial test when the cell pressure is increased from 0.10 N/mm^2 to 0.26 N/mm^2, the pore water pressure increases from 0.07 N/mm^2 to 0.15 N/mm^2. Skempton's pore pressure parameter B is
   a) 0.5 b) – 0.5
   c) 2.0 d) – 2.0

121. Sensitivity of a soil can be defined as
   a) percentage of volume change of soil under saturated condition
   b) ratio of compressive strength of unconfined undisturbed soil to that of soil in a remoulded state
   c) ratio of volume of voids to volume of solids
   d) none of the above

122. Rankine's theory of earth pressure assumes that the back of the wall is
   a) plane and smooth
   b) plane and rough
   c) vertical and smooth
   d) vertical and rough

123. The coefficient of active earth pressure for a loose sand having an angle of internal friction of 30° is
   a) 1/3 b) 3
   c) 1 d) 1/2

124. The major principal stress in an element of cohesionless soil within the backfill of a retaining wall is
   a) vertical if the soil is in an active state of plastic equilibrium
   b) vertical if the soil is in a passive state of plastic equilibrium
   c) inclined at 45° to the vertical plane
   d) none of the above

125. Passive earth pressure in a soil mass is proportional to
   a) $\tan^2\left(45° + \frac{\phi}{2}\right)$ b) $\frac{\mu}{(1-\mu)}$
   c) $\tan^2\left(45° - \frac{\phi}{2}\right)$ d) $\cot^2\left(45° + \frac{\phi}{2}\right)$

   where μ is Poisson's ratio and ϕ is the effective angle of internal friction of soil.

126. The effect of cohesion on a soil is to
   a) reduce both the active earth pressure intensity and passive earth pressure intensity
   b) increase both the active earth pressure intensity and passive earth pressure intensity
   c) reduce the active earth pressure intensity but to increase the passive earth pressure intensity
   d) increase the active earth pressure intensity but to reduce the passive earth pressure intensity

[GATE 99]

127. A retaining wall 6 m high supports a backfill with a surcharge angle of 10°. The back of the wall is inclined to the vertical at a positive batter angle of 5°. If the angle of wall friction is 7°, then the resultant active earth pressure will act at a distance of 2 m above the base and inclined to the horizontal at an angle of

a) 7° b) 10°
c) 12° d) 17°

128. Coefficient of earth pressure at rest is

a) less than active earth pressure but greater than passive earth pressure
b) greater than active earth pressure but less than passive earth pressure
c) greater than both the active earth pressure and passive earth pressure
d) less than both the active and passive earth pressures

129. If the top surface of the backfill of a retaining wall is inclined to the horizontal at an angle β, then the coefficient of passive earth pressure is equal to

a) $\dfrac{\cos\beta\left(\cos\beta-\sqrt{\cos^2\beta-\cos^2\phi}\right)}{\cos\beta+\sqrt{\cos^2\beta-\cos^2\phi}}$

b) $\dfrac{\cos\beta\left(\cos\beta+\sqrt{\cos^2\beta-\cos^2\phi}\right)}{\cos\beta-\sqrt{\cos^2\beta-\cos^2\phi}}$

c) $\dfrac{\cos\beta+\sqrt{\cos^2\beta-\cos^2\phi}}{\cos\beta\left(\cos\beta-\sqrt{\cos^2\beta-\cos^2\phi}\right)}$

d) $\dfrac{\cos\beta-\sqrt{\cos^2\beta-\cos^2\phi}}{\cos\beta\left(\cos\beta+\sqrt{\cos^2\beta-\cos^2\phi}\right)}$

where ϕ is the angle of internal friction of soil

130. The critical height of an unsupported vertical cut in a cohesive soil is given by

a) $\dfrac{4C}{\gamma}\tan\left(45°+\dfrac{\phi}{2}\right)$

b) $\dfrac{2C}{\gamma}\tan\left(45°+\dfrac{\phi}{2}\right)$

c) $\dfrac{4C}{\gamma}\cot\left(45°+\dfrac{\phi}{2}\right)$

d) $\dfrac{2C}{\gamma}\cot\left(45°+\dfrac{\phi}{2}\right)$

where C = unit cohesion

ϕ = angle of internal friction

γ = unit weight of soil

131. Total lateral earth pressure is proportional to

a) depth of soil
b) square of depth of soil
c) angle of internal friction of soil
d) none of above

132. Cohesive soils are

a) good for backfill because of low lateral pressure
b) good for backfill because of high shear strength
c) poor for backfill because of large lateral pressure
d) none of the above

133. Which of the following earth pressure theories is directly applicable to bulkheads?

a) Rankine's theory
b) Coulomb's theory
c) both
d) none of the above

134. Taylor's stability number is equal to

a) $\dfrac{C}{F_c H}$ b) $\dfrac{C}{F_c\gamma H_c}$

c) $\dfrac{C}{\gamma H}$ d) $\dfrac{C}{\gamma H_c}$

where C = unit cohesion

F_c = factor of safety with respect to cohesion

γ = unit weight of soil

H_c = critical height

H = actual height

135. For a base failure, the depth factor D_f is
a) zero b) 1
c) $0 < D_f < 1$ d) $D_f > 1$

136. Base failure of a finite slope
a) occurs when soil below the level of toe is strong
b) occurs when there is a relatively weak zone in upper part of the slope
c) occurs when the soil below the toe is relatively soft and weak
d) is a most common failure and occurs in relatively steep slopes

137. Bishop's method of stability analysis
a) is more conservative
b) neglects the effect of forces acting on the sides of the slices
c) assumes the slip surface as an arc of a circle
d) all of the above

138. Allowable bearing pressure for a foundation depends upon
a) allowable settlement only
b) ultimate bearing capacity of soil only
c) both allowable settlement and ultimate bearing capacity
d) none of above

139. According to Rankine's analysis, minimum depth of foundation is equal to

a) $\frac{q}{\gamma}\left(\frac{1+\sin\phi}{1-\sin\phi}\right)^2$ b) $\frac{q}{\gamma}\left(\frac{1-\sin\phi}{1+\sin\phi}\right)^2$

c) $\frac{q}{\gamma}\left(\frac{1+\sin\phi}{1-\sin\phi}\right)$ d) $\frac{q}{\gamma}\left(\frac{1-\sin\phi}{1+\sin\phi}\right)$

where q = intensity of loading
γ = unit weight of soil
ϕ = angle of internal friction

140. According to *Terzaghi's theory*, the ultimate bearing capacity at ground surface for a purely cohesive soil and for a smooth base of a strip footing is
a) 2.57 C b) 5.14 C
c) 5.7C d) 6.2 C
where C = unit cohesion of soil

141. The net ultimate bearing capacity of a purely cohesive soil
a) depends on width of footing and is independent of depth of footing
b) depends on depth of footing and is independent of width of footing
c) depends on both depth and width of footing
d) is independent of both depth and width of footing

142. The rise of water table below the foundation influences the bearing capacity of soil mainly by reducing
a) cohesion and effective angle of shearing resistance
b) cohesion and effective unit weight of soil
c) effective unit weight of soil and effective angle of shearing resistance
d) effective angle of shearing resistance

143. Terzaghi's general bearing capacity formula for a strip footing
$(C N_c + \gamma D N_q + 0.5 \gamma N_\gamma B)$ gives
a) safe bearing capacity
b) net safe bearing capacity
c) ultimate bearing capacity
d) net ultimate bearing capacity
where
C = unit cohesion
γ = unit weight of soil
D = depth of foundation
B = width of foundation
N_c, N_q, N_γ = bearing capacity factors

144. Terzaghi's bearing capacity factors N_c, N_q and N_γ are functions of
a) cohesion only
b) angle of internal friction only
c) both cohesion and angle of internal friction
d) none of the above

145. In the plate loading test for determining the bearing capacity of soil, the size of square bearing plate should be
a) less than 300 mm
b) between 300 mm and 750 mm
c) between 750 mm and 1 m
d) greater than 1 m

146. Select the incorrect statement.
a) bearing capacity of a soil depends upon the amount and direction of load.
b) bearing capacity of a soil depends on the type of soil.
c) bearing capacity of a soil depends upon shape and size of footing.
d) bearing capacity of a soil is independent of rate of loading.

147. A 600 mm square bearing plate settles by 15 mm in plate load test on a cohesionless soil under an intensity of loading of 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) between 15 mm and 25 mm
c) 25 mm
d) greater than 25 mm

148. 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

149. Rise of water table in cohesionless soils upto ground surface reduces the net ultimate bearing capacity approximately by
a) 25% b) 50%
c) 75% d) 90%

150. Contact pressure beneath a rigid footing resting on cohesive soil is
a) less at edges compared to middle
b) more at edges compared to middle
c) uniform throughout
d) none of the above

151. According to IS specifications, the minimum depths of foundation in sand and clay should be respectively
a) 600 mm and 700 mm
b) 800 mm and 900 mm
c) 1 m and 800 mm
d) 1 m and 1.2 m

152. The maximum differential settlement in isolated footings on clayey soils should be limited to
a) 25 mm b) 40 mm
c) 65 mm d) 100 mm

153. A combined footing is generally used when
a) number of columns is more than two and they are spaced far apart
b) number of columns is two and they are spaced close to each other
c) number of columns is two and they are spaced far apart
d) there is only one column

154. Negative skin friction on a pile
a) acts downward and increases the load carrying capacity of the pile
b) acts upward and increases the load carrying capacity of the pile
c) acts downward and reduces the load carrying capacity of the pile
d) acts upward and reduces the load carrying capacity of the pile

155. A single acting steam hammer weighing 22.5 kN and falling through a heignt of 1.2 m drives a pile. If the final set is 12.5 mm, then according to Engineering News formula
a) allowable load for the pile is 300 kN
b) ultimate bearing capacity of the pile is 300 kN
c) allowable load for the pile is 120 kN
d) ultimate bearing capacity of the pile is 120 kN

156. Generally the bearing capacity of a pile group is
a) equal to the sum of bearing capacities of individual piles in case of friction piles
b) equal to the sum of bearing capacities of individual piles in case of end bearing piles
c) less than the sum of bearing capacities of individual piles in case of end bearing piles
d) greater than the sum of bearing capacities of individual piles in case of friction or end bearing piles.

157. The settlement of a group of friction piles as compared to that of a single pile is
a) same
b) less
c) more
d) none of the above

158. Select the correct statement.
a) Both negative skin friction and skin frictional resistance are caused by relative settlement of soil.
b) Both negative skin friction and skin frictional resistance are caused by relative settlement of pile.
c) Negative skin friction is caused by relative settlement of soil and skin frictional resistance is caused by relative settlement of pile.
d) Negative skin friction is caused by relative settlement of pile and skin frictional resistance is caused by relative settlement of soil.

159. Select the incorrect statement.
a) Static formulae are suitable for friction piles driven through cohesive soils.
b) Dynamic formulae are most suitable for friction piles driven through cohesive soils.
c) Dynamic formulae are suitable for friction piles driven through cohesionless soils.
d) Dynamic formulae do not take into account the reduced bearing capacity of a pile in a group.

160. Mechanical stabilization of soil is done with the help of
a) cement b) lime
c) bitumen d) proper grading

161. Lime stabilisation is very effective in treating
a) sandy soils
b) silty soils
c) non-plastic soils
d) plastic clayey soils

162. Undisturbed samples are obtained by
a) direct excavations
b) thin-walled samplers
c) thick-walled samplers
d) augers

163. Select the correct statement.
a) Stationary piston sampler and rotary sampler are both thick-walled samplers.
b) Stationary piston sampler and rotary sampler are both thin-walled samplers.
c) Stationary piston sampler is a thick-walled sampler and rotary sampler is a thin-walled sampler.
d) Stationary piston sampler is a thin-walled sampler and rotary sampler is a thick-walled sampler.

164. The curves A, B and C shown in Fig. 8.2 are respectively the stress-strain curves for

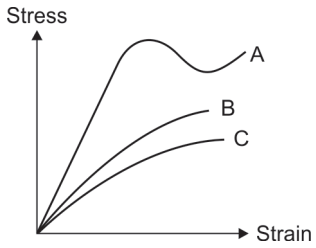


Fig. 8.2

a) dense sand, clay and loose sand
b) dense sand, loose sand and clay
c) loose sand, dense sand and clay
d) clay, loose sand and dense sand

165. Greater skin friction
a) retards the sinking of well
b) accelerates the sinking of well
c) does not affect the sinking of well
d) none of the above

166. The bearing capacity of a strip footing on a saturated clay is 120 kN/m^2. The bearing capacity of a circular footing (diameter = width) will be
a) more than 120 kN/m^2
b) equal to 120 kN/m^2
c) less than 120 kN/m^2
d) any of the above

167. A plate load test is useful to estimate
a) bearing capacity of foundation
b) settlement of foundation

c) both bearing capacity and settlement of foundation
d) none of the above

168. The radius of friction circle or ϕ-circle in friction circle method is
a) r b) $r \sin \phi$
c) $r \cos \phi$ d) $r \tan \phi$
where r is the radius of failure arc
[ES 94]

*169. The largest value of stability number is
a) 0.261 b) 0.5
c) 1.0 d) 2.0

170. 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

171. For an anisotropic soil, permeabilities in x and y directions are K_x and K_y respectively in a two dimensional flow. The effective permeability K_{eq} for the soil is given by:
a) $K_x + K_y$ b) K_x/K_y
c) $(K_x^2 + K_y^2)^{1/2}$ d) $(K_x K_y)^{1/2}$
[GATE 99]

*172. For sand of uniform spherical particles, the ratio of void ratios in the loosest and the densest states is:
a) 2.6 b) 3.5
c) 4.6 d) 3.0 [GATE 91]

173. The description of 'sandy silty clay' signifies that
a) the soil contains unequal proportions of the three constituents, in the order sand > silt > clay
b) the soil contains equal proportions of sand, silt and clay
c) the soil contains unequal proportions of sand, silt and clay.
d) the soil contains unequal proportions of the three constituents such that clay > silt > sand. [GATE 92]

174. Increasing the depth of foundation in saturated clays results in an increased ultimate bearing capacity for strip footings
a) because the bearing capacity factor N_γ decreases.
b) because the bearing capacity factor N_c, increases as the depth increases.
c) the term in the bearing capacity equation qN_q, increases with depth.
d) because the angle of internal friction decreases as the depth of foundation increases. [GATE 92]

175. A soil having particles of nearly the same size is known as:
a) well graded
b) uniformly graded
c) poorly graded
d) gap graded [GATE 95]

176. The unit weight of a soil at zero air voids depends on:
a) specific gravity
b) water content
c) unit weight of water
d) all the above [GATE 95]

177. The soils most susceptible to liquefaction are
a) saturated dense sands
b) saturated fine and medium sands of uniform particle size
c) saturated clays of uniform size
d) saturated gravels and cobbles
[GATE 96]

178. The value of bearing capacity factor for cohesion N_c, for piles as per Meyerhof is taken as
a) 6.2 b) 9.0
c) 5.14 d) 5.17
[GATE 96]

179. The slope of the e-log p curve for a soil mass gives
a) coefficient of permeability, k
b) coefficient of consolidation, C_v
c) compression index, C_c
d) coefficient of volume co-mpressibility, m_v
[GATE 97]

180. If r = frequency ratio, D = damping ratio, then magnification factor in a damped forced vibration is equal to:

a) $1/\sqrt{(1-r^2)^2+4r^2D^2}$

b) $1/\sqrt{(1-r^2)^2+4Dr}$

c) $1/\sqrt{(1-r^2)^2-4r^2D^2}$

d) $1/\sqrt{(1+r^2)^2-4r^2D^2}$

181. Degree of freedom of a block type machine foundation is

a) 2 b) 3
c) 4 d) 6

*182. Given that damping ratio = 0.10 and damping coefficient = 225 kN sec/m. Then the critical damping coefficient in kN sec/m will be

a) 22.5 b) 225
c) 2250 d) 22500

183. The natural frequency of a vibrating foundation system

(i) increases as the square root of the spring stiffness
(ii) decreases with the square root of the spring stiffness
(iii) increases as the square root of the mass of the body
(iv) decreases with the square root of the mass of the body

Of these statements:

a) (i) and (iii) are correct
b) (i) and (iv) are correct
c) (ii) and (iii) are correct
d) (ii) and (iv) are correct

184. In case of free over damped vibration,

a) $C=\sqrt{\text{k.m}}$

b) $C=2\sqrt{\text{k.m}}$

c) $C>2\sqrt{\text{k.m}}$

d) $C<2\sqrt{\text{k.m}}$

185. As per converse Labarre formula, group efficiency of friction piles is given by:

a) $1-\frac{\alpha}{90}\left[\frac{(n-1)\,m+(m-1)\,n}{mn}\right]$

b) $1-\frac{\alpha}{90}\left[\frac{(n+1)\,m+(m+1)\,n}{mn}\right]$

c) $1-\frac{\alpha}{90}\left[\frac{(n-1)\,m-(m-1)\,n}{mn}\right]$

d) $1-\frac{\alpha}{90}\left[\frac{(n+1)\,m-(m+1)\,n}{mn}\right]$

where

m = number of columns

n = number of rows

$\alpha = \tan^{-1}(d/s)$ (in degree)

d = diameter of pile

s = c/c spacing of pile

186. The correct increasing order of the surface areas of the given soils is

a) silt, sand, colloids, clay
b) sand, silt, colloids, clay
c) sand, silt, clay, colloids
d) clay, silt, sand, colloids [CS 93]

*187. For a given soil sample,

C_c = coefficient of gradation

C_u = coefficient of uniformity

D_{10} = effective size

D_{30} = diameter through which 30 per cent of the total soil mass is passing

If $C_c = 1.0$ and $C_u = 4.0$, then the value of D_{30}/D_{10} would be

a) 2.00 b) 1.75
c) 1.50 d) 1.25 [CS 93]

188. Match List I with List II and select the correct answer using the codes given below the Lists.

List I (Name of person)	List II (Field of contribution)
A. Stoke	1. flow through capaillary
B. Darcy	2. classification of soils
C. Poiseuille	3. consistency limits
D. Atterberg	4. flow of water through a soil mass
	5. velocity of settling particle

Codes:

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

[CS 93]

189. In a standard Proctor compaction, the water content (w) and maximum dry density (γ_{dmax}) are related as:
a) γ_{dmax} is linearly proportional to w
b) w is inversely proportional to γ_{dmax}
c) γ_{dmax} corresponds to a unique value of w
d) γ_{dmax} corresponds to $w = (w_p + w_L)/2$
where w_p and w_L are respectively plastic and liquid limits.

