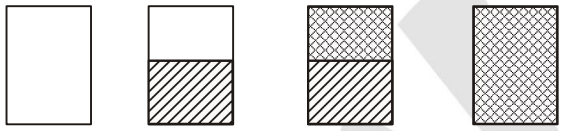
QUESTION BANK

1. The liquid limit and plastic limit of sample are 65% and 29% respectively. The percentage of the soil fraction with grain size finer than 0.002 mm is 24. The activity ratio of the soil sample is

(a) 0.50 (b) 1.00

(c) 1.5 (d) 2.00

2. The given figure indicate the weights of different pycnometers:



Empty Pycnometer W_1 | Pycnometer +Dry Soil W_2 | Pycnometer +Soil + Water W_3 | Pycnometer +Water W_4

The specific gravity of the solids is given by

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

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

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

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

3. 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%

4. In a wet soil mass, air occupies one-sixth of its volume and water occupies one-third of its volume. The void ratio of the soil is

(a) 0.25 (b) 0.5

(c) 1.00 (d) 1.50

5 ***Assertion (A):*** If the water table is very near to the subgrade of the road. It will ultimately cause cracking of the road surface.

Reason (R): The consistency of the soil will change from plastic to liquid state leading to its volumetric decrease.

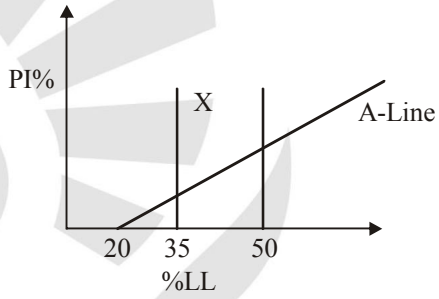
(a) Both A and R are true and R is the correct explanation of A

(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

6. The standard plasticity chart to classify fine grained soils is shown in the given figure.



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

7. 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

8. A dry soil has mass specific gravity of 1.35.If the specific gravity of solids is 2.7, then the void ratio will be

(a) 0.5 (b) 1.0 (c) 1.5 (d) 2.0

9. A clay sample has a void ratio of 0.50 in dry state and specific gravity of solids = 2.70. Its shrinkage limit will be

(a) 12% (b) 13.5%

(c) 18.5% (d) 22%

10. 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

11. Consider the following statements in relation to the given sketch:

Volume (cc)		Weight (g)
0.2	Air	0
0.3	Water	0.3
0.5	Solids	0.1

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

Which of these statements is/are correct?

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

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

12. 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

13. 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

14. A fill having a volume of 1,50.000 cum is to be constructed at a void ratio of 0.8. The borrow pit soil has a void ratio of 1.4. The volume of soil required (in cubic meters) to be excavated from the borrow pit will be

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

(c) 2,10,000 (d) 2,25,000

15. 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

16. The initial and final void ratios of a clay sample in a consolidation test are 1 and 0.5, respectively. If 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

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

(a) 70 (b) 60

(c) 40 (d) 30

18. A clayey soil has liquid limit = w_L; plastic limit = w_p and natural moisture content = w. The consistency index of the soil is given by

(a) $\frac{w_L - w}{w_L - w_P}$ (b) $\frac{w_L - w_p}{w_L - w}$

(c) $\frac{w_P - w}{w_L - w_P}$ (d) $\frac{w_L - w_p}{w_P - w}$

19. 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.

Which of these statements is/are correct?