[CS 93]

190. Using Mohr's diagram, the relation between major principal stress σ_1 and minor principal stress σ_3, and shear parameters c and ϕ is given by
$\sigma_1 = \sigma_3 N_\phi + 2c\sqrt{N_\phi} \cdot \sigma_q$ where N_ϕ is equal to
a) $\sin\phi/(1 + \sin\phi)$
b) $\sin\phi/(1 - \sin\phi)$
c) $(1 - \sin\phi)/(1 + \sin\phi)$
d) $(1 + \sin\phi)/(1 - \sin\phi)$

[CS 93]

191. A and B are Skempton's pore pressure parameters and $\Delta\sigma_1$ and $\Delta\sigma_3$ are incremental principal stresses. Skempton's pore pressure equation is given by
a) $\Delta u = A[\Delta\sigma_3 + B(\Delta\sigma_1 - \Delta\sigma_3)]$
b) $\Delta u = B[\Delta\sigma_3 + A(\Delta\sigma_1 - \Delta\sigma_3)]$
c) $\Delta u = A[\Delta\sigma_3 + B(\Delta\sigma_1 + \Delta\sigma_3)]$
d) $\Delta u = B[\Delta\sigma_3 + A(\Delta\sigma_1 + \Delta\sigma_3)]$

[CS 93]

192. The total settlement of a compressible soil stratum 2 m deep and having a coefficient of volume compressibility of 0.02 cm^2/ kg under a pressure increment of 2 kg/cm^2 will be
a) 2 cm
b) 4 cm
c) 8 cm
d) 10 cm

[CS 93]

193. Given that for a single degree of freedom system,
k = stiffness coefficient
m = mass of machine and foundation, critical damping is best defined by the expression
a) $2\sqrt{km}$ b) $2k\sqrt{m}$
c) $2\pi k\sqrt{\frac{1}{m}}$ d) $\frac{1}{2\pi}\sqrt{\frac{k}{m}}$

[CS 93]

*194. The relationship between water content (w%) and number of blows (N) in soils, as obtained from Casagrande's liquid limit device, is given by
$w = 20 - \log_{10} N$
The liquid limit of the soil is
a) 15.6%
b) 16.6%
c) 17.6%
d) 18.6% [CS 94]

195. The results (curves A, B, C and D) of four compaction tests on different soils are shown in Fig. 8.3.

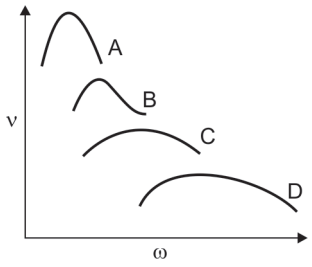


Fig. 8.3

Tests
(1) silty sand, modified test
(2) silty sand, standard test
(3) fat clay, modified test
(4) fat clay, standard test

Curves A, B, C and D correspond respectively to tests.

a) (l), (3), (2) and (4)
b) (l), (2), (3) and (4)
c) (2), (1), (3) and (4)
d) (2), (1), (4) and (3)

[CS 94]

196. The results of a consolidated drained triaxial shear test on a normally consolidated clay are shown in Fig. 8.4.

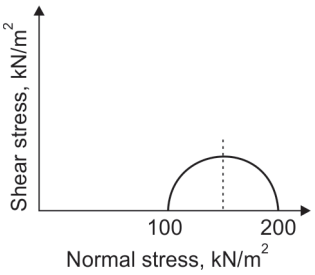


Fig. 8.4

The angle of internal friction is

a) $\sin^{-1}\left(\frac{1}{3}\right)$

b) $\sin^{-1}\left(\frac{1}{2}\right)$

c) $\sin^{-1}\left(\frac{2}{3}\right)$

d) $\sin^{-1}\left(\frac{1}{\sqrt{2}}\right)$

[CS 94]

197. Which one of the following statements 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 consolidation cannot be ensured.

[CS 94]

198. Match List I with List II and select the correct answer using the codes given below the Lists.

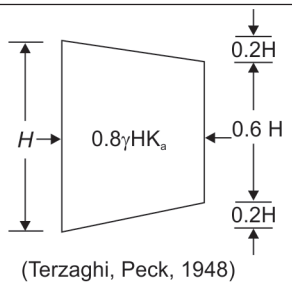
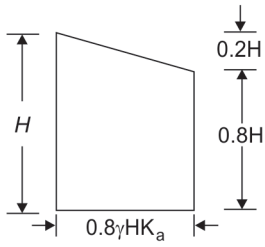
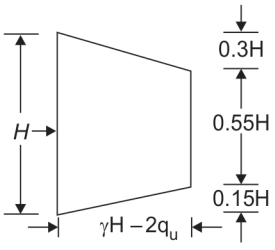
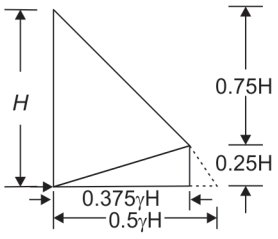
List I (Pressure distribution for strutted excavation of foundation trench)	List II (Soil type)
A.  (Terzaghi, Peck, 1948)	1. Dense sand
B.  (Terzaghi, Peck, 1948)	2. Moderately stiff clay
C.  (Terzaghi, Peck, 1948)	3. Loose sand
D.  (Tschebetoriff, 1973)	4. Plastic clay

Fig. 8.5

Codes:

	A	B	C	D
a)	1	3	4	2

b) A B C D
4 2 1 3
c) A B C D
2 4 3 1
d) A B C D
1 2 3 4
[CS 94 & ES 93]

*199. Two specimens of clay A and B are tested in a consolidation apparatus.
If $(m_v)_A = 3.6 \times 10^{-4}$ m²/kN and
$(m_v)_B = 1.8 \times 10^{-4}$ m²/kN
$(C_v)_A = 3.8 \times 10^{-4}$ cm²/s
$(C_v)_B = 1.9 \times 10^{-4}$ cm²/s
then the ratio k_A/k_B is equal to
a) 0.0625 b) 0.25
c) 1.0 d) 4.0 [CS 94]

200. Terzaghi's equation of ultimate bearing capacity for a strip footing may be used for square footing resting on pure clay soil with the correction factor
a) 0.4 b) 0.6
c) 1.2 d) 1.3 [CS 94]

201. Match List I with List II and select the correct answer using the codes given below the Lists.

List I (Bearing capacity terms)	List II (Definition)
A. ultimate bearing capacity	1. net loading intensity at which neither soil fails in shear nor is there any excessive settlement
B. net safe bearing capacity	2. the maximum pressure which soil can carry safely without risk of shear failure
C. safe bearing capacity	3. net ultimate bearing capacity divided by factor of safety
D. allowable bearing pressure	4. minimum gross pressure intensity at the base of foundation at which soil fails in shear

Codes:
a) A B C D
4 3 2 1
b) A B C D
2 1 4 3
c) A B C D
4 2 3 1
d) A B C D
2 1 3 4 [CS 94]

202. A building is supported on shallow foundation in sand at 1 m below ground level. The water table is at 5 m below the ground surface. For which one of the following foundations will the net bearing capacity of the soil be a maximum?
a) 2 m wide strip footing
b) 2 m × 2 m square footing
c) 2 m diameter circular footing
d) 4 m × l m rectangular footing
[CS 94]

203. The determination of ultimate bearing capacity on an eccentrically loaded square footing depends upon the concept of useful
a) square
b) width
c) triangle
d) circle
[CS 94]

204. Figure 8.6 shows the contact pressure distribution in pure clayey soil subjected to a uniformly distributed load (udl) through rigid footing (placed on the surface).

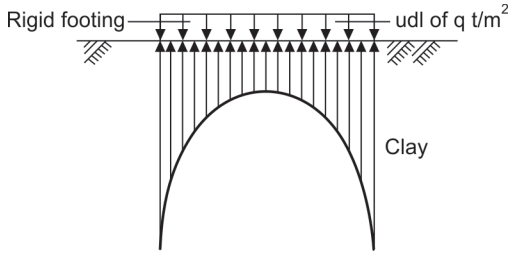


Fig. 8.6

Which of the following would cause the contact pressure distribution maximum at

the centre and decrease towards the outer edges leading to parabolic shape?

(1) when udl is transmitted through rigid footing placed on the surface of a cohesionless soil.
(2) when udl is transmitted through flexible footing placed on the surface of a cohesive soil.
(3) when udl is transmitted through flexible footing placed on the surface of a pure clay.

Select the correct answer using the codes given below.

Codes:

a) (1), (2) and (3)
b) (1) and (2)
c) (2) and (3)
d) (1) alone [CS 94]

*205. A *cast-in situ* bored pile 0.50 m diameter and 10 m deep is placed in a purely cohesive soil. If the cohesion of the soil is 4 t/m^2 and adhesion between the pile and the soil is half the value of cohesion, then the ultimate bearing capacity of the pile is given by

a) $\frac{19\pi}{4}$ tonnes
b) $\frac{29\pi}{4}$ tonnes
c) $\frac{39\pi}{4}$ tonnes
d) $\frac{49\pi}{4}$ tonnes [CS 94]

*206. A test concrete block is subjected to vertical vibration and resonance occurred at a frequency of 20 cycles per second. If mass of vibration is 6 kg and mass of foundation is 244 kg, then the coefficient of elastic uniform compression of soil is given by

a) $4\pi^2 \times 10^2$ kg/m^3
b) $4\pi^2 \times 10^3$ kg/m^3
c) $4\pi^2 \times 10^4$ kg/m^3
d) $4\pi^2 \times 10^5$ kg/m^3 [CS 94]

207. Match List I and List II and select the correct answer using the codes given below the Lists.

List I (Property of soil)	List II (Laboratory equipment)
A. grain size	1. pycnometer
B. specific gravity	2. permeameter
C. coefficient of permeability	3. vane shear apparatus
D. cohesion	4. pipette
	5. sand pouring cylinder

Codes:

	A	B	C	D	
a)	4	1	2	3	
b)	4	5	2	3	
c)	5	1	2	4	
d)	1	5	3	2	[CS 95]

208. The upstream slope of an earth dam under steady seepage condition is

a) equipotential line b) phreatic line
c) flow-line d) seepage line [CS 95]

209. Consider the following statements related to triaxial test:

(1) failure occurs along predetermined plane.
(2) intermediate and minor principal stresses are equal.
(3) volume changes can be measured.
(4) field conditions can be simulated.

Of these statements

a) (1), (2) and (3) are correct
b) (1), (2) and (4) are correct
c) (1), (3) and (4) are correct
d) (2), (3) and (4) are correct [CS 95]

*210. A vane 20 cm long and 10 cm in diameter was pressed into a soft marine clay at the bottom of a bore hole. Torque was applied gradually and failure occurred at 1000 kg/cm. The cohesion of the clay in kg/cm^2 is:

a) $\frac{1}{\pi} \times \frac{6}{7}$ b) $\frac{1}{\pi} \times \frac{5}{7}$

c) $\frac{1}{\pi} \times \frac{4}{7}$ d) $\frac{1}{\pi} \times \frac{3}{7}$ [CS 95]

211. Match List I with List II and select the correct answer using the codes given below the Lists.

	List I		List II
A.	active pressure	1.	wall moves towards backfill
B.	passive pressure	2.	no movement of wall
C.	earth pressure at rest	3.	wall moves away from backfill

Codes:

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

[CS 95]

212. A cohesionless soil having an angle of shearing resistance of ϕ, is standing at a slope angle of i. The factor of safety of the slope is

a) $\frac{\tan i}{\tan \phi}$ b) $\tan i - \tan \phi$

c) $\frac{\tan \phi}{\tan i}$ d) $\tan \phi - \tan i$

[CS 95]

213. Match List I with List II and select the correct answer using the codes given below the Lists.

	List I (Cause)		List II (Effect)
A.	water present in the soil above water table	1.	increase in effective stress
B.	upward seepage flow	2.	no change in effective stress
C.	downward seepage flow	3.	water is in a state of tension
D.	fluctuation of water level ground level	4.	decrease in effective stress

Codes:

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

[CS 95]

214. In consolidation testing, curve fitting method is used to determine

a) compression index
b) swelling index
c) coefficient of consolidation
d) time factor [CS 95]

215. Westergaard's analysis for stress distribution beneath loaded areas is applicable to

a) sandy soils b) clayey soils
c) stratified soils d) silty soils

[CS 95]

216. Consider the following characteristics of soil layer:

(1) Poisson's ratio
(2) Young's modulus
(3) finite nature of soil layer
(4) effect of water table
(5) rigidity of footing

Westergaard's analysis for pressure distribution in soils utilises

a) (1), (3), (4) and (5)
b) (2), (3), (4) and (5)
c) (3), (4) and (5)
d) (1) and (2) [CS 95]

217. A square footing is to be proportioned on a cohesionless soil with an average N value of 40. The allowable bearing pressure of this footing will be governed by

a) general shear failure
b) local shear failure
c) progressive failure
d) settlement criteria [CS 95]

218. According to Skempton's formula for a surface footing of square shape, the net ultimate bearing capacity on a purely cohesive soil of cohesion c is
a) 1.4 c b) 6.0 c
c) 7.4 c d) 9.0 c [CS 95]

219. Undisturbed soil samples are required for conducting
a) hydrometer test
b) shrinkage limit test
c) consolidation test
d) specific gravity test
[CS 95]

220. Soil pressure distribution below a rigid footing on the surface of a cohesive soil is
a) maximum at the centre and minimum at edges
b) minimum at the centre and maximum at edges
c) uniform throughout
d) maximum at one end and minimum at the other end [CS 95]

221. 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) preconsolidation pressure of clay
[CS 96]

*222. When the degree of consolidation is 50%, the time factor is about
a) 0.2 b) 0.5
c) 1.0 d) 2.0
[CS 96]

223. According to Bousinesq's theory, the vertical stress at a point in a semi-infinite soil mass depends upon
a) point load, coordinates of the point and modulus of elasticity of soil
b) point load, coordinates of the point, modulus of elasticity of soil and its Poisson's ratio
c) point load and coordinates of the point
d) point load, coordinates of the point, modulus of elasticity of soil and its density [CS 96]

224. The process by which a mass of saturated soil is caused by external forces to suddenly lose its shear strength and to behave as a fluid is called
a) piping b) slide
c) quick condition d) liquefaction
[CS 96]

225. By using sieve analysis, the particle size distribution curve has been plotted for a particular soil. The coefficient of curvature C_c is given by
a) $\frac{D_{30}}{D_{30} \times D_{10}}$ b) $\frac{\sqrt{D_{30}}}{D_{60} \times D_{10}}$
c) $\frac{D_{30}}{\sqrt{D_{60} \times D_{10}}}$ d) $\frac{D_{30}^2}{D_{60} \times D_{10}}$
[CS 96]

226. Given below are methods of compaction:
(1) vibration technique
(2) flooding the soil
(3) sheep-foot roller
(4) tandem roller
(5) heavy weights dropped from a height
The methods suitable for cohesionless soils include
a) (1), (2) and (3) b) (2), (3) and (4)
c) (1), (2) and (5) d) (3), (4) and (5)
[CS 96]

227. Consider the following factors pertaining to flow through soil:
(1) hydraulic gradient
(2) grain size
(3) void ratio
(4) cross-sectional area of the sample
Of these, the factors affecting permeability include
a) (1) and (4)
b) (2) and (3)
c) (1), (2) and (3)
d) (2), (3) and (4) [CS 96]

228. Which one of the following, gives the correct decreasing order of the densities of a soil sample?
a) saturated, submerged, wet, dry
b) saturated, wet, submerged, dry
c) saturated, wet, dry, submerged
d) wet, saturated, submerged, dry [CS 96]

229. For sampling saturated sands and other soft and wet soils satisfactorily, the most suitable soil sampler is
a) open drive thin-walled tube sampler
b) standard split-spoon sampler
c) stationary piston sampler
d) rotary sampler [CS 96]

230. Match List I and List II and select the correct answer using the codes given below the Lists.

	List I (Condition under which it is suite)		List II (Type of foundation)
A.	when structural load is uniform and soil is soft clay, made up of marshy land	1.	footings
B.	when structural load is heavy and/or soil having low bearing capacityfor a considerable depth	2.	piles
C.	when soil is having good bearing capacity at shallow depth and structural load is within permissible limit	3.	raft
D.	when structural load of bridge is to be transferred through sandy soil to bed rock	4.	wells or pier

Codes:

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

[CS 96]

231. Figure 8.7 shows the relation between void ratio and shear strain for a sand under two density conditions. The void ratio corresponding to the dashed line is called as the

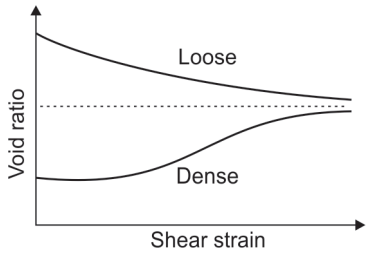


Fig. 8.7

a) optimum void ratio
b) critical void ratio
c) residual void ratio
d) undisturbed void ratio [CS 96]

232. A vane shear test on a soil sample gives moment of total resistance M. The shear stress failure, 'S' being more or less uniform at top, bottom and surface of cylinder of soil, is given by (where H = height of vane, D = Diameter of vane)

a) $S = \dfrac{2M}{\pi D^2 H}$

b) $S = \dfrac{2M}{\pi D^2 (H + D)}$

c) $S = \dfrac{2M}{\pi D^2 \left(H + \dfrac{D}{3}\right)}$

d) $S = \dfrac{2M}{\pi DH}$ [CS 96]

233. The following refer to the stability analysis of an earth dam under different conditions:
(1) stability of D/S slope during steady seepage
(2) stability of U/S slope during sudden drawdown
(3) stability of U/S and D/S slopes during construction

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 [CS 96]

234. If the settlement of a single pile in sand is denoted by S and that of a group of N identical piles (each pile carrying the same load) by S_g, then the ratio S_g/S will
a) be equal to 1 irrespective of width of the group
b) be equal to N irrespective of width of the group
c) decrease as the width of the group increases
d) increase as the width of the group increases [CS 96]

235. Match List I and List II containing terms related to vibration of damped single degree-of-freedom foundation system and select the correct answer using the codes given below the Lists.

List I		List II	
A.	critical damping coefficient	1.	$\frac{2\pi D}{\sqrt{1-D^2}}$
B.	damped circular frequency	2.	$\frac{\pi D^2}{\sqrt{1-D^2}}$
C.	logarithmic decrement	3.	$\sqrt{\frac{k}{m}}$
		4.	$2\sqrt{km}$
		5.	$\omega_n \sqrt{1-D^2}$
		6.	$\frac{\omega_n}{D}$

Codes:

a)	A	B	C
	3	5	1
b)	A	B	C
	3	6	2
c)	A	B	C
	4	5	1
d)	A	B	C
	4	6	2

[CS 96]

236. Match List I with List II and select the correct answer using the codes given below the Lists.

List I (Field test)		List II (Useful for)	
A.	vane shear test	1.	end bearing and skin friction resistance
B.	standard penetration test	2.	*In situ* stress-strain characteristics
C.	static cone penetration test	3.	soft clay
D.	pressure meter test	4.	sandy deposits

Codes:

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

[CS 96]

237. Consider the following statements regarding settlement of foundations:
(1) differential settlement of foundation leads to structural damage to the superstructure.
(2) in noncohesive soils, the major components of settlement is due to consolidation.
(3) lowering of ground water table contributes to settlement of foundations.

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 [CS 96]

238. Consider the following types of soil tests:
(1) california bearing ratio
(2) consolidation
(3) unconfined compression

The soil tests required to be done in the case of undisturbed samples include
a) (1), (2) and (3)
b) (1) and (2)
c) (1) and (3)
d) (2) and (3)

[CS 96]

239. Boring method is to be chosen depending upon the type of exploratory strata. In this context, match List I with List II and select the correct answer using the codes given below the Lists.

	List I		List II
A.	auger boring	1.	partly saturated sands, silts and medium to stiff cohesive soils
B.	wash boring	2.	all types of soils and rocks except in stony or porous soils and fissured rocks
C.	percussion drilling	3.	practically all types of soils except hard and cemented soil or rock
D.	rotary drilling	4.	all types of soils and rocks. Difficult in loose sands and soft sticky clays.

Code:

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

[CS 96]

240. Consider the following statements:
Clays which exhibit high activity
(1) contain montmorillonite
(2) contain kaolinite
(3) have a high silt content
(4) have a high plasticity index
(5) have a low plasticity index

Of these statements
a) (1), (3) and (5) are correct
b) (2), (3) and (5) are correct
c) (2) and (4) are correct
d) (1) and (4) are correct [CS 97]

241. A sample of clay and a sample of sand have the same specific gravity and void ratio. Their permeabilities would differ because
a) their porosities would be different
b) their degrees of saturation would be different
c) their densities would be different
d) the size ranges of their voids would be different [CS 97]

242. During, seepage through an earth mass, the direction of seepage is
a) parallel to the equipotential lines
b) perpendicular to the stream lines
c) perpendicular to the equipotential lines
d) along the direction of gravity

[CS 97]

243. Consider the following limitations:
(1) can be performed only on purely cohesionless soils
(2) plane of failure is predetermined
(3) there is virtually no control on drainage
(4) non-uniform distribution of stresses
(5) principle stresses in the sample cannot be determined.

The limitation inherent in direct shear test include:
a) (1), (2) and (3)
b) (2), (3) and (4)
c) (3), (4) and (5)
d) (1), (2) and (5) [CS 97]

244. Consider the following assumptions:
(1) failure occurs on a plane surface.
(2) wall is smooth but not necessarily vertical.
(3) failure wedge is a rigid body.

Coulomb's theory of earth pressure is based on assumptions
a) (1), (2) and (3)
b) (1) and (2)
c) (1) and (3)
d) (2) and (3) [CS 97]

245. In a saturated clay layer undergoing consolidation with single drainage at its top, the pore water pressure would be the maximum at its
a) top
b) middle
c) bottom
d) top as well as the bottom [CS 97]

*246. A saturated clay stratum of thickness 10 m, bounded on top and bottom by medium coarse sand layers, has a coefficient of consolidation of 0.002 cm^2/s. If this stratum is subjected to loading, it is likely that it would undergo 50% of its primary consolidation in
a) 1136 days b) 227 days
c) 284 days d) 568 days
[CS 97]

*247. The stress distribution at a depth beneath a loaded area is determined using Newmark's influence chart which indicate an influence value of 0.005. The number of the segments covered by the loaded area in the chart is 20 and the intensity of loading on the area is 10 T/m^2. The intensity of stress distribution at that depth is
a) 1 T/m^2 b) 2 T/m^2
c) 5 T/m^2 d) 10 T/m^2
[CS 97]

248. Consider the following field tests:
(1) vertical pile load test
(2) cyclic pile load test
(3) lateral pile load test
(4) instrumented test pile

While estimating the load carrying capacity of a pile, the tests that can be used for separating the skin resistance from point resistance, would include
a) (1) and (3) b) (l) and (4)
c) (2) and (3) d) (2) and (4)
[CS 97]

*249. The difference between maximum void ratio and minimum void ratio of a sand sample is 0.30. If the relative density of this sample is 66.6% at a void ratio of 0.40, then the void ratio of this sample at its loosest state will be
a) 0.40 b) 0.60
c) 0.70 d) 0.75 [CS 98]

250. A particular soil sample is subjected to test for the determination of permeability coefficient in two separate constant head permeameters, whose specifications are as under:

	Permeameter A	Permeameter B
Diameter of sample	D	$2D$
Length of sample	$2L$	L

If the tests on both the permeameters are conducted with equal head of water applied on the samples, then the ratio of amount of water discharged through the permeameters A and B during a period of one hour will be :
a) 4.000 b) 1.000
c) 0.250 d) 0.125
[CS 98]

251. The foundation soil under the toe of a dam has a void ratio 'e'. The specific gravity of the soil solid is G. Factor of safety against piping is to be taken as 2.5. The maximum permissible upward exit gradient is given by
a) $i = 2.5\left[\frac{G-1}{1+e}\right]$
b) $i = 2.5\left[\frac{1+e}{G-1}\right]$
c) $i = 0.4\left[\frac{1+e}{G-1}\right]$
d) $i = 0.4\left[\frac{G-1}{1+e}\right]$ [CS 98]

252. A homogeneous earth dam with no horizontal drainage filter at downstream is shown in Fig. 8.8. The slope of the downstream side, β is less than 30°. In order to determine the value of '*a*', the discharge '*q*' per unit length through the section of height a sin β is assumed to be (*k* = coefficient of permeability of soil)

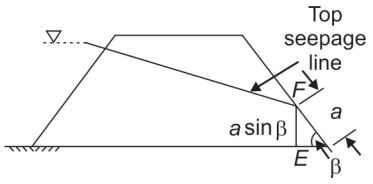


Fig. 8.8

a) $ka \sin \beta \cos \beta$
b) $ka \sin \beta \tan \beta$
c) $ka \sin^2 \beta$
d) $ka \sin^2 \beta \cos^2 \beta$ [CS 98]

253. Consider the flow net shown in Fig. 8.9:

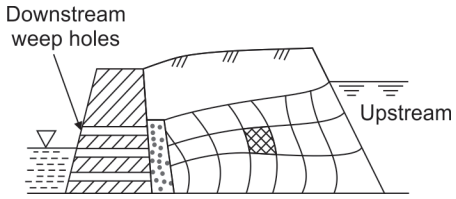


Fig. 8.9

The ratio of the number of flow channels to the number of potential drops is

a) 3/8 b) 3/7
c) 4/7 d) 4/8

[CS 98]

254. Which one of the following parameters can be used to estimate the angle of internal friction of a sandy soil?

a) Particle size
b) Roughness of particle
c) Particle size distribution
d) Density index [CS 98]

255. Which one of the following diagrams (Fig. 8.10) correctly illustrates the Mohr's stress conditions of unconfined shear test on cohesive soil (x-axis normal stress; y-axis shear stress)?

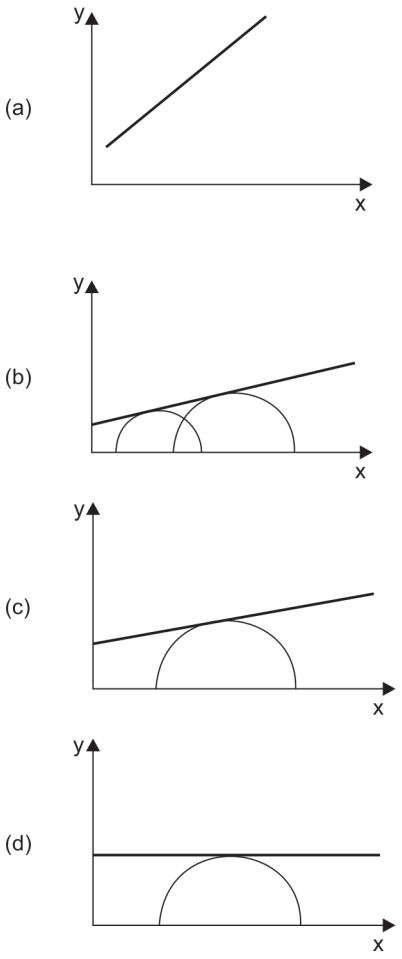
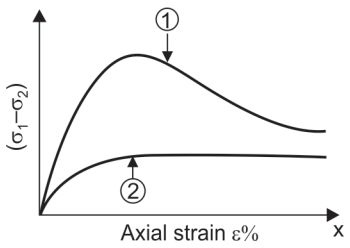
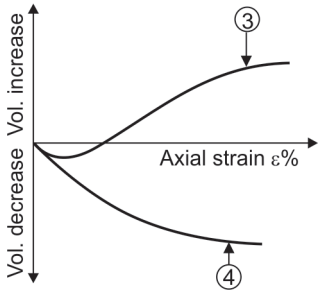


Fig. 8.10

256. A CD triaxial test is performed on a clay soil. Figures 8.11 (a) and (b) show two curves each for deviator stress, v/s axial strain % and volume change v/s axial strain %. If the clay is overconsolidated, then the results would be as in curves.



(a)



(b)

Fig. 8.11

a) (l) and (3) b) (1) and (4)
c) (2) and (3) d) (2) and (4)
[CS 98]

257. A cantilever sheet pile derives its stability from
a) lateral resistance of soil
b) self-weight
c) the deadman
d) the anchor rod [CS 98]

258. Deflection of a sheet pile in a braced cut
a) increases from top to bottom
b) decreases from top to bottom
c) increases from top and then decreases
d) decreases from top and then increases
[CS 98]

259. A completely saturated normally consolidated clay is tested in a triaxial test under consolidated undrained condition. The value of pore pressure coefficient at failure, A_f is given by ($\Delta\sigma_3$ = change in cell pressure; $\Delta\sigma_1$ = change in axial stress; Δu = corresponding change in pore pressure)

a) $A_f = \left[\frac{\Delta u - \Delta\sigma_1}{\Delta u - \Delta\sigma_3}\right]$

b) $A_f = \left[\frac{\Delta u - \Delta\sigma_1}{\Delta\sigma_1 - \Delta\sigma_3}\right]$

c) $A_f = \left[\frac{\Delta u - \Delta\sigma_3}{\Delta u - \Delta\sigma_1}\right]$

d) $A_f = \left[\frac{\Delta u - \Delta\sigma_3}{\Delta\sigma_1 - \Delta\sigma_3}\right]$ [CS 98]

260. The time 't' required for attaining a certain degree of consolidation of a clay layer is proportional to
a) H^2 and C_V b) H^2 and $1/C_V$
c) $1/H^2$ and C_V d) $1/H^2$ and $1/C_V$
[CS 98]

261. Match List 1 with List II and select the correct answer using the codes given below the Lists.

	List I		List II
A.	elastic settlement	1.	constant effective stress with change in volume of soil
B.	primary consolidation	2.	dissipation of excess pore water pressure
C.	secondary consolidation	3.	occurs within a short period
D.	creep	4.	compression and rearrangement of particles

Codes:

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

[CS 98]

262. Given that for an overconsolidated clay soil deposit, the pressure under which the deposit has been fully consolidated in the past is 125 kN/m^2 and the present overburden pressure is 75 kN/m^2, the overconsolidation ratio of the soil deposit is
a) 75/125 b) 50/75
c) 125/75 d) 200/75 [CS 98]

263. Match List I with List II and select the correct answer using the codes given below the Lists.

	List I		List II
A.	stress distribution due to point load in homogeneous isotropic medium	1.	Stein Brenner