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

(c) 2 and 3 (d) 3 alone

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

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

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

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

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

21. The saturated and dry densities of a soil are respectively 2000 kg/m^3 and 1500 kg/m^3. The water content (in percentage) of the soil in the saturated state would be

(a) 25 (b) 33.33
(c) 50 (d) 66.66

22. If a soil sample of weight 0.18 kg having a volume of 10^{-4} m^3 and dry unit weight of 1600 kg/m^3 is mixed with 0.02 kg of water then the water content in the sample will be

(a) 30% (b) 25%
(c) 20% (d) 15%

23. Match List-I (Terms) with List-II (Formulae) and select the correct answer using the codes given below the lists:

List-I	List-II
A. Void Ratio	**1.** $\frac{V_V}{V}$
B. Porosity	**2.** $\frac{W_W}{W_S}$
C. Degree of saturation	**3.** $\frac{V_W}{V_V}$
D. Water content	**4.** $\frac{W}{V}$
	5. $\frac{V_V}{V_S}$

Codes:

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

24. 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

25. The value of porosity of a soil sample in which the total volume of soil grains is equal to twice the total volume of voids would be

(a) 75% (b) 66.66%
(c) 50% (d) 33.33%

26. A soil has a liquid limit of 40% and plasticity index of 20%. The plastic limit of the soil will be

(a) 20% (b) 30%
(c) 40% (d) 60%

27. A sample of saturated sand has a dry unit weight of 18 kN/m^3 and a specific gravity of 2.7. If density of water is 10 kN/m^3, the void ratio of the soil sample will be

(a) 0.5 (b) 0.6
(c) 0.4 (d) 0.9

Common Data for Questions :28 & 29

For constructing an embankment, the soil is transported from a borrow area using a truck which can carry 6m^3 of soil at a time. The details are as follows.

Property	Borrow area	Truck (loose)	Field (compacted)
Bulk density (g / cc)	1.66	1.15	1.82
Water content (%)	8	6	14

28. The quantity of soil to be excavated from the borrow pit, in m^3 for a compacted earth fill of 100 m^3 is

(a) 104 cum (b) 146 cum
(c) 98 cum (d) 87 cum

29. The number of truck loads of soil required to obtain 100m^3 of compacted earth fill

(a) 12 nos. (b) 56 nos.
(c) 25 nos. (d) 33 nos

30. When the product of rock weathering is not transported as sediment but remains in place, is called
(a) alluvial soil (b) glacial soil
(c) residual soil (d) aeoline soil

31. Aeolian soils are
(a) Residual soils (b) Wind deposits
(c) Gravity deposits (d) Water deposits

32. If the porosity of a soil sample is 20%, the void ratio is
(a) 0.20 (b) 0.80
(c) 1.00 (d) 0.25

33. Consistency Index for a clayey soil is [{LL= Liquid Limit, PI = Plasticity Index, w = natural moisture content]
(a) $\frac{LL - w}{PI}$ (b) $\frac{w - PL}{PI}$
(c) LL – PL (d) 0.5 w

34. If soil is dried beyond its shrinkage limit, it will show
(a) Large volume change
(b) Moderate volume change
(c) Low volume change
(d) No volume change

35. The toughness index of clayey soils is given by
(a) Plasticity index/Flow index
(b) liquid limit /Plastic limit
(c) Liquidity index /plastic limit
(d) Plastic limit/Liquidity index

36. A soil sample in its natural state has mass of 2.290 kg and a volume of 1.15×10^{-3} m^3. After being oven dried, the mass of the sample is 2.035 kg. G_s for soil is 2.68. The void ratio of the natural soil is
(a) 0.40 (b) 0.45
(c) 0.55 (d) 0.53

37. Principle involved in the relationship between submerged unit weight and saturated weight of a soil is based on
(a) Equilibrium of floating bodies
(b) Archimedes' principle
(c) Stokes' law
(d) Darcy's law

38. A soil sample has a void ratio of 0.5 and its porosity will be close to
(a) 50% (b) 66%
(c) 100% (d) 33%

39. A borrow pit soil has a dry density of 17 kN/m^3. How many cubic meters of this soil will be required to construct an embankment of 100 m^3 volume with a dry density of 16 kN/m^3.
(a) 94 m^3 (b) 106 m^3
(c) 100m^3 (d) 90m^3

40. The void ratio and specific gravity of a soil are 0.65 and 2.72 respectively. The degree of saturation (in percent) corresponding to water content of 20% is
(a) 65.3 (b) 20.9
(c) 83.7 (d) 54.4