B.	stress distribution due to point load in an anisotopic medium	2. Newmark
C.	influence chart for stress distribution in a rectangular area	3. Boussinesq
D.	influence chart for stress distribution in irregularly shaped areas	4. Westergaard

Codes:

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

[CS 98]

264. Given that

ω_n = natural frequency of foundation soil system,

C_u = coefficient of elastic uniform compression of soil,

A = contact area of foundation with soil, and m = mass of machine plus foundation natural frequency of foundation soil system for analysis of machine foundation shall be determined by Barken's method by using the equation.

a) $\omega_n = C_u \frac{A}{m}$ b) $\omega_n = C_u \sqrt{\frac{A}{m}}$

c) $\omega_n = \frac{A}{m}\sqrt{C_u}$ d) $\omega_n = \sqrt{\frac{C_u A}{m}}$

[CS 98]

265. Figure 8.12 relates to design features of samplers affecting soil disturbance. The area ratio of the soil sample is given by

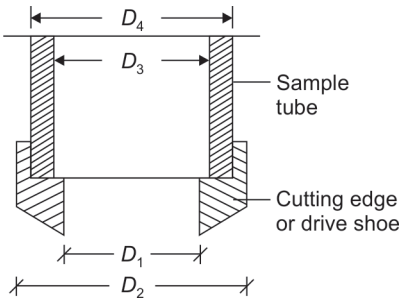


Fig. 8.12

a) $\frac{D_2^2 - D_3^2}{D_2^2}$ b) $\frac{D_2^2 - D_1^2}{D_1^2}$

c) $\frac{D_2^2 - D_4^2}{D_4^2}$ d) $\frac{D_3^2 - D_1^2}{D_1^2}$

[CS 98]

266. The static cone penetration test and a standard penetration test are performed on a soil at a certain depth. The value of static cone penetration test is 8 MPa and the N value is 20. The soil met with at that depth is

a) sandy silt
b) clay-silt mixture
c) sand and gravel mixture
d) medium dense sand

[CS 98]

267. Which of the following have an influence on the value of permeability?

(1) Void ratio
(2) Degree of saturation
(3) Pressure head
(4) Grain size

Select the correct answer using the codes given

Codes:

a) (1), (2) and (4)
b) (1), (2) and (3)
c) (2), (3) and (4)
d) (1), (3) and (4)

[CS 99]

268. Match List I with List II and select the correct answer using the codes given below the Lists.

List I		List II	
A.	optimum moisture content	1.	compaction of cohesive soil
B.	vibratory rollers	2.	compaction of granular soil
C.	zero air void line	3.	maximum dry density
		4.	relative density
		5.	100% saturation

Codes:

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

[CS 99]

*269. In a flownet diagram, the length of the flow line in the last square is 2 m, 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) 3.00 [CS 99]

270. A soil sample has 28 g of soil solids, 10 cu cm of voids, 9 g of water and specific gravity of soil grains of 2.7; consider the following statements in this regard:

(1) The water content is $9/28 \times 100\%$
(2) The void ratio is $10 \times 2.7/28$
(3) Degree of saturation is $9 \times 100/(10 \times 2.7)$
(4) The porosity is $10 \times 2.7/(28 + 10 \times 2.7)$

Of these statements

a) (1), (2) and (3) are correct
b) (2), (3) and (4) are correct
c) (1), (3) and (4) are correct
d) (1), (2) and (4) are correct

[CS 99]

271. A clear dry sand sample is tested in a direct shear test. The normal stress and the shear stress at failure are both equal to 120 kN/m^2 The angle of shearing resistance of the sand will be

a) 25° b) 35°
c) 45° d) 55° [CS 99]

272. 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 cm
c) 25 sq cm d) 30 sq cm

[CS 99]

273.

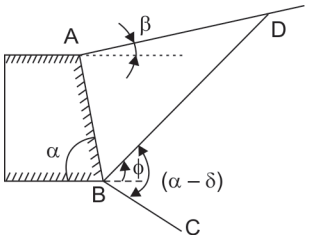


Fig. 8.13

Figure 8.13 shows Culmann's graphical construction for earth pressure. δ is the angle of wall friction. The earth pressure line is represented by

a) AB b) BC
c) BD d) AD [CS 99]

274. A slope is to be constructed at an angle of 30° to the horizontal from a soil having the properties, C = 15 kN/m^2; ϕ = 22.5°; γ = 19 kN/m^3. Taylor's stability number is 0.046. If a factor of safety (with respect to cohesion) of 1.5 is required, then the safe height of the slope will be

a) 25.8 m b) 19.1 m
c) 17.2 m d) 11.5 m [CS 99]

275. A fully compensated raft foundation for 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.

[CS 99]

276. 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
[CS 99]

*277. 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 [CS 99]

278. Under a given load, a clay layer attains 30% degree of consolidation in 100 days. The time taken by the same clay layer to attain 60% degree of consolidation will be
a) 1600 days b) 800 days
c) 400 days d) 200 days
[CS 99]

279. Match List I with List II for Fig. 8.14 and select the correct answer using the codes given below the Lists.

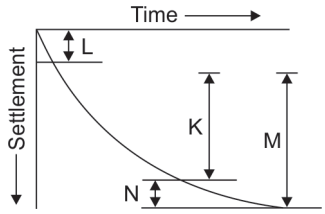


Fig. 8.14

	List I (Type of settlement)		List II (Notation on diagram)
A.	immediate settlement	1.	K
B.	primary consolidation	2.	L
C.	secondary compression	3.	M
D.	time-dependent settlement	4.	N

Codes:

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

[CS 99]

280. 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		List II
A.	activity number	1.	liquid limit-water content/ plasticity index
B.	liquidity index	2.	plasticity index/ percent finer than 2 microns
C.	sensitivity	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)	A	B	C
	1	3	4
b)	A	B	C
	1	2	3
c)	A	B	C
	3	2	1
d)	A	B	C
	2	3	4

[ES 93]

281. 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
[ES 93]

282. 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 [ES 93]

283. 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 [ES 93]

*284. For a sandy soil, the angle of internal friction is 30°. If the major principal stress is 50 kN/m^2 at failure, then the corresponding minor principal stress (in kN/m^2) will be
a) 12.2 b) 16.66
c) 20.8 d) 27.2 [ES 93]

285. 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 σ_f of 2 kg/cm^2, then the angle of internal friction of soil is given by
a) $\tan^{-1}$ (2) b) $\tan^{-1}$ (l)
c) $\tan^{-1}$ (1/2) d) $\tan^{-1}$ (1/4) [ES 93]

*286. Given:
μ_1 = Poisson's ratio of soil sample 1
μ_2 = Poisson's ratio of soil sample 2
k_1 = coefficient of earth pressure at rest for soil sample 1
k_2 = coefficient of earth pressure at rest for soil sample 2
If $\mu_1/\mu_2 = 1.5$ and $(1-\mu_1)/(1-\mu_2) = 0.875$, then the value of k_1/k_2 will be
a) 1.3125 b) 1.7143
c) 1.9687 d) 1.8213 [ES 93]

*287. 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) $\cot^{-1}(0.621)$ [ES 93]

*288. A normally consolidated clay layer settles 1 cm when the pressure increases from 1 kg/cm^2 to 2 kg/cm^2. Additional settlement for the same soil for further increase of pressure from 2 kg/cm^2 to 4 kg/cm^2 will be
a) 1 cm b) 2 cm
c) 3 cm d) 4 cm [ES 93]

289. 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 [ES 93]

*290. 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 [ES 93]

291. The gross bearing capacity of a footing is 450 kN/m^2. If the footing is 1.5 m wide at a depth of 1 m in clayey soil with unit weight of 20 kN/m^3, then the net bearing capacity (in kN/m^2) will be
a) 400 b) 430
c) 435 d) 440 [ES 93]

292. Permissible settlement is relatively higher for

a) isolated footings on clays
b) isolated footings on sands
c) rafts on clays
d) rafts on sands [ES 93]

*293. 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) $\delta^2 = 39.4784 \frac{C_C^2 - C^2}{C^2}$ [ES 93]

294. For undisturbed sampling, the area ratio for a thin-wall sampler should not normally exceed

a) 15% b) 25%
c) 30% d) 35%

[ES 93]

295. Which of the following pairs are correctly matched ?

(1) Standard penetration test .... Relative density
(2) Vane shear .... Cohesion
(3) Consolidation test ... Bearing capacity

Select the correct answer using the codes given below.

Codes:

a) (1), (2) and (3)
b) (1) alone
c) (1) and (2)
d) (2) and (3) [ES 93]

296. 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)	A	B	C	D
	3	1	4	2
b)	A	B	C	D
	3	4	1	2
c)	A	B	C	D
	2	4	1	3
d)	A	B	C	D
	2	1	4	3

[ES 94]

*297. A sample of soil has the following properties:

Liquid limit = 45%

Plastic limit = 25%

Shrinkage limit = 17%

Natural moisture content = 30%

The consistency index of the soil is

a) 15/20 b) 13/20
c) 8/20 d) 5/20 [ES 94]

*298. A stratum of soil consists of three layers of equal thickness. The permeabilities of top and bottom layers are $K = 10^{-4}$ cm/s and that of the middle layer is $K = 10^{-3}$ cm/s. Then the value of the horizontal coefficient of permeability K_H for the entire soil layers is

a) 2×10^{-3} cm/s b) 4×10^{-4} cm/s
c) 3×10^{-4} cm/s d) 1.5×10^{-4} cm/s

[ES 94]

299. 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 [ES 94]

300. Consider the following statements about the properties of flownets:
(1) flow lines are perpendicular to equipotential lines.
(2) no two flow lines or equipotential lines start from the same point.
(3) no two flow lines cross each other.
Of these statements
a) (1), (2) and (3) are correct
b) (2) and (3) are correct
c) (1) and (2) are correct
d) (1) and (3) are correct [ES 94]

301. An undrained triaxial compression test is carried out on a saturated clay sample under a cell pressure of 100 kN/m^2. The sample failed at a deviator stress of 200 kN/m^2. The cohesion of the given sample of clay is
a) 50 kN/m^2 b) 100 kN/m^2
c) 200 kN/m^2 d) 300 kN/m^2
[ES 94]

302. 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 [ES 94]

303. A retaining wall retains a c–ϕ soil backfill. Tension cracks have occurred in the backfill. The total active earth pressure is given by (γ = unit weight of soil, H = height of retaining wall, k_A = coefficient of active earth pressure, c' = cohesion of soil)

a) $P_A = \frac{1}{2}\gamma H^2 k_A - 2c'H\sqrt{k_A}$

b) $P_A = \frac{1}{2}\gamma H^2 k_A + 2c'H\sqrt{k_A}$

c) $P_A = \frac{1}{2}\gamma H^2 k_A - 2c'H\sqrt{k_A} - \frac{2(c')^2}{\gamma}$

d) $P_A = \frac{1}{2}\gamma H^2 k_A - 2c'H\sqrt{k_A} + \frac{2(c')^2}{\gamma}$

[ES 94]

304. 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) loess and overconsolidated clay
d) dense sand and overconsolidated clay
[ES 94]

305. 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
[ES 94]

*306. A fully saturated clay specimen is placed in a consolidometer and subjected to a loading of 200 kN/m^2. After a period of time it was found that the average pore pressure in the specimen was 70 kN/m^2. The percentage of consolidation reached by then was
a) 70 b) 65
c) 35 d) 29 [ES 94]

*307.

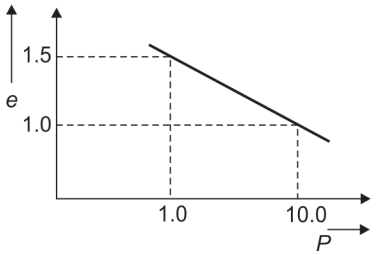


Fig. 8.15

The virgin compression curve for a particular soil is shown in Fig. 8.15. The compression index of the soil is
a) 0.35 b) 0.50
c) 1.0 d) 1.5 [ES 94]

308. 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} = 2 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 [ES 94]

*309. 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 [ES 94]

310. Match List I with List II and select the correct answer using the codes given below the Lists.

	List I		List II
A.	friction pile	1.	stiff clay
B.	batter pile	2.	loose granular soil
C.	tension pile	3.	lateral load
D.	compaction pile	4.	uplift load

Codes:

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

[ES 94]

311. 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
[ES 94]

312. Figure 8.16 indicate the weights of different pycnometers.

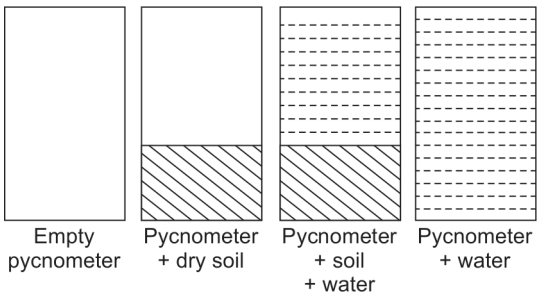


Fig. 8.16

The specific gravity of solids is given by

a) $\frac{W_2}{(W_4 - W_2)}$

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

c) $\frac{W_2}{(W_3 - W_4)}$

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

*313. 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% [ES 95]

*314. 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
[ES 95]

315. 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) $(h_1 - h_2) = (h_2 - h_3)$ [ES 95]

316. For conducting a standard Proctor compaction test, the weight of hammer (P in kg), the fall of hammer (Q in mm), the number of blows per layer (R) and the number of layers (S) required are respectively

	P	Q	R	S
a)	5.89	550	50	3
b)	4.89	450	25	3
c)	3.60	310	35	4
d)	2.60	310	25	3

[ES 95]

317. 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 co-efficient of permeability [ES 95]

*318. A laboratory vane shear test apparatus is used to determine the shear strength of a clay sample and only one end of the vane takes part in shearing the soil. If T = applied torque, H = height of vane and D = diameter of the vane, then the shear strength of the clay is given by

a) $\frac{T}{\pi D^2\left(H+\frac{D}{6}\right)}$ b) $\frac{T}{\pi D^2\left(\frac{H}{2}+\frac{D}{6}\right)}$

c) $\frac{T}{\pi D^2\left(H+\frac{D}{12}\right)}$ d) $\frac{T}{\pi D^2\left(\frac{H}{2}+\frac{D}{12}\right)}$

[ES 95]

319. A retaining wall retains a sand strata with $\phi = 30°$ upto its top. If a uniform surcharge of 12 t/m^2 is subsequently put on the sand strata, then the increase in the lateral earth pressure intensity on the retaining wall will be

a) 1 t/m^2 b) 2 t/m^2
c) 4 t/m^2 d) 8 t/m^2 [ES 95]

320. Consider the following assumptions for slope stability analysis:
(1) friction is fully mobilized.
(2) effective stress analysis is adopted.
(3) total stress analysis is used.
(4) resultant 'R' passes through the centre of the circle.
(5) resultant 'R' is tangential to the friction circle.

The assumptions necessary for friction circle method of analysis would include

a) (1), (3) and (4)
b) (1), (3) and (5)
c) (2) and (4)
d) (2) and (5) [ES 95]

321. If the saturated density of a given soil is 2.1 t/m^2, then the total stress (T in t/m^2) and the effective stress (E in t/m^2) of a saturated soil stratum at a depth of 4 m will be

	T	E
a)	4.4	2.4
b)	5.4	3.4
c)	7.4	4.0
d)	8.4	4.4

[ES 95]

322. The void ratio–pressure diagram is shown in Fig. 8.17.

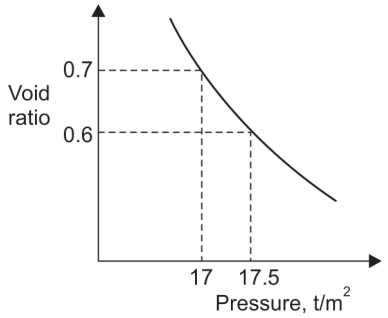


Fig. 8.17

The coefficient of compressibility is

a) 0.050 m^2/t b) 0.073 m^2/t
c) 0.20 m^2/t d) 0.25 m^2/t

[ES 95]

323. 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

[ES 95]

324. 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

[ES 95]

325. A concentrated load of 50t acts vertically at a point on the soil surface. If Boussinesq's equation is applied for computation of stress, then the ratio of vertical stresses at depths of 3 m and 5 m respectively vertically below the point of application of load will be

a) 0.36 b) 0.60
c) 1.66 d) 2.77 [ES 95]

326. 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) $\dfrac{\text{Maximum load carried by a pile in the group}}{\text{Minimum load carried by a pile in the group}}$

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

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

[ES 95]

327. No tension should develop at the base of the rectangular well foundation or at any horizontal section within the well. For no tension at the base, the resultant of 'Pa' (total active thrust) and W (weight of soil and well above the base) must pass through middle

a) half of the base
b) third of the base
c) quarter of the base
d) of the base [ES 95]

328. Match List I with List II and select the correct answer using the codes given below the Lists.

List I (Soil property measured)	List II (*In situ* test)
A. modulus of sub-grade reaction	1. cyclic pile load test
B. relative density and strength	2. pressure-meter test
C. skin friction and point bearing	3. plate load test
D. elastic constants	4. standard penetration test

Codes:

a) A B C D
1 3 2 4
b) A B C D
1 2 4 3
c) A B C D
2 4 1 3
d) A B C D
3 4 1 2 [ES 95]

329. 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 [ES 96]

*330. A bed of sand consists of three horizontal layers of equal thickness. The value of Darcy's k for the upper and lower layers is 1×10^{-2} cm/sec and that for the middle layer is 1×10^{-1} cm/sec. The ratio of the permeability of the bed in the horizontal direction to that in the vertical direction is

a) 10.0 to 1 b) 2.8 to 1
c) 2.0 to 1 d) 1 to 10 [ES 96]

331. 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 [ES 96]

332. Sheep-foot rollers are recommended for compacting

a) granular soils
b) cohesive soils
c) hard rock
d) any type of soil [ES 96]

*333. A deposit of fine sand has a porosity n and specific gravity of soil solids is G. The hydraulic gradient of the deposit to develop boiling condition of sand is given by
a) $i_e = (G-1)(1-n)$
b) $i_e = (G-1)(1+n)$
c) $i_e = \frac{G-1}{1-n}$
d) $i_e = \frac{G-1}{1+n}$ [ES 96]

334. In the schematic flow-net shown in Fig. 8.18, the hydraulic potential at point A is

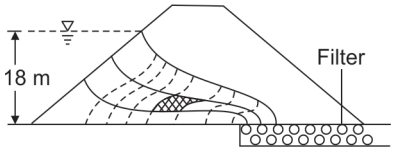


Fig. 8.18

a) 5 m of water
b) 12 m of water
c) 15 m of water
d) 25 m of water [ES 96]

335. Consider the following statements relation to the given sketch:

Volume, cm^3		Weight, g
0.2	Air	0
0.3	Water	0.3
0.5	Solids	1.0

(1) Soil is partially saturated at degree of saturation = 60%
(2) Void ratio = 40%
(3) Water content = 30%
(4) Saturated unit weight =1.5 g/cc.

Of these statements
a) (1), (2) and (3) are correct
b) (1), (3) and (4) are correct
c) (2), (3) and (4) are correct
d) (1), (2) and (4) are correct [ES 96]

336. 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_u, ϕ_u – Undrained
(3) C'_d, 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) [ES 96]

337. Which one of the following Fig. 8.19 gives the failure envelope for a normally consolidated saturated clay sample tested in triaxial test under drained conditions?

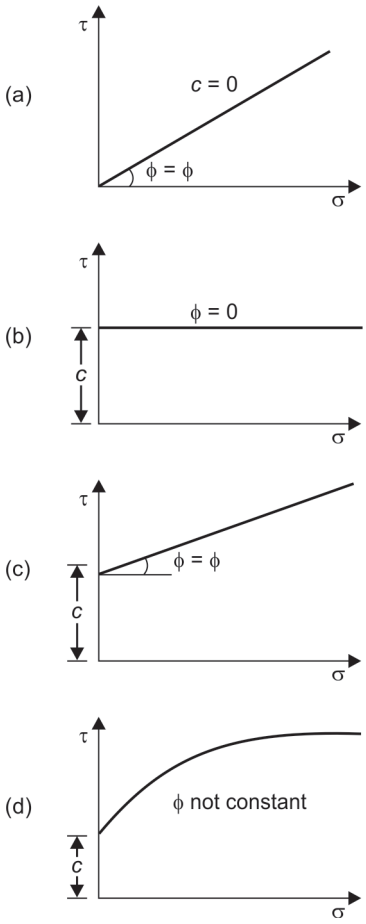


Fig. 8.19 [ES 96]

338. Match List I with List II and select the correct answer using the codes given below the Lists.

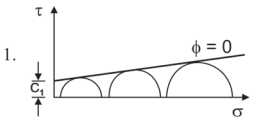
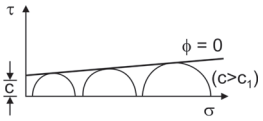
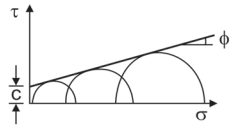
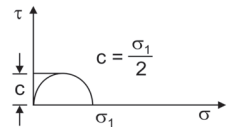
List I (Type of shear tests)	List II (Mohr circle and its envelope)
A. undrained test on normally consolidated saturated clays	1. 
B. consolidated undrained test on normally consolidated saturated clays	2. 
C. drained tests on saturated cohesive soil	3. 
D. unconfined test on clays	4. 

Fig. 8.20

Codes:

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

[ES 96]

339. A soil fails under an axial vertical stress of 100 kN/m^2 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/m^2, 0°
b) 50.0 kN/m^2, 0°
c) 41.9kN/m^2, 10°
d) 50.0 kN/m^2, 10°

[ES 96]

340. Active earth pressure per metre length on the retaining wall with a smooth vertical back as shown in Fig. 8.21 will be

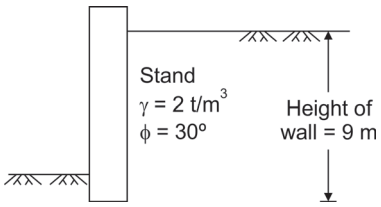


Fig. 8.21

a) 81 t b) 27 t
c) 2 t d) 1 t

[ES 96]

341. 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

[ES 96]

*342. A rectangular footing 1 m × 2 m is placed at a depth of 2 m in a saturated clay behaving an unconfined compressive strength of 100 kN/m^2. According to Skempton, the net ultimate bearing capacity is

a) 420 kN/m^2
b) 412.5 kN/m^2
c) 385 kN/m^2
d) 350 kN/m^2 [ES 96]

*343. 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/m^2 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 [ES 96]

344. 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
[ES 96]

345. In the following figures (Fig. 8.22; a-d), 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

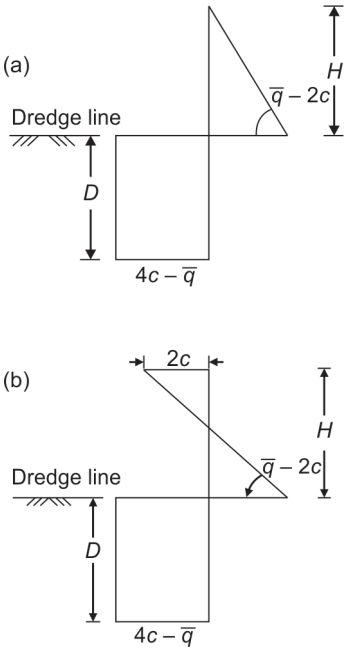


Fig. 8.22 [ES 96]

346. A raft foundation is to be constructed on a sandy soil. The maximum differential settlement and limiting maximum settlement as recommended by Indian Standard Code are

	Max. differential settlement	Limiting max. settlement
a)	40 mm	65 mm to 100 mm
b)	40 mm	40 mm to 65 mm
c)	25 mm	65 mm to 100 mm
d)	25 mm	40 mm to 65 mm

[ES 96]

347. Consider the following statements:
In subsoil exploration programme the term "significant depth of exploration" is upto
(1) the width of foundation.
(2) twice the width of foundation.
(3) the depth where the additional stress intensity is less than 20% of overburden pressure.
(4) the depth where the additional stress intensity is less than 10% of the over-burden pressure.
(5) hard rock level.

Of these statements
a) (1), (3) and (5) are correct
b) (2), (3) and (5) are correct
c) (1) and (4) are correct
d) (2) and (4) are correct [ES 96]

348. Lacustrine soils are soils
a) transported by rivers and streams
b) transported by glaciers
c) deposited in sea beds
d) deposited in lake beds
[ES 96]

349. The standard plasticity chart to classify fine grained soils is shown in Fig. 8.23.

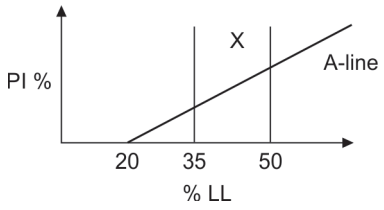


Fig. 8.23

The area marked 'X' represents
a) silt of low plasticity
b) clay of high plasticity
c) organic soil of medium plasticity
d) clay of intermediate plasticity
[ES 96]

350. Consider the following statements in the context of aeolian soils:
(1) the soil has low density and 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 [ES 97]

351. A soil has a liquid limit of 45% and lies above the A-line when plotted on a plasticity chart. The group symbol of the soil as per IS soil classification is
a) CH b) CI
c) CL d) MI [ES 97]

*352. The dry density of a soil is 1.5 g/cc. If the saturation water content were 50%, then its saturated density and submerged density would, respectively, be
a) 1.5 g/cc and 1.0 g/cc
b) 2.0 g/cc and 1.0 g/cc
c) 2.25 g/cc and 1.25 g/cc
d) 2.50 g/cc and 1.50 g/cc [ES 97]

*353. A fill having a volume of 1,50,000 cumec 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
[ES 97]

354. The moisture content of a clayey soil is gradually decreased from a large value. What will be the correct sequence of the occurrence of the following limits?
(1) shrinkage limit
(2) plastic limit
(3) liquid limit

Select the correct answer using the codes given below:
a) (1), (2), (3) b) (1), (3), (2)
c) (3), (2), (1) d) (3), (1), (2)
[ES 97]

355. 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) $G = 1.5\,i - 1$
[ES 97]

356. Match List I with List II and select the correct answer using the codes given below the Lists.

	List I (Effect)		List II (Reason)
A.	excessive Settlement	1.	rise of water table
B.	high Expansivity	2.	high compressibility
C.	reduction of Bearing Capacity	3.	montmorillonite
D.	acceleration of Consolidation	4.	sand drains

Codes:

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

[ES 97]

*357. A flow-net constructed to determine the seepage through an earth dam which is homogeneous but anisotropic, gave four flow channels and sixteen equipotential drops. The coefficients of permeability in the horizontal and vertical directions are 4.0×10^{-7} m/s and 1.0×10^{-7} m/s, respectively. If the storage head was 20 m, then the seepage per unit length of the dam (in m^3/s) would be

a) 5×10^{-7}
b) 10×10^{-7}
c) 20×10^{-7}
d) 40×10^{-7}

[ES 97]

358. 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

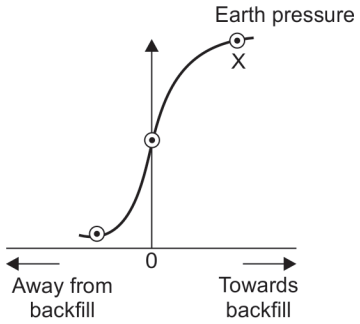
[ES 97]

359. 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) $s = c - \sigma_n \tan \phi$

[ES 97]

360. Earth pressure and resultant possibilities of wall movement are shown in Fig. 8.24. The point marked 'X' in the diagram denotes



Lateral movement of retaining wall

Fig. 8.24

a) earth pressure at rest
b) active earth pressure
c) arching active pressure
d) passive earth pressure [ES 97]

361. 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

[ES 97]

362. Given that for a soil deposit,
K_0 = 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 $(1 - \mu)/\mu$ is given by

a) K_a/K_p b) K_0/K_a
c) K_p/K_a d) $1/K_0$ [ES 97]

363. 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 $B = 1$ [ES 97]

364. 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 decrease in effective pressure
d) a decrease in pore water pressure and an increase in effective pressure

[ES 97]

365. 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) $15 + \left[\frac{(15-N)}{2}\right]$

366. 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	List II
A. coefficient of compressibility	1. stress-deformation
B. compression index	2. stress-void ratio
C. coefficient of sub-grade modulus	3. volume pressure
	4. log stress-void ratio

Codes:

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

[ES 97]

*367. 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° [ES 97]

*368. 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 [ES 97]

369.

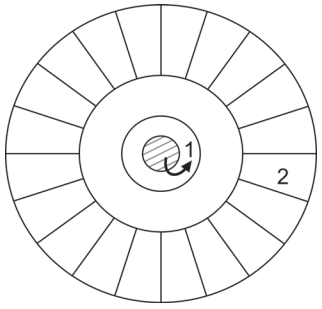


Fig. 8.25

A part of the Newmark's influence chart with four concentric circles is shown in Fig. 8.25. If the hatched areas 1 and 2 are loaded separately with the same intensity of loading, then the intensity of pressure yielded

a) by 1 will be more than that yielded by 2
b) by 2 will be more than that yielded by 1
c) by 1 and 2 will be equal
d) at the center will be in inverse proportion to the radii of the two circles

[ES 97]

370. Consider the following statements regarding under-reamed piles:

(1) they are used in expansive soils.
(2) they are of pre-cast reinforced concrete.
(3) the ratio of bulb to shaft diameters is usually 2 to 3.
(4) minimum spacing between the piles should not be less than 1.5 times the bulb diameter.

Of these statements

a) (1), (2) and (3) are correct
b) (1), (3) and (4) are correct
c) (2), (3) and (4) are correct
d) (1), (2) and (4) are correct [ES 97]

371. Match List I with List II and select the correct answer using the codes given below the Lists.

	List I (Field test)		List I (Parameters Measured)
A.	plate load test	1.	total and frictional resistances
B.	standard penetration test	2.	load intensity and settlement values
C.	static Dutch cone penetration test	3.	NCD Values
D.	dynamic penetration test	4.	SPT values

Codes:

a)	A	B	C	D	
	2	4	3	1	
b)	A	B	C	D	
	4	2	3	1	
c)	A	B	C	D	
	2	4	1	3	
d)	A	B	C	D	
	4	2	1	3	[ES 97]

372. In standard penetration test, the splitspoon 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 [ES 97]

373. To make certain that the backfill material is more pervious than the soil to be drained, the relationship used is

a) $(D_{15})_{\text{filter}} \le 5\,(D_{85})_{\text{protected soil}}$
b) $(D_{15})_{\text{filter}} \ge 5\,(D_{85})_{\text{protected soil}}$
c) $(D_{15})_{\text{filter}} \le 5\,(D_{15})_{\text{protected soil}}$
d) $(D_{15})_{\text{filter}} \ge 5\,(D_{15})_{\text{protected soil}}$ [ES 97]

*374. Given that plasticity index (PI) of local soil = 15 and PI of sand = 0, for a desired PI of 6, the percentage of sand in the mix should be

a) 70 b) 60
c) 40 d) 30 [ES 97]

375. Consider the following statements:

(1) dynamic cone penetration test for site investigation is based on the principle that elastic shock waves travel in different materials at different velocities.
(2) electrical resistivity method of subsurface investigation is capable of detecting only the strata having different electrical resistivity.
(3) *in situ* vane shear test is useful for determining the strength of very soft soil and sensitive clays and is unsuitable for sandy soil.

Of these statements

a) (1) and (2) are correct
b) (1) and (3) are correct
c) (2) and (3) are correct
d) (2) alone is correct [ES 98]

376. Consider the following statements:

A well-graded sand should have

(1) uniformity coefficient greater 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 [ES 98]

377. 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 [ES 98]

378. Consider the following statements:

(1) constant head permeameter is best suited for determination of coefficient of permeability of highly impermeable soils.
(2) coefficient of permeability of a soil mass decreases with increase in viscosity of the pore fluid.
(3) coefficient of permeability of a soil mass increases with increase in temperature of the pore fluid.

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 [ES 98]

379. Consider the following statements:

(1) 'relative compaction' is not the same as 'relative density'.
(2) vibrofloatation is not effective in the case of highly cohesive soils.
(3) 'zero air void line' and '100% saturation line' are not identical.

Of these statements

a) (1) and (2) are correct
b) (1) and (3) are correct
c) (2) and (3) are correct
d) (3) alone is correct [ES 98]

380. The configuration of flow nets depends 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 [ES 98]

381. Consider the following statements:

Phreatic line in an earth dam is

(1) elliptic in shape.
(2) an equipotential line.
(3) the topmost flow line with zero water pressure.
(4) approximately a parabola.