41. A dry soil sample has equal amounts of solids and voids by volume. It void ratio and porosity will be

	Void ratio	Porosity (%)
(a)	1.0	100%
(b)	0.5	50%
(c)	0.5	100%
(d)	1.0	50%

42. The plasticity index and the percentage of grain size finer than 2 microns of a clay sample are 25 and 15, respectively. Its activity ratio is
(a) 2.5 (b) 1.67
(c) 1.0 (d) 0.6

43. A soil sample having a void ratio of 1.3, water content of 50% and a specific gravity of 2.60, is in a state of
(a) partial saturation (b) full saturation
(c) over saturation (d) under saturation

44. The natural void ratio of a sand sample is 0.6 and its density index is 0.6. If its void ratio in the loosest state is 0.9, then the void ratio in the densest state will be
(a) 0.2 (b) 0.3
(c) 0.4 (d) 0.5

45. Which one of the following correctly represents the dry unit weight of a soil sample which has a bulk unit weight of γ_t at a moisture content of w%?
(a) $\frac{w\gamma_t}{100}$ (b) $\gamma_t\left(1 + \frac{w}{100}\right)$
(c) $\gamma_t\left(\frac{100}{100 + w}\right)$ (d) $\frac{\gamma_t(100 - w)}{100}$

46. Given that coefficient of curvature = 1.4, D_{30} = 3 mm, D_{10} 0.6 mm.
Based on this information of particle size distribution for use as subgrade, this soil will be taken to be
(a) uniformly-graded sand
(b) well-graded sand
(c) very fine sand
(d) poorly-graded sand

47. The following data were obtained from a liquid limit test conducted on a soil sample.

Number of blows	17	22	25	28	34
Water Content	63.8	63.1	61.9	60.6	60.5

The liquid limit of the soil is:
(a) 63.1% (b) 62.8%
(c) 61.9% (d) 60.6%

48. The void ratios at the densest, loosest and the natural states of a sand deposit are 0.2, 0.6, and 0.4 respectively. The relative density of the deposit is
(a) 100% (b) 75%
(c) 50% (d) 25%

49. While computing the values of limits of consistency and consistency indices, it is found that liquidity index, has a negative value.
1. Liquidity index cannot have a negative value and should be taken as zero.
2. Liquidity index can have a negative value.
3. The soil tested is in semisolid state and stiff.
4. The soil tested is in medium soft state.
Which of these statements are correct?
(a) 1 and 4 (b) 1 and 3
(c) 2 and 4 (d) 2 and 3

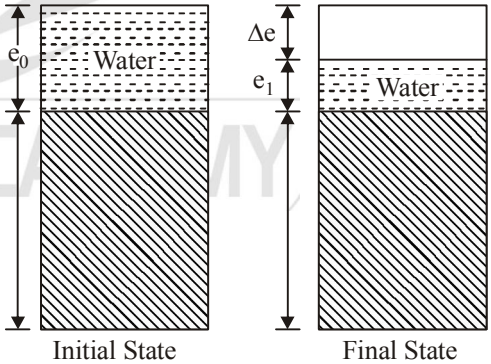
50. Which one of the following represents relative density of saturated sand deposit having moisture content of 25%, if maximum and minimum void ratio of sand are 0.95 and 0.45 respectively and specific gravity of sand particles is 2.6?
(a) 40% (b) 50%
(c) 60% (d) 70%

51. ***Assertion (A):*** A soil is at its liquid limit if the consistency index of the soil is equal to zero.
Reason (R): The consistency index of a soil is defined as ratio of (liquid limit minus the natural water content) to (natural water content minus plastic limit).
Codes given below :
(a) Both and R are true and R is the correct explanation of A
(b) Both 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

52. Consistency as applied to cohesive soils is an indicator of its
(a) density (b) moisture content
(c) shear strength (d) porosity

53. The ratio of saturated unit weight to dry unit weight of a soil is 1.25. If the specific gravity of solids (G_s) is 2.65, the void ratio of the soil is
(a) 0.625 (b) 0.663
(c) 0.944 (d) 1.325

54. In the phase diagrams given the change due to initial state changing into final state is shown due to consolidation. Depth of soil layer undergoing consolidation is H; e_0 is initial void ratio; e_r is final void ratio; Δe is change in void ratio.