Of these statements

a) (1), (2) and (3) are correct
b) (2), (3) and (4) are correct
c) (3) and (4) are correct
d) (1) alone is correct [ES 98]

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

a) $S = \dfrac{1+w}{\frac{r_w}{r}(1+w)-\frac{1}{G}}$

b) $S = \dfrac{w}{\frac{r_w}{r}(1+w)-\frac{1}{G}}$

c) $S = \dfrac{(1+w)}{\frac{r_w}{r}(1+w)-\frac{1}{wG}}$

d) $S = \dfrac{w}{\frac{r_w}{r}(1+w)-\frac{1}{wG}}$ [ES 98]

383. 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 [ES 98]

384. A triaxial test was conducted on a granular soil. At failure $\sigma_1'/\sigma_3' = 4$. The effective minor principal stress at failure was 100 kPa. The values of approximate ϕ and the principal stress difference at failure are, respectively

a) 45° and 570 kPa
b) 40° and 400 kPa

c) 37° and 300 kPa
d) 30° and 200 kPa [ES 98]

385. 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
[ES 98]

386. Consider the following statements:
Ranking's theory and Coulomb's theory give same values of coefficients of active and passive earth pressures when
(1) the retaining wall has a vertical back
(2) the backfill is cohesionless
(3) angle of slope of backfill is equal to the angle of internal friction
(4) angle of slope of backfill is 0°
(5) angle of wall friction δ is 0°
(6) angle of wall friction δ is equal to ϕ
Of these statements
a) (1), (2), (3) and (5) are correct
b) (1), (2), (4) and (5) are correct
c) (2), (3) and (6) are correct
d) (1), (4) and (6) are correct [ES 98]

387. Consider the following statements:
(1) coulomb's earth pressure theory does not take the roughness of wall into consideration
(2) in case of non-cohesive soils, the coefficients of active earth pressure and earth pressure at rest are equal
(3) any movement of retaining wall away from the fill corresponds to active earth pressure condition
Of these statements
a) (1) alone is correct
b) (1) and (2) are correct
c) (2) alone is correct
d) (3) alone is correct
[ES 98]

388. A rectangular footing $L \times B$ is to be placed at a depth D below ground level such that $D/B < 2.5$. The factor N_C to be used in deciding on the allowable bearing capacity for the footing as given by Skempton is calculated using the equation (where $N_{C_R} = N_C$ for rectangular footing, $N_{C_S} = N_C$ at surface)
a) $N_{C_R} = 1.5\, N_{C_S}$
b) $N_{C_R} = \left[1 + 0.2\frac{D}{B}\right] N_{C_S}$
c) $N_{C_R} = \left[1 + 0.2\frac{B}{L}\right] N_{C_S}$
d) $N_{C_R} = \left[1 + 0.2\frac{B}{L}\right]\left[1 + 0.2\frac{D}{B}\right] N_{C_S}$
[ES 98]

389. Consider the following statements associated with local shear failure of soils:
(1) Failure is sudden with well-defined ultimate load.
(2) This failure occurs in highly compressible soils.
(3) Failure is preceded by large settlement.
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 [ES 98]

390. 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 [ES 98]

391. 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% [ES 98]

392. 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 [ES 98]

393. Consider the following statements:
The Standard Penetration Test (SPT) in soils is the most commonly used field test. SPT is used to determine
(1) consistency of clay.
(2) undrained shear strength of soft sensitive clay.

(3) relative density of sands.
(4) drained shear strength of fine loose sand.

Of these statements
a) (1) and (2) are correct
b) (2) and (4) are correct
c) (1) and (3) are correct
d) (3) and (4) are correct [ES 98]

394. Match List I with List II and select the correct answer using the codes given below the Lists.

List I (Terms)	List II (Formulae)
A. void ratio	1. V_v/V
B. porosity	2. W_w/W_s
C. degree of saturation	3. W_w/V_v
D. water content	4. W/V
	5. V_v/V_s

Codes:

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

[ES 98]

395. Match List 1 (field problems) with List II (type of laboratory shear test) and select the correct answer using the codes given below the Lists.

List I	List II
A. stability of a clay foundation of an embankment, whose rate of construction is such that some consolidation occurs	1. undrained triaxial test
B. initial stability of a footing on saturated clay	2. drained triaxial test
C. long-term stability of a slope in stiff, fissured clay	3. consolidated undrained test
D. foundation on soft marine clay deposits	4. quick vane shear test

Codes:

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

[ES 99 CS 97]

396. If an unconfined compressive 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

[ES 99]

397. In a direct shear test, the shear stress and normal stress on a dry sand sample at failure are 0.6 kg/cm^2 and 1 kg/cm^2 respectively. The angle of internal friction of the sand will be nearly
a) 25°
b) 31°
c) 37°
d) 43°

[ES 99]

398. If an infinite slope of clay at a depth 5 m has cohesion of 1t/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

[ES 99]

399. Which one of the following typical pressure distribution diagrams (Fig. 8.26) represents the lateral pressure distribution on braced sheeting in stiff clay with temporary support, as given by Tschebotarioff?

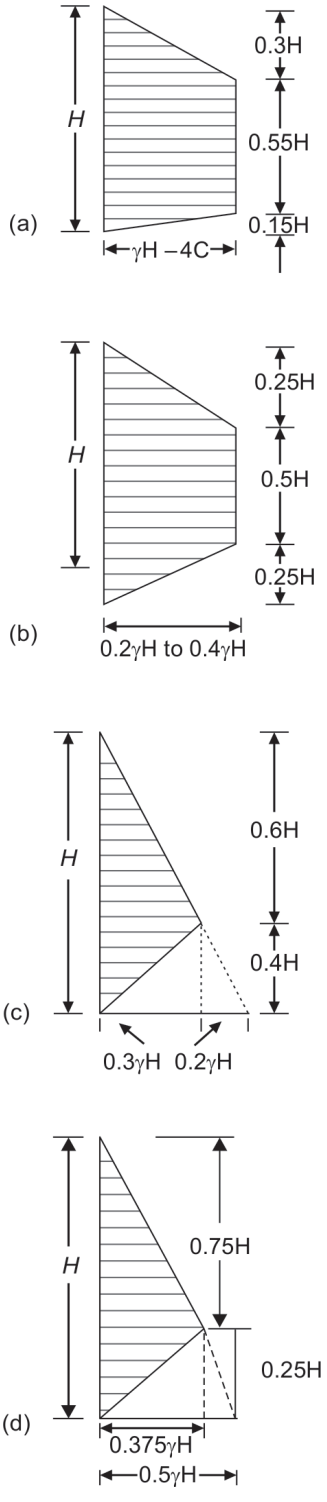


Fig. 8.26 [ES 99]

400. Given that $c = 2$ t/m^2, $\phi = 0°$ and $\gamma = 2$ t/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 [ES 99]

401. Match List I (Investigator) with List II (Equation) and select the correct answer using the codes given below the Lists.

	List I		List II
A.	Skempton	1.	$v = k_i$
B.	Coulomb	2.	$\sigma' = \sigma_u$
C.	Stokes	3.	$v = \frac{D^2(\gamma_s - \gamma_w)}{18\eta}$
D.	Terzaghi	4.	$s = c + \sigma \tan \phi$
		5.	$u = B[\sigma_3 + A(\sigma_1 - \sigma_3)]$

Codes:

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

[ES 99]

402. Which one of the following pairs of parameters and expressions is not correctly matched?
a) Co-efficient of consolidation .... $\frac{T_v H^2}{t}$
b) Co-efficient 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 .... $\frac{a_v}{1+e_0}$
[ES 99]

403. 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 soil deposit includes
a) (1), (2) and (3)
b) (2), (3) and (4)
c) (1), (3) and (4)
d) (1), (2) and (4) [ES 99]

404. 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
[ES 99]

405. 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 [ES 99]

406. Ratio of bearing capacity of double Under Reamed (UR) pile to that of single UR pile is nearly
a) 2 b) 1.5
c) 1.2 d) 1.7 [ES 99]

407. 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
[ES 99]

408. The standard penetration resistance N of a granular deposit is found to be 20. The soil can be classified approximately in terms of ϕ and density index respectively as
a) 20° and 10 % for very loose condition
b) 32° and 50 % for medium condition
c) 32° and 30 % for loose condition
d) 38° and 65 % for dense condition
[ES 99]

409. 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 [ES 99]

Directions: *Select your answers for the questions from 410 to 438 using the codes given below:*

Codes:
a) *Both A and R are true and R is the correct explanation of A*
b) *Both A and R are true but R is not a correct explanation of A*
c) *A is true but R is false*
d) *A is false but R is true*

410. **Assertion A:** Black cotton soils are expansive soils.

Reason R: Black cotton soils are residual soils. [ES 94]

411. **Assertion A:** Lowering of ground water table causes settlement.

Reason R: Removal of neutral pressure increases the effective pressure. [ES 94]

412. **Assertion A:** A rigid footing resting on sand layer and carrying uniformly distributed load develops contact pressure, the magnitude of which is less at the edges than at the center of footing.

Reason R: In the case of a rigid footing, the settlement has to be uniform for which the contact pressure distribution is non-uniform. [ES 94]

413. **Assertion A:** Transition stage from semisolid state to solid state of soil is termed as shrinkage limit.

Reason R: After the semisolid state, any reduction in water content will cause shrinkage in the volume of the soil.
[ES 93]

414. **Assertion A:** The rate of settlement of buildings constructed on sandy clays are faster than those constructed on clayey soils.

Reason R: The rate of consolidation is dependent on permeability of soils. [ES 93]

415. **Assertion A:** Boussinesq equation is not suitable for sedimentary deposits.

Reason R: Sedimentary deposits do not represent an isotropic and homogeneous system. [ES 93]

416. **Assertion A:** All theoretical approaches indicate that at greater depths, bearing capacity of pile base in sand is practically independent of its size and is proportional to overburden.

Reason R: When the depth of overburden is very great, the value of the term "$\frac{1}{2}\gamma BN_\gamma$" of the bearing capacity equation is neglected for all practical purposes. [ES 93]

417. **Assertion A:** Plate load test is a field test to determine the ultimate bearing capacity of soil and also the probable settlement under a given loading.

Reason R: The plate load test does not give the ultimate settlement, particularly in the case of cohesive soils. [ES 94]

418. **Assertion A:** The quick sand leading to liquefaction is not a type of sand but a flow condition occurring within a cohesionless soil when its effective pressure is reduced to zero.

Reason R: Equal amounts of the upward water pressure and the downward pressure of the submerged soil mass are acting. [ES 94]

419. **Assertion A:** Terzaghi's bearing capacity theory is not applied to deep foundations.

Reason R: Shear strength is mobilized on the sides of deep foundations. [ES 95]

420. **Assertion A:** Bearing capacity of an under-reamed pile is less than that of a straight bored pile of the same diameter.

Reason R: Under-reamed piles have enlarged bulbs. [ES 95]

421. **Assertion A:** At depth Z below the surface of a submerged soil, water pressure is $\gamma_w Z$ and it is the stress caused by the water which is called the "neutral stress".

Reason R: The water pressure acts equally in all directions and transmits the same fully on grain to grain contact causing compression in the soil. [ES 95]

422. **Assertion A:** The safe height ($2Z_0$) to which an unsupported vertical cut in clay can be made is $4C/\gamma$.

Reason R: Active earth pressure of cohesive backfill shows that the negative pressure (tension) is developed at top level. This tension decreases to zero at depth Z_0 and total net pressure up to a depth $2Z_0$ is zero. [ES 96]

423. **Assertion A:** Negative skin friction will act on piles in filled up soils, which should be considered in design of pile foundations.

Reason R: The filled up soils start consolidating and develop a drag force on the pile. [ES 96 & CS 96]

424. **Assertion A:** Constant-head permeability test is not used for fine-grained soils.

Reason R: The lesser the permeability of the soil, lesser is the discharge. [ES 97]

425. **Assertion A:** In box shear test, the failure plane is predetermined and is horizontal.

Reason R: The shear stress is applied in the vertical direction. [ES 97]

426. **Assertion A:** In the case of sand deposits with uniform density, N values are found to increase with depth.

Reason R: Overburden pressure increases with depth below ground level. [ES 97]

427. **Assertion A:** In the case of unconfined compression test, Mohr's circle passes through the origin.

Reason R: The major principal stress is zero. [ES 97]

428. **Assertion A:** Permeability continues to decrease with the increase in dry density of a compacted soil.

Reason R: Soil particles in water surroundings may be mutually attracted or repulsed. [ES 98]

429. **Assertion A:** For a fully saturated soil, the pore pressure parameter is equal to zero.

Reason R: The compressibility of water is much smaller than the coefficient of volume compressibility. [ES 98]

430. **Assertion A:** Wash boring is recommended to obtain undisturbed soil sample above ground water table.

Reason R: In wash boring, water pumped through the hollow drill rods emerges through the ports of the chopping bit carrying disintegrated soil fragment. [ES 99]

431. **Assertion A:** Terzaghi's theory of consolidation considers only primary consolidation.

Reason R: Secondary consolidation takes place only at the end of the primary consolidation. [ES 99]

432. **Assertion A:** Mohr's circle for unconfined compression test passes through the origin.

Reason R: In an unconfined compression test, the axial stress is equal to confining stress.

433. **Assertion A:** Secondary consolidation takes place at a rate much slower than that of primary consolidation.

Reason R: There is dissipation of excess pore water pressure during secondary consolidation. [ES 96]

434. **Assertion A:** The ratio of operating frequency of machine 'f and natural frequency of foundation soil system' f_n should be either less than 0.5 or more than 1.5.

Reason R: The high amplitude caused during resonance ($f = f_n$) would damage the delicate parts of the machine. [CS 98]

435. **Assertion A:** When a saturated soil mass is subjected to consolidation, its volume at any instant is related to the total stress.

Reason R: Total stress is equal to the sum of the effective stress and pore water pressure. [CS 97]

436. **Assertion A:** Highly plastic swelling type of clay can be best stabilized by using lime as admixture.

Reason R: Absorption of water by lime in the soil improves its shear resistance. [CS 97]

437. **Assertion A:** The load carrying capacity of bored *cast-in situ* pile in a sandy soil is much less than that of a driven pile of similar dimensions.

Reason R: A drive pile generates much more point bearing resistance than a bored pile. [CS 99]

438. **Assertion A:** The phenomenon of quicksand occurs mostly in coarse sands and gravels.

Reason R: Quicksand condition does not occur in clayey soils as their cohesion holds the grains together even under upward flow at critical hydraulic gradient. [CS 99]

439. In the consolidated undrained triaxial test on a saturated soil sample, the pore water pressure is zero

a) during shearing stage only
b) at the end of consolidation stage only
c) both at the end of consolidation and during shearing stages
d) under none of the above conditions

[GATE 16]

*440. OMC-SP and MDD-SP denote the optimum moisture content and maximum dry density obtained from standard Proctor compaction test, respectively. OMC-MP and MDD-MP denote the optimum moisture content and maximum dry density obtained from the modified Proctor compaction test, respectively. Which one of the following is correct?

a) OMC-SP < OMC-MP and MDD-SP < MDD-MP
b) OMC-SP > OMC-MP and MDD-SP < MDD-MP

c) OMC-SP < OMC-MP and MDD-SP > MDD-MP
d) OMC-SP > OMC-MP and MDD-SP > MDD-MP [GATE 16]

*441. The results of a consolidation test on an undisturbed soil, sampled at a depth of 10 m below the ground level are as follows:

Saturated unit weight: 16 kN/m^3
Pre-consolidation pressure: 90 kPa
The water table was encountered at the ground level.