Indicate which of the following expressions gives settlement of the layer.
(a) $H \log_{10}\left(\frac{\Delta e}{1+e_0}\right)$ (b) $\log_{10}\left(H\frac{\Delta e}{1+e_0}\right)$
(c) $\frac{\Delta e}{1+e_0}$ (d) $H\frac{\Delta e}{1+e_0}$

55. match List-I (Unit/Test) with List-II (Purpose) and select the correct answer using the codes given below the lists

List-I

A. Casagrande's apparatus
B. Hydrometer
C. Plate load test
D. Oedometer

List-II

1. Determination of grain size distribution
2. Consolidation characteristics
3. Determination of consistency limits
4. Determination of safe bearing capacity of soil

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

56. Two soil sample A and B have porosities $n_A = 40\%$ and $n_B = 60\%$ respectively. What is the ratio of void ratios $e_A : e_B$?

(a) 2 : 3 (b) 3 : 2
(c) 4 : 9 (d) 9 : 4

57. Match List-I (Densities) with List-II (Expressions) and select the correct answer using the codes given below the lists:

(Symbols G, e, γ_w and S stand for specific gravity of soil grains, void ratio, unit weight of water and degree of saturation respectively)

List-I	List-II
A. Dry density	**1.** $\frac{\gamma_w (G + Se)}{(1 + e)}$
B. Moist density	**2.** $\frac{\gamma_w G}{(1 + e)}$
C. Submerged density	3. $\frac{\gamma_w (G + e)}{(1 + e)}$
D. Saturated density	**4.** $\frac{\gamma_w (G - 1)}{(1 + e)}$

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

58. What are the respective values of void ratio, porosity ratio and saturated density (in kN/m^3) for a soil sample which has saturation moisture content of 20% and specific gravity of grains as 2.6? (take density of water as 10 kN/m^3)

(a) 0.52, 1.08, 18.07 (b) 0.52, 0.34, 18.07
(c) 0.77, 1.08, 16.64 (d) 0.52, 0.3, 20.14

59. Embankment fill is to be compacted at a density of 18 kN/m^3. The soil of the borrow area is at a density of 15 kN/m^3. What is the estimated number of trips of 6 m^3 capacity truck for hauling the soil required for compacting 100 m^3 fill of the embankment? (Assume that the soil in the borrow area and that in the embankment are at the same moisture content)

(a) 14 (b) 18
(c) 20 (d) 23

60. Well-graded dense saturated sands have high shear strength because

(a) such sands have a better grade (superior type of sand grains resulting in higher strength
(b) such sands have lower water content, which increases shear strength
(c) such sands have better interlocking of grains, higher inter-particle contacts and higher inter-particle frictional resistance resulting in higher strength
(d) presence of water in such sands induces capillary pressure generating higher inter granular stresses, which generate apparent cohesion and hence higher shear strength.

❑❑❑

ANSWERS AND EXPLANATIONS

1. *Ans. (c)*

$$\text{Activity} = \frac{\text{Plasticity Index}}{\%\text{ of clay fraction}}$$

$$= \frac{65-29}{24} = \frac{36}{24} = 1.5 > 1.25$$

2. *Ans. (d)*

Specific Gravity of solids is given by

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

3. *Ans. (a)*

Shrinkage limit, $w_s = \frac{e}{G} \times 100$

$$\therefore \quad e = 0.1 \times 2.7 = 0.27$$

Porosity,

$$n = \frac{e}{1+e} \times 100 = \frac{0.27}{1+0.27} \times 100 = 21.2\%$$

4. *Ans. (c)*

$$\boxed{\text{Void ratio, } e = \frac{V_v}{V_s}}$$

V_V = air void + water filled voids

$$\boxed{= \frac{1}{6}V + \frac{1}{3}V = \frac{V}{2}} \; ; \; \boxed{V_s = V - V_v = \frac{V}{2}}$$