Assuming the unit weight of water as 10 kN/m^3, the over-consolidation ratio of the soil is

a) 0.67 b) 1.50
c) 1.77 d) 2.00
[GATE 16]

*442. A strip footing is resting on the ground surface of a pure clay bed having an undrained cohesion C_u. The ultimate bearing capacity of the footing is equal to

(a) $2\pi C_u$
b) πC_u
c) $(\pi + 1) C_u$
d) $(\pi + 2) C_u$ [GATE 17]

*443. The laboratory tests on a soil sample yields the following results; natural moisture content = 18% liquid limit = 60%, plastic limit = 25%, percentage of clay sized fraction = 25%. The liquidity index and activity (as per the expression proposed by Skempton) of the soil, respectively, are

a) – 0.2 and 1.4
b) 0.2 and 1.4
c) –1.2 and 0.714
d) 1.2 and 0.714 [GATE 17]

*444. The plate load test was conducted on a clayey stratum by using a plate of 0.3 m × 0.3 m dimensions and the ultimate load per unit area for the plate was found to be 180 kPa. The ultimate bearing capacity (in kPa) of a 2 m wide square footing would be

a) 27
b) 180
c) 1200
d) 2000 [GATE 17]

445. Following are the statements related to the stress path in a triaxial testing of soils:

P. If $\sigma 1 = \sigma 3$, the stress point lies at the origin of the p-q plot.

Q. If $\sigma 1 = \sigma 3$, the stress point lies on the p-axis of the p-q plot.

R. If $\sigma 1 > \sigma 3$, both the stress points p and q are positive.

For the above statements, the correct combination is

a) P False; Q True; R True
b) P True; Q False; R True
c) P False; Q True; R False
d) P True; Q False; R False
[GATE 17]

*446. Consider the following statements related to the pore pressure parameters, A and B

P. A always lies between 0 and 1.0
Q. A can be less than 0 or greater than 1.0
R. B always lies between 0 and 1.0
S. B can be less than 0 or greater than 1.0

For these statements, which one of the following options is correct?

a) P and R b) P and S
c) Q and R d) Q and S
[GATE 17]

*447. A 3 m high vertical earth retaining wall retains a dry granular backfill with angle of internal friction of 300 and unit weight of 20 kN/m^3. If the wall is prevented from yielding (no movement), the total horizontal thrust (in kN per unit length) on the wall is

a) 0 b) 30
c) 45 d) 270 [GATE 18]

448. Which one of the following statements is NOT correct?

a) When the water content of soil lies between its liquid limit and plastic limit, the soil is said to be in plastic state.
b) Boussinesq's theory is used for the analysis of stratified soil.
c) The inclination of stable slope in cohesive soil can be greater than its angle of internal friction.

d) For saturated dense fine sand, after applying overburden correction, if the Standard Penetration Test value exceeds 15, dilatancy correction is to be applied. [GATE 18]

*449. In a soil specimen, the total stress, effective stress, hydraulic gradient and critical hydraulic gradient are σ, σ', i and ic, respectively. For initiation of quicksand condition, which one of the following statement is TRUE?

a) $\sigma' = 0$ and $i = ic$
b) $\sigma = 0$ and $i = ic$
c) $\sigma' \neq 0$ and $i = ic$
d) $\sigma' \neq 0$ and $i \neq ic$ [GATE 19]

450. For the following statements:

P The lateral stress in the soil while being tested in an oedometer is always at-rest.

Q For a perfectly rigid strip footing at deeper depths in a sand deposit, the vertical normal contact

R The corrections for overburden pressure and dilatancy are not applied to measured SPT-N values in case of clay deposits.

The correct combination of the statements is

a) P True; Q True; R True
b) P False; Q False; R True
c) P True; Q True; R False
d) P False; Q False; R False

[GATE 19]

*451. In a soil investigation work at a site, Standard Penetration Test (SPT) was conducted at every 1.5 m interval up to 30 m depth. At 3 m depth, the observed number of hammer blows for three successive 150 mm penetrations were 8, 6 and 9, respectively. The SPTN-value at 3 m depth, is

a) 14
b) 17
c) 15
d) 23 [GATE 20]

452. Which one of the following statements is NOT correct?

a) a clay deposit with a liquidity index greater than unity is in a state of plastic consistency.
b) the cohesion of normally consolidated clay is zero when tri-axial test is conducted under consolidated undrained condition.
c) in case of a point load, Boussinesq's equation predicts higher value of vertical stress at a point directly beneath the load as compared to Westergaard's equation.
d) the ultimate bearing capacity of a strip foundation supported on the surface of sandy soil increase in direct proportion to the width of footing.

[GATE 20]

*453. In an Oedometer apparatus, a specimen of fully saturated clay has been consolidated under a vertical pressure of 50 kN/m^2 and is presently at equilibrium. The effective stress and pore water pressure immediately on increasing the vertical stress to 150 kN/m^2, respectively are

a) 0 and 150 kN/m^2
b) 100 kN/m^2 and 50 kN/m^2
c) 50 kN/m^2 and 100 kN/m^2
d) 150 kN/m^2 and 0 [GATE 21]

454. As per the Unified Soil Classification System (USCS), the type of soil represented by 'MH' is

a) inorganic silts of high plasticity with liquid limit more than 50%
b) inorganic silts of low plasticity with liquid limit less than 50%
c) inorganic clays of low plasticity with liquid limit more than 50%
d) inorganic clays of high plasticity with liquid limit less than 50%

[GATE 21]

*455. From laboratory investigations, the liquid limit, plastic limit, natural moisture content and flow index of a soil specimen are obtained as 60%, 27%, 32% and 27, respectively. The corresponding toughness

index and liquidity index of the soil specimen, respectively, are

a) 6.60 and 0.19 b) 0.15 and 1.22
c) 1.22 and 0.15 d) 0.19 and 6.06

[GATE 21]

*456. Four different soils are classified as CH, ML, SP, and SW, as per the Unified Soil Classification System. Which one of the following options correctly represents their arrangement in the decreasing order of hydraulic conductivity?

a) SW, SP, ML, CH
b) CH, ML, SP, SW
c) SP, SW, CH, ML
d) ML, SP, CH, SW [GATE 22]

457. Let σ'_v and σ'_h denote the effective vertical stress and effective horizontal stress, respectively. Which one of the following conditions must be satisfied for a soil element to reach the failure state under Rankine's passive earth pressure condition?

a) $\sigma'_v < \sigma'_h$ b) $\sigma'_v > \sigma'_h$
c) $\sigma'_v = \sigma'_h$ d) $\sigma'_v + \sigma'_h = 0$

[GATE 22]

458. Let Ψ represent soil suction head and K represent hydraulic conductivity of the soil. If the soil moisture content θ increases, which one of the following statements is TRUE?

a) ψ decreases and K increases
b) ψ increases and K decreases
c) Both ψ and K decrease
d) Both ψ and K increase

[GATE 22]

459. The correct match between the physical states of the soils given in Group I and the governing conditions given in Group II is

Group I	Group II
1. Normally consolidated soil	P. Sensitivity > 16
2. Quick clay	Q. Dilation angle = 0
3. Sand in critical state	R. Liquid limit > 50
4. Clay of high plasticity	S. Over consolidation ratio = 1

a) 1-S, 2-P, 3-Q, 4-R
b) 1-Q, 2-S, 3-P, 4-R
c) 1-Q, 2-P, 3-R, 4-S
d) 1-S, 2-Q, 3-P, 4-R [GATE 22]

460. As per Rankine's theory of earth pressure, the inclination of failure planes is $(45 + \phi/2)°$ with respect to the direction of the minor principal stress. The above statement is correct for which one of the following options?

a) Only the active state and not the passive state
b) Only the passive state and not the active state
c) Both active as well as passive states
d) Neither active nor passive state

[GATE 22]

461. Read the following statements:

(P) While designing a shallow footing in sandy soil, monsoon season is considered for critical design in terms of bearing capacity.
(Q) For slope stability of an earthen dam, sudden drawdown is never a critical condition.
(R) In a sandy sea beach, quicksand condition can arise only if the critical hydraulic gradient exceeds the existing hydraulic gradient.
(S) The active earth thrust on a rigid retaining wall supporting homogeneous cohesionless backfill will reduce with the lowering of water table in the backfill.

Which one of the following combinations is correct?

a) (P)-True, (Q)-False, (R)-False, (S)-False
b) (P)-False, (Q)-True, (R)-True, (S)-True
c) (P)-True, (Q)-False, (R)-True, (S)-True
d) (P)-False, (Q)-True, (R)-False, (S)-False

[GATE 22]

462. Match the following in Column X with Column Y:

Column X	Column Y
(P) In a triaxial compression test, with increase of axial strain in loose sand under drained shear condition, the volumetric strain	(I) Decreases.

(Q) In a triaxial compression test, with increase of axial strain in loose sand under undrained shear condition, the excess pore water pressure	(II) increases.
(R) In a triaxial compression test, the pore pressure parameter "B" for a saturated soil	(III) remains same.
(S) For shallow strip footing in pure saturated clay, Terzaghi's bearing capacity factor (Nq) due to surcharge	(IV) is always 0.0.
	(V) is always 1.0.
	(VI) is always 0.5.

Which one of the following combinations is correct?

a) (P)-(I), (Q)-(II), (R)-(V), (S)-(V)
b) (P)-(II), (Q)-(I), (R)-(IV), (S)-(V)
c) (P)-(I), (Q)-(III), (R)-(VI), (S)-(IV)
d) (P)-(I), (Q)-(II), (R)-(V), (S)-(VI)

[GATE 22]

463. Consider the following statements:
(1) illite is the mineral largely responsible for the swelling and shrinkage behaviour of clayey soils.
(2) a differential free swell value of 55% indicates a soil with low degree of expansiveness.
(3) higher the plasticity index of a soil, greater its swelling potential.
(4) a low shrinkage limit of a soil indicates possibility of swelling at low water content.

Which of the above statements are correct?

a) 1 and 2 only b) 2 and 3 only
c) 1 and 4 only d) 3 and 4 only

[ES 17]

464. Consider the following effects as indicative of complete saturation of a soil sample:
(1) Pore water pressure is positive
(2) Volume of water to volume of voids is equal to 1
(3) Relative density is equal to 1

Which of the above statements are correct?

a) 1 and 2 only
b) 1 and 3 only
c) 2 and 3 only
d) 1, 2 and 3

[ES 17]

465. Consider the following statements:
(1) secondary consolidation of soil follows Terzaghi's one-dimensional theory of consolidation.
(2) consolidation is a function of total stress.
(3) even after complete dissipation of excess pore pressure, the soil undergoes a little more consolidation.

Which of the above statements is/are correct?

a) 3 only b) 1 and 2 only
c) 2 and 3 only d) 1 only

[ES 17]

*466. An undrained triaxial compression test is carried out on a saturated clay sample under a cell pressure of 50 kN/m^2. The sample failed at a deviator stress of 100 kN/m^2. The cohesion of this clay sample would be

a) 25 kN/m^2 b) 50 kN/m^2
c) 75 kN/m^2 d) 100 kN/m^2

[ES 17]

467. Which of the following statements are correct?
(1) Stress isobar can be prepared using Boussinesq's stress distribution theory.
(2) Equivalent point load method yields accurate results.
(3) Newmarks's method relates the vertical stress with the help of influence chart.
(4) Westergaard's method helps in determination of stress distribution for layered soils.

Select the correct answer using the codes given below:

a) 1, 2 and 3 only
b) 1, 3 and 4 only
c) 1, 2 and 4 only
d) 2, 3 and 4 only [ES 17]

468. Consider the following statements:
(1) immediate settlement takes place as soon as the load is placed.
(2) secondary settlement is significant in the case of organic soil.
(3) secondary settlement is estimated based on the 'void ratio versus time curve' for a particular load under consolidation test.

Which of the above statements are correct?
a) 1 and 2 only
b) 1, 2 and 3
c) 2 and 3 only
d) 1 and 3 only [ES 17]

*469. In a plate load test on a soil, at a particular magnitude of the settlement, it was observed that the bearing pressure beneath the footing is 100 kN/m^2 and the perimeter shear is 25 kN/m^2. Correspondingly, the load capacity of a 2 m square footing at the same settlement will be
a) 200 kN b) 300 kN
c) 400 kN d) 600 kN
[ES 17]

470. Consider the following statements:
(1) according to Terzaghi, a foundation is shallow if its depth is equal to or less than its width.
(2) spread footing, strap footing and raft footing are types of shallow foundations.
(3) combined footing may be trapezoidal if the two columns carry unequal loads; and rectangular if both columns carry equal loads.
(4) for water tanks, providing raft foundations will avoid unequal settlements.

Which of the above statements are correct?
a) 1, 2, 3 and 4
b) 1, 2 and 3 only
c) 1, 2 and 4 only
d) 3 and 4 only [ES 17]

471. Consider the following statements:
(1) the maximum shear stress is one half of the normal stress in the case of uniaxial stress field.
(2) in a biaxial stress field, acted upon by normal stresses unaccompanied by shear stresses, the maximum shear stress is anyone of the normal stresses.
(3) the Mohr's stress circle will be tangential to the vertical axis in the case of uniaxial stress field.

Which of the above statements are correct?
a) 1, 2 and 3 b) 1 and 2 only
c) 2 and 3 only d) 1 and 3 only
[ES 17]

472. Consider the following statements:
(1) all soils can be identified in the field by visual examination
(2) fine-grained soils can be identified in the field by visual examination and touch
(3) fine grained soils can be identified in the field by dilatancy test
(4) by visual examination, only coarse-grained soils can be identified

Which of the above statements are correct?
a) 1 and 2 only b) 2 and 3 only
c) 3 and 4 only d) 1 and 4 only
[ES 18]

*473. Consider the following statements:
(1) when a soil sample is dried beyond its shrinkage limit, the volume of the soil slowly decreases
(2) plastic limit is always lower than the liquid limit for any type of soil
(3) at the liquid limit, the soil behaves like a liquid and possesses no shear strength at all
(4) when subjected to drying, the volume of the soil remains unchanged once the water content of the soil goes below its shrinkage limit.

Which of the above statements are correct?
a) 1 and 3 only b) 1 and 4 only
c) 2 and 3 only d) 2 and 4 only
[ES 18]

474. A sand sample has a porosity of 30% and specific gravity of solids as 2.6. What is its degree of saturation at moisture content of 4.94%?

a) 40% b) 35%
c) 30% d) 25% [ES 18]

475. What will be the unit weight of a fully saturated soil sample having water content of 38% and grain specific gravity of 2.65?
a) 19.88 kN/m^3 b) 17.88 kN/m^3
c) 16.52 kN/m^3 d) 14.65 kN/m^3
[ES 18]

*476. How many cubic metres of soil having void ratio of 0.7 can be made from 30 m^3 of soil with void ratio of 1.2?
a) 36.6 m^3 b) 30.0 m^3
c) 25.9 m^3 d) 23.2 m^3
[ES 18]

*477. A dry sand specimen is put through a tri-axial 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) 45° d) 55° [ES 18]

478. Consider the following statements with regard to soil testing:
(1) The origin and pole are at the same point in a Mohr's circle
(2) The shear stress is maximum on the failure plane
(3) Mohr's circle drawn with data from an unconfined compression test passes through the origin
(4) Maximum shear stress occurs on a plane inclined at 45° to the principal plane.

Which of the above statements are correct?
a) 1 and 2 only b) 2 and 3 only
c) 3 and 4 only d) 1 and 4 only
[ES 18]

479. A soil yielded a maximum dry unit weight of 18 kN/m^3 at a moisture content of 16% during a standard proctor test. What is the degree of saturation of the soil if its specific gravity is 2.65?
a) 98.42% b) 95.50%
c) 84.32% d) 75.71%
[ES 18]

480. Consider the following assumptions regarding Coulomb's Wedge Theory:
(1) There is equilibrium of every element within the soil mass of the material
(2) There is equilibrium of the whole of the material
(3) Backfill is wet, cohesive, and ideally elastic
(4) The wall surface is rough

Which of the above assumptions are correct?
a) 1 and 3 only b) 1 and 4 only
c) 2 and 3 only d) 2 and 4 only
[ES 18]

481. In a clayey soil having 50 kN/m^2 as unit cohesion and 18 kN/m^3 as unit weight, an excavation is made with a vertical face. Taking Taylor's stability number as 0.261, what is the maximum depth of excavation so that the vertical face remains stable?
a) 5.30 m b) 7.06 m
c) 10.6 m d) 12.4 m
[ES 18]

482. The property of clays by virtue of which they regain, if left alone for a time, a part of the strength lost due to remoulding at unaltered moisture content, is known as
a) thixotropy b) sensitivity
c) consistency d) activity
[ES 19]

*483. The plastic limit and liquid limit of a soil are 30% and 42% respectively. The percentage-volume change from liquid limit to dry state is 35% of the dry volume. Similarly, the percentage volume change from plastic limit to dry state is 22% of the dry volume. The shrinkage ratio will be nearly
a) 4.2 b) 3.1
c) 2.2 d) 1.1 [ES 19]

484. The ratio of a given volume change in a soil, expressed as percentage of the dry volume, to the corresponding change in water content is called
a) specific gravity of soil solids
b) mass-specific gravity of soils

c) shrinkage ratio of soils
d) density ratio of soils [ES 19]

*485. A masonry dam is founded on pervious sand. A factor of safety of 4 is required against boiling. For the sand, $n = 45\%$ and $G_s = 2.65$. The maximum permissible upward hydraulic gradient will be nearly
a) 0.18 b) 0.23
c) 0.28 d) 0.33
[ES 19]

*486. The representative liquid limit and plastic limit values of a saturated consolidated clay deposit are 60% and 30%, respectively. The saturated unit weight of the soil is 19 kN/m^3. The water table is at 8 m below ground level. At a depth of 10 m from the ground surface, the undrained shear strength of the soil will be nearly
a) 37.7 kN/m^2 b) 33.5 kN/m^2
c) 29.3 kN/m^2 d) 25.1 kN/m^2
[ES 19]

*487. A 6 in high retaining wall with a vertical back has a backfill of silty sand with a slope of 10° for the backfill. With values of $K_H = 760$ kg/m^2/m and $K_V = 100$ kg/m^2/m, the total active earth pressure will approximately be
a) 128 kN/m b) 134 kN/m
c) 138 kN/m d) 142 kN/m
[ES 19]

488. The vertical stress at any point at a radial distance r and at depth z as determined by using Boussinesq's influence factor K_B and Westergaard's influence factor K_W would be almost same for (r/z) ratios equal to or greater than
a) 2.0 b) 1.8
c) 1.5 d) 1.2
[ES 19]

489. A strip footing 2 m in width, with its base at a depth of 1.5 m below ground surface, rests on a saturated clay soil with γ_{sat} = 20 kN/m^3; $C_u = 40$ kN/m^2; $\phi_u = 0$; $c' = 10$ kN/m^2; and $\phi' = 20°$. The natural water table is at 1 m depth below ground level. As per IS:6403–1981, the ultimate bearing capacity of this footing will be (taking the relevant N_c as 5.14)
a) 327 kN/m^2 b) 285 kN/m^2
c) 253 kN/m^2 d) 231 kN/m^2
[ES 19]

490. The settlement due to secondary compression is predominant in
a) granular soils
b) inorganic clays
c) organic clays
d) very fine sand and silts [ES 19]

*491. A raft foundation 10 m wide and 12 m long is to be constructed in a clayey soil having shear strength of 12 kN/m^2. Unit weight of soil is 16 kN/m^3. The ground surface carries a surcharge of 20 kN/m^2; the factor of safety is 1.2 and the value of $N_s = 5.7$. The safe depth of foundation will be nearly
a) 8.2 m b) 7.3m
c) 6.4m d) 5.5 m [ES 19]

492. The skin frictional resistance of a pile driven in sand does not depend on
a) lateral earth pressure
b) coefficient Angle of friction between pile and soil
c) pile material
d) total stress analysis [ES 19]

*493. An excavation is made with a vertical face in a clay soil which has $C_u = 50$ kN/m^2, $\gamma_t = 18$ kN/m^3 and $s_n = 0.261$. The maximum depth of a stable excavation will be nearly
a) 10.6 m b) 12.4 m
c) 14.2 m d) 16.0 m
[ES 19]

494. A soil sample has a porosity of 40% and the specific gravity of solid is 2.70. If the soil is 50% saturated, the unit weight will be nearly
a) 22 kN/m^3 b) 20 kN/m^3
c) 18 kN/m^3 d) 16 kN/m^3
[ES 20]

*495. Oven dry mass of a pat of clay is 10.8 gm and mass of mercury displaced on immersion is 84.2 gm. If the specific gravity of solids is 2.72 and the density of

the mercury is 13.6 g/cm^3, the shrinkage limit of the soil will be nearly
a) 12%
b) 15%
c) 18%
d) 21% [ES 20]

*496. The suitability number of a backfill for $D_{50} = 1$ mm, $D_{20} = 0.5$ mm and $D_{10} = 0.08$ mm will be nearly
a) 16 b) 18
c) 20 d) 22
[ES 20]

497. A coarse-grained soil has a void ratio of 0.78 and specific gravity as 2.67. The critical gradient at which a quick sand condition occurs will be
a) 0.62 b) 0.74
c) 0.82 d) 0.94 [ES 20]

*498. A bed consists of compressible clay of 4 m thickness with pervious sand on top and impervious rock at the bottom. In a consolidation test on an undisturbed specimen of clay from this deposit 90% settlement was reached in 4 hours. The specimen was 20 mm thick. The time for the building founded over this deposit to reach 90% of its final settlement will be
a) 91 years b) 82 years
c) 73 years d) 64 years
[ES 20]

499. A 30 cm square bearing plate settles by 8 mm in the plate load test on cohesionless soil when the intensity of loading is 180 kN/m^2. The settlement of a shallow foundation of 1.5 m square under the same intensity of loading will be nearly
a) 30 mm b) 26 mm
c) 22 mm d) 18 mm
[ES 20]

*500. A canal of 4 m deep has side slopes of 1:1. The properties of the soil are c = 15 kN/m^2, $\phi = 15°$, $e = 0.76$ and $G = 2.7$. Taylor's stability number for that sudden draw down = 0.136. The factor of safety with respect to cohesion in the case of sudden draw down will be
a) 0.64 b) 1.43
c) 2.22 d) 3.01 [ES 20]

501. The stability or shear strength of fine-grained soils can be increased by draining them with the passage of direct current through them. This process is known as
a) Electro-osmosis
b) zeta potential
c) electro-chemical hardening
d) consolidation [ES 20]

*502. A soil has bulk density of 20.1 kN/m^3 and water content 15%. What is the water content if the soil partially dries to a density of 19.4 kN/m^3 and the void ratio remains unchanged?
a) 10.86% b) 10.76%
c) 10.68% d) 10.66%
[ES 21]

*503. A fine grained soil is found to have a liquid limit of 90% and a plasticity index of 50. The natural water content is 28%. What is the liquidity index?
a) –0.34 b) –0.14
c) –0.24 d) –2.40 [ES 21]

*504. A concentrated load of 2000 kN is applied at the ground surface. What is the vertical stress at a point 6 m directly below the load?
a) 16.42 kN/m^2 b) 26.53 kN/m^2
c) 36.12 kN/m^2 d) 40.51 kN/m^2
[ES 21]

505. A sample of silty clay has a volume of 14.88 cm^3, a total mass of 28.81 gm, a dry mass of 24.83 gm and a specific gravity of solids 2.7. What is the void ratio?
a) 0.412 b) 0.521
c) 0.618 d) 0.663 [ES 21]

*506. A constant head permeability test is carried out on a cylindrical sample of sand 10 cm diameter and 15 cm height. 160 cm^3 of water is collected in 1.75 minutes, under a head of 30 cm. What is the coefficient of permeability in m/year?
a) 1257 m/year
b) 2111 m/year
c) 3060 m/year
d) 3382 m/year [ES 21]

507. Which one of the following is the correct assumption of Rankine's theory?
a) Soil mass is infinite
b) Soil mass is non homogeneous
c) Soil mass is cohesive
d) Ground surface is a plane which may be horizontal or inclined
[ES 21]

508. If retaining wall 5 m high is restrained from yielding, what is the at-rest earth pressure per meter length of wall? (Consider the backfill is cohesionless soil having $\phi = 30$ and $\gamma = 18 kN\ m^3$)
a) 108 kN/m b) 112.5 kN/m
c) 115 kN/m d) 124 kN/m
[ES 21]

*509. The void ratio of a clay sample is 0.5 and the degree of saturation is 70%. What is the bulk unit weight of the soil? (Assume $G = 2.7$)
a) 10.46 kN/m^3 b) 14.32 kN/m^3
c) 17.77 kN/m^3 d) 19.95 kN/m^3
[ES 21]

*510. What is the coefficient of volume change (using change in void ratio method) for pressure range 100 kN /m^2 to 200 kN/m^2? (Consider $\sigma_0' = 100$ kN/m^2, $e_0 = 1.121$, $\sigma' = 200$ kN/m^2, $e_0' = 0.964$, $\Delta\sigma = 100$ kN/m^2 and $\Delta e = -0.157$)
a) 0.25 m^2/MN b) 0.48 m^2/MN
c) 0.69 m^2/MN d) 0.74 m^2/MN
[ES 21]

511. For non-homogeneous clays, the coefficient of permeability in (mm/s) should be ranges between
a) 10^{-1} to 10^{-2} b) 10^{-2} to 10^{-3}
c) 10^{-3} to 10^{-4} d) 10^{-4} to 10^{-6}
[ES 22]

512. The maximum test load on a working pile should not exceed
a) 250 kN
b) 180 kN
c) two and a half times the design load
d) one and a half times the design load
[ES 22]

513. Which one of the following does NOT affect the permeability of soils?
a) void ratio b) soil strength
c) grain size d) temperature
[ES 22]

514. Consistency is a term used to indicate
a) the quantitative analysis of soils
b) the degree of firmness of cohesive soils
c) the fineness of non-cohesive soils
d) the fineness of clay soils [ES 22]

515. The primary function of geogrids is
a) connecting two layers
b) separators
c) reinforcement
d) protection from corrosion [ES 22]

516. Which one of the following characteristics is NOT measured by geophysical method of soil exploration?
a) magnetism
b) density
c) electrical resistivity
d) plasticity [ES 22]

517. According to Highway Research Board (HRB) classification system, which one of the following is NOT relevant for dependency of group index of soil?
a) the amount of material passing the 75-micron IS sieve
b) the liquid limit
c) the plastic limit
d) The shrinkage limit [ES 22]

*518. An oven-dried soil having a mass of 200 g is placed in a pycnometer which is then completely filled with water. The total mass of the pycnometer with water and soil inside is 1605 g. The pycnometer filled with water alone has a mass of 1480 g. What is the specific gravity of the soil?
a) 2.21 b) 2.41
c) 2.67 d) 3.32
[ES 22]

519. A soil sample has a porosity of 40%. The specific gravity of solids is 2.70. What is voids ratio?
a) 0.467 b) 0.567
c) 0.667 d) 0.743 [ES 22]

*520. In a rock core sampling method at site, six intact pieces of rocks of lengths 180 mm, 170 mm, 70 mm, 120 mm, 50 mm, and 250 mm were collected in 1.2 m length of drilling in rocky strata. The value of rock quality designation (RQD) and core recovery respectively for the rock sample is
a) 60% and 70% b) 65% and 75%
c) 70% and 60% d) 60% and 75%

*521. A cohesive soil was tested in natural state and in the remoulded state. If the unconfined compressive strength of 40 kN/m^2 in the natural state of clay reduces half in the remoulded state, then its sensitivity will be
a) 0.5 b) 1
c) 2 d) 4

522. Compression index developed by Casagrande is
a) $C_v = 0.009$ (LL + 10%)
b) $C_v = 0.009$ (LL – 10%)
c) $C_v = 0.0009$ (LL + 10%)
d) $C_v = 0.0009$ (LL – 10%)

*523. A cohesive soil was tested in natural state and in the remoulded state. The unconfined compressive strength of 40 kN/m^2 in the natural state of clay reduces to 8 kN/m^2 in the remoulded state. Based on sensitivity, the soil can be described as
a) insensitive
b) medium sensitive
c) sensitive
d) very sensitive

524. In an unconsolidated undrained triaxial test, it is observed that an increase in cell pressure from 150 kPa to 250 kPa leads to a pore pressure increase of 80 kPa. It is further observed that, an increase of 50 kPa in deviator stress results in an increase of 25 kPa in the pore pressure. The value of Skemption's pore pressure parameter B is
a) 0.5 b) 0.625
c) 0.8 d) 1.0

525. Stress path equation for triaxial test upon application of deviation stress is, $q = 10\sqrt{3} + 0.5$. The respective values of cohesion, (in kPa) and angle of internal friction, are
a) 20 and 200 b) 20 and 300
c) 30 and 300 d) 30 and 200

526. Surcharge loading required to be placed on the horizontal backfill of a smooth retaining vertical wall so as to completely eliminate tensile crack is
a) $2c$ b) $2ck_a$
c) $2c\sqrt{k_a}$ d) $\dfrac{2c}{\sqrt{k_a}}$

527. Consider the following statements:
(1) Activity is a property typical of clay soils.
(2) An activity value of 7 in a clay soil is indicative of the presence of montmorillonite mineral.
(3) An activity value of 7 in a clay soil is indicative of the presence of illite mineral.
Which of these statements are correct?
a) 1, 2 and 3 b) 1 and 2 only
c) 1 and 3 only d) 2 and 3 only

528. In a wet soil mass air, occupies one-fourth of its volume and water occupies one-half of its volume. The void ratio of this soil is
a) 1 b) 2
c) 3 d) 4

529. Consider the following statements:
(1) A conspicuous break in the continuity of a grain size distribution curve indicates a mixture of soil from two different layers.
(2) A steep grain size distribution curve indicates prevalence of nearly uniform grain size.
(3) A flat grain size distribution curve indicates certain range of missing grain sizes.
Which of these statements are correct?
a) 1, 2 and 3 b) 2 and 3 only
c) 1 and 3 only d) 1 and 2 only

530. When a structural load is applied on a soil stratum, which of the following soil types will have the minimum settlement?
a) over-consolidated clay stratum
b) clayey silt stratum

c) normally consolidated clay stratum
d) sandy clay stratum

531. Unconfined compression test is most suitable for determining the
(1) sensitivity of clays
(2) settlement of embankments
(3) 'strength' of partially saturated clay sample
(4) 'strength' of fully saturated clay sample
a) 1, 2, 3 and 4 b) 2 and 3 only
c) 3 and 4 only d) 1 and 4 only

532. The lateral earth pressure coefficients of a soil, K_a for active state, K_p for passive state and K_0 for at-rest condition compare as:
a) $K_0 < K_a < K_p$ b) $K_a < K_0 < K_p$
c) $K_a < K_p < K_o$ d) $K_p < K_0 < K_a$

533. A clay soil sample is tested in a triaxial apparatus in consolidated-drained conditions at a cell pressure of 100 kN/m^2. What will be the pore water pressure at a deviator stress of 40 kN/m^2?
a) 0 b) 20 kN/m^2
c) 40 kN/m^2 d) 60 kN/m^2

534. In an untrained triaxial test on a saturated clay, the Poisson's ratio is
a) $\sigma_3/(\sigma_1 + \sigma_3)$ b) $\sigma_3/(\sigma_1 - \sigma_3)$
c) $(\sigma_1 - \sigma_3)/\sigma_3$ d) $(\sigma_1 + \sigma_3)/\sigma_3$

535. For checking the stability of the upstream slope of an earthen dam under rapid drawdown condition, the correct shear parameters to be used are from
a) consolidated drained test
b) consolidated undrained test with pore pressure measurement
c) unconsolidated undrained test
d) unconsolidated undrained test with pore pressure measurement

536. Consider the following statements:
(1) General shear failure is followed by low strain (<5%).
(2) Local shear failure is followed by a large strain (>10 to 20%).
(3) For general shear failure, angle of shearing resistance >36°.
(4) For local shear failure, angle of shearing resistance <36°.
Which of the above statements are correct?
a) 1, 2 and 3 only b) 1, 2 and 4 only
c) 2, 3 and 4 only d) 1, 2, 3 and 4

537. The description 'sandy silty clay' signifies that
a) the soil contains unequal proportions of the three constituents, in the order, sand > silt > clay.
b) the soil contains equal proportions of sand, silt and clay.
c) the soil contains unequal proportions of the three constituents such that clay > silt > sand
d) the soil contains unequal proportions of sand, silt and clay but there is no information regarding the relative proportions of the three.

538. Increasing the depth of foundation in saturated clays results in an increased ultimate bearing capacity for strip footings
a) because the bearing capacity factor, N_γ, decreases
b) because the bearing capacity factor, N_c increases as the depth increases
c) the term in the bearing capacity equation, qN_q, increases with depth
d) because the angle of internal friction decreases as the depth of foundation increases.

539. For degree of consolidation U < 60%, the time factor is
a) $(\pi/2) \times (U/100)^2$
b) $(\pi/4) \times (U/100)^2$
c) $(\pi/16) \times (U/100)^2$
d) $(\pi/2) \times (U/100)^3$

540. Modified values of the shear parameters c' and ϕ' respectively, for the condition of local shear failure are given by
a) $c/3$ and $\tan^{-1}(\tan \phi/3)$
b) $c/3$ and $\tan^{-1}(2 \tan \phi/3)$
c) $2c/3$ and $\tan^{-1}(\tan \phi/3)$
d) $2c/3$ and $\tan^{-1}(2 \tan \phi/3)$