$$\boxed{\therefore \quad e = \frac{V/2}{V/2} = 1.0}$$

5 *Ans. (c)*

The volume of soil increases from plastic limit to liquid limit. The cracking in soil is due to reduction in bearing capacity and consequent failure and heaving.

6. *Ans. (d)*

% LL (Liquid Limit)	Plasticity
< 35	Low
35 – 50	Intermediate
> 50	High

Soils above A-line are clays and soils below A-line are silts and organic soils.

Equation of A-line is, PI = 0.73 (w_L – 20)

7. *Ans. (b)*

Given, S = 100%

$$\therefore \quad w = \frac{Se}{G} = \frac{100 \times 0.78}{2.60} = 30\%$$

8. *Ans. (b)*

$$G_m = G_s(1-n) = \frac{G_s}{1+e}$$

G_m is mass specific gravity

G_m is specific gravity of solids

$$\therefore \quad e = \frac{G_s}{G_m} - 1 \qquad \Rightarrow \; e = \frac{2.7}{1.35} - 1 = 1$$

9. *Ans. (c)*

At shrinkage limit, soil is fully saturated.

$$\therefore \quad w_s = \frac{e}{G} \times 100 = \frac{0.5}{2.5} \times 100 = 18.5\%$$

10. *Ans. (c)*

Liquidity Index

$$= \frac{w - w_P}{w_L - w_P} = \frac{50-35}{60-35} = \frac{15}{25} = 0.6$$

Consistency Index = 1 – 0.6 = 0.4

11. *Ans. (b)*

- Degree of saturation $S = \frac{V_w}{V_v} \times 100 = 60\%$

  partially saturated.

  $$= \frac{0.3}{0.2+0.3} \times 100 = 60\%$$

- end Void ratio $e = \frac{V_v}{V_s} = \frac{0.2+0.3}{0.5} = 1$

  $$1 \times 100 = 100\%$$

➢ Water content

$$\boxed{w = \frac{W_w}{W_s} = \frac{0.3}{1.0} = 30\%}$$

➢ Saturated unit weight

$$\boxed{\gamma_t = \frac{W}{V} = \frac{1.0+0.3+0.2}{0.2+0.3+0.5} = 1.5\ g/cc}$$

In case of fully saturated condition air voids will be filled by water.

12. ***Ans. (b)***

Liquid limit 45% lies between 35% to 50% for intermediate plasticity. The soil above A line should be given symbol Cl.

13. ***Ans. (c)***

$$\gamma_{sat} = \gamma_d(1+w) = 1.5\times1.5 = 2.25\ g/cc$$

$$\gamma_{sub} = \gamma_{sat} - \gamma_w = 2.25 - 1.0 = 1.25\ g/cc$$

14. ***Ans. (b)***

Volume of solids will remain same in fill and barrow pit

$$V_s = \frac{V}{1+e};\ \left(\frac{V}{1+e}\right)_{fill} = \left(\frac{V}{1+e}\right)_{borrow\ pit}$$

$$\boxed{\frac{150000}{1+0.8} = \frac{V}{1+1.4};\qquad V = 2,00,000\ cum}$$

15. ***Ans. (c)***

Liquid limit > Plastic limit > Shrinkage limit

16. ***Ans. (b)***

$$\boxed{\frac{\Delta H}{H} = \frac{\Delta e}{1+e_0};\quad \frac{\Delta H}{2.4} = \frac{0.5-1}{1+1}}$$

$$\boxed{\Delta H = -0.6\ cm;\ H_f = H + \Delta H}$$

$$= 2.4 - 0.6 = 1.8\ cm$$

17. ***Ans. (b)***

Assuming in mix, x part is sand and (1 – x) part is soil

$$\boxed{PI\ of\ mix = \frac{x(PI)_{sand} + (1-x)PI_{soil}}{1}}$$

$$6 = x\times0 + (1-x)\times15$$

$$\boxed{x = 1 - \frac{6}{15} = \frac{9}{15} = 0.6 = 60\%}$$

18. ***Ans. (a)***

19. ***Ans. (a)***

'Zero air void line[1] and 100% saturation line are identical.

20. ***Ans. (b)***

21. ***Ans. (b)***

$$\boxed{\gamma_d = \frac{\gamma_t}{1+w} = 1500 = \frac{2000}{1+w}}$$

$$w = 0.3333 = 33.33\%$$

22. ***Ans. (b)***

Dry weight of sample = $1600 \times 10\ r^{-4} = 0.1\ 6$ kg Weight of water in soil before mixing additional quantity = 0.18 – 0.16 = 0.02 kg After mixing water the total quantity of water = 0.02 + 0.02 = 0.04 kg water

Thus, water content = $\frac{0.04}{0.16}\times100 = 25\%$

23. ***Ans. (d)***

Degree of saturation,

$$S = \frac{V_w}{V_v}\times100 = \frac{W_w}{V_v}\times100$$

Density of water is 1 gm/cc.

24. ***Ans. (c)***

$$Sensitivity = \frac{(UCS)_{natural}}{(UCS)_{remoulded}} = \frac{4}{(4/4)} = 4$$

25. ***Ans. (d)***

Given, $V_s = 2V_v$

Void ratio, $e = \frac{V_v}{V_s} = 0.5$

Porosity, $n = \frac{e}{1+e} = \frac{0.5}{1.5} = \frac{1}{3}$ or 33.33%

26. ***Ans. (a)***

Plastic limit, $w_p = w_L - PI = 40 - 20 - 20\%$

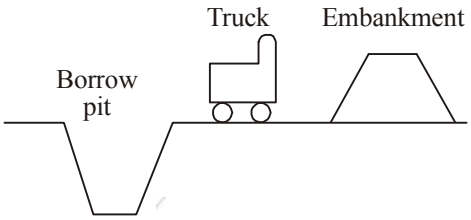
27. ***Ans. (a)***

$$\gamma_d = \frac{G}{1+e}\gamma_w$$

$$\Rightarrow \quad e = \frac{G\gamma_w}{\gamma_d} - 1 = \frac{2.7 \times 10}{18} = 0.5$$

28. ***Ans. (a)***

29. ***Ans. (c)***



$\gamma_1 = 1.66$ gm/cc $\quad \gamma_2 = 1.15$ gm/cc $\quad \gamma_3 = 1.82$ gm/cc

$w_1 = 8\%$ $\quad w_2 = 6\%$ $\quad w_3 = 14\%$

γ_{d_1} $\quad \gamma_{d_2}$ $\quad \gamma_{d_3}$

V_1 $\quad V_2$ $\quad V_3$

$$\gamma_{d_1} = \frac{\gamma_1}{1 + w_1}$$

$$\therefore \quad \gamma_{d_1} = \frac{1.66}{1 + 0.08} = 1.537 \text{ gm/cc}$$

$$\gamma_{d_2} = \frac{.15}{1 + 0.06} = 1.085 \text{ gm/cc}$$

$$\therefore \quad \gamma_{d_3} = \frac{1.82}{1 + 0.14} = 1.596 \text{ gm/cc}$$

To find volume of borrow pit (V_1) the following equation may be used.

$$\frac{V_1}{V_3} = \frac{\gamma_{d_3}}{\gamma_{d_1}}; \quad \frac{V_1}{100} = \frac{1.596}{1.537}$$

$$V_1 = 103.84 \text{ m}^3 \text{ say } 104 \text{ m}^3$$

To find number of trunk load :

$$\frac{V_2}{V_3} = \frac{\gamma_{d_3}}{\gamma_{d_2}}; \quad \frac{V_2}{100} = \frac{1.596}{1.085}$$

$$\therefore \quad V_2 = 147 \text{ m}^3$$

No. of truck loads

$$= \frac{147}{6} = 24.5 \text{ nos ;}$$

Say 25 nos.

30. ***Ans. (c)***

31. ***Ans. (b)***

32. ***Ans. (d)***

$$e = \frac{n}{1-n} = \frac{0.20}{1-0.2} = 0.25$$

33. ***Ans. (a)***

34. ***Ans. (d)***

35. ***Ans. (a)***

36. ***Ans. (d)***

Given $\quad G = 2.68,$

Take $\quad \gamma_w = 1000 \text{ Kg/m}^3$

$$\gamma = \frac{W}{V} = \frac{2.290}{1.15 \times 10^{-3}} = 1991 \text{ Kg/m}^3$$

Water content,

$$w = \frac{W - W_d}{W_d} \times 100 = \frac{2.290 - 2.035}{2.035} \times 100$$

$$= 12.53\%$$

$$\gamma_d = \frac{\gamma}{1 + W} = \frac{1991}{1 + 0.1253} = 1769.3 \text{ Kg/m}^3$$

$$\gamma_d = \frac{\gamma_w \cdot G}{1 + e}; \quad 1769.3 = \frac{1000 \times 2.68}{1 + e}$$

$$e = 0.52$$

37. ***Ans. (b)***

38. ***Ans. (d)***

$$n = \frac{e}{1 + e} = \frac{0.5}{1 + 0.5} = 0.333 = 33.3\%$$

39. ***Ans. (a)***

Borrow pit:

$\gamma_{d_1} = 17 \text{kN/m}^3$; Volume $= V_1$

Embankment:

$\gamma_{d_2} = 16 \text{kN/m}^3$; $V_2 = 100 \text{ m}^3$

Using the relationship,

$$\frac{V_1}{V_2} = \frac{\gamma_{d_2}}{\gamma_{d_1}}; \frac{V_1}{100} = \frac{16}{17}$$

$$V_1 = 94.11 \text{ m}^3$$

40. ***Ans. (c)***

$$e = \frac{wG}{S_r}; 0.65 = \frac{0.20 \times 2.72}{S_r}$$

$$S_r = 0.837 = 83.7\%$$

41. ***Ans. (d)***

Void ratio, $e = \frac{V_v}{V_s} = 1$

Porosity,

$$n = \frac{e}{1+e} \times 100 = \frac{1}{1+1} \times 100 = 50\%$$

42. ***Ans. (b)***

Activity

$$= \frac{\text{Plasticity Index}}{\text{Percent of clay particles finer than 2 } \mu\text{m}}$$

$$= \frac{25}{15} = 1.67$$

As activity is more than 1.25 so it is active soil.

43. ***Ans. (b)***

$$Gw = Se$$

$$S = \frac{260 \times 50}{1.3} = 100\%$$

Therefore soil is fully saturated.

Remember	$S \le 100\%$ always
	w can be more than 100%
	e can be more than 1.0.

44. ***Ans. (c)***

$$\text{Density Index} = \frac{e_{max} - e}{e_{max} - e_{min}} = 0.6$$

Void ratio in loosest state, $e_{max} = 0.9$

Void ratio in natural state, $e = 0.6$

$$\therefore \quad 0.9 - e_{min} = \frac{0.9 - 0.6}{0.6}$$

$$e_{min} = 0.9 - 0.5 = 0.4$$

45. ***Ans. (c)***

$$\gamma_d = \frac{\gamma_t}{\left(1 + \frac{w}{100}\right)} = \frac{100\gamma_t}{(100 + w)}$$

46. ***Ans. (b)***

Coefficient of curvature

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

Coefficient of uniformity,

$$C_u = \frac{D_{30}^2}{C_c \times D_{10}^2} = \frac{D_{60}}{D_{10}} = \left(\frac{3}{0.6}\right)^2 \times \frac{1}{1.4} = 17.9$$

As $1 < C_c < 3$ and $C_u > 6$ so it is well graded sand.

47. ***Ans. (c)***

Liquid limit is the water content corresponding to number of blows of 25.

48. ***Ans. (c)***

Relative density or Density index,

$$I_D = \frac{e_{max} - e}{e_{max} - e_{min}} \times 100 = 50\%$$

49. ***Ans. (d)***

$$\text{Consistency index} = \frac{w_L - w}{w_L - w_p}$$

$$I_L = \frac{w - w_P}{w_L - w_P}$$

w can be grater than w_p

50. ***Ans. (c)***

At saturated moisture content void ratio is

$$e = \frac{Gw}{S} = \frac{26 \times 25}{100} = 0.65$$

Relative density,

$$D_r = \frac{e_{max} - e}{e_{max} - e_{min}} = \frac{0.95 - 0.65}{0.95 - 0.45} = 0.6$$

$$D_r = 60\%$$

51. ***Ans. (c)***

For $w = w_L$

$$\text{Consistency index} = \frac{w_L - w}{w_L - w_P} = 0$$

52. ***Ans. (c)***

Consistency of soil refers to the resistance offered by it against forces that tend to deform or rupture the soil aggregate. It is related to strength.

53. ***Ans. (b)***

Given $\frac{\gamma_{sat}}{\gamma_d} = 1.25$, $G_s = 2.65$

$$\gamma_{sat} = \frac{\gamma_w (G_s + e)}{1 + e};\ \gamma_d = \frac{\gamma_w \cdot G_s}{1 + e}$$

$$\frac{\gamma_{sat}}{\gamma_d} = \frac{G_s + e}{G_s};\ 1.25 = \frac{2.65 + e}{2.65}$$

$$e = 0.663$$

54. ***Ans. (d)***

$$\text{Settlement, } \Delta H = H\left(\frac{e_0 - e_f}{1 + e_0}\right) = \frac{H\Delta e}{1 + e_0}$$

55. ***Ans. (d)***

56. ***Ans. (c)***

$$e_A = \frac{n_A}{1 - n_A} = \frac{0.4}{0.6} = \frac{2}{3}$$

$$e_B = \frac{n_B}{1 - n_B} = \frac{0.6}{0.4} = \frac{3}{2}$$

$$\therefore \quad \frac{e_A}{e_B} = \frac{4}{9}$$

57. ***Ans. (a)***

Moist density,

$$\gamma = \left(\frac{G + Se}{1 + e}\right)\gamma_w$$

For dry density put S = 0

For saturated density put S = 1

Submerged density

= saturated density – density of water

58. ***Ans. (d)***

Given w = 20%, G = 2.6, S = 100%

$$\therefore\ e = \frac{Gw}{S} = \frac{2.6 \times 20}{100} = 0.52;\ n = \frac{e}{1 + e} = 0.34$$

$$\gamma_{sat} = \left(\frac{G + e}{1 + e}\right)\gamma_w = \frac{2.6 + 0.52}{1 + 0.52} \times 10$$

$$= 20.53\ \text{kN/m}^3$$

If density of water is taken as 9.81 kN/m^3

$$\gamma_{sat} = 20.14\ \text{kN/m}^3$$

59. ***Ans. (c)***

In problems of fill and borrow pit, the volume of soil solids shall be equated.

$$V_s = \frac{V}{1 + e} = \frac{V\gamma}{G(1 + w)\gamma_w}$$

As the moisture content of borrow area and that of embankment are same.

$$V_1\gamma_1 = V_2\gamma_2$$

For 100 m fill at embankment, the volume required from borrow pit

$$V_2 = \frac{100 \times 18}{15} = 120\text{m}^3$$

$$\text{Number of trips of truck} = \frac{120}{6} = 20$$

60. ***Ans. (c)***

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