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DIRECTOR'S *Message*

To reach heights one must start climbing and if the journey is difficult then perseverance is the key to success. As a teacher we have realized over past years that success in any competitive exam requires hard work and proper guidance. **Engineers Academy** with its unique teaching methodologies has always proved that we meet the expectations of thousands of students and parents to make their dreams come true. With changing patterns, we have adapted ourselves to deliver the best and ensure better results.

This book has been organized and executed with a lot of care, dedication and passion for lucidity. A conscious attempt has been made to simplify the concepts to facilitate better understanding of the subject.

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We would feel satisfied if the book meets the needs of the students for whom it is meant.

Lastly, we are thankful to all the engineers, authors whose work has been the source of enlightenment, inspiration and guidance in presenting this book.

It is hoped that the book in its new form will enjoy its ever increasing popularity.

Regards

Dr. Pankaj Goyal

Preface

This book has been written to meet the growing requirements of candidates appearing for BSNL, DRDO, ISRO, BARC, ECIL, TTA, RRB-JE, State and Public Sector Engineering Examinations. Though every candidate has ability to succeed but competitive environment, in-depth knowledge, quality guidance, time management and good source of study is required to achieve goals.

This book includes Multiple Choice Questions (MCQ) which works as a mock exam practice for the reader. Questions of all the subject have been organized in systematic, concepts oriented and error less manner so that it become easy and interesting for even a beginner to understand. It is a very convenient book and must be solved by candidate aiming for competitive exams.

After solving this booklet students can feel encouraged and develop confidence to attempt each and every type of numerical as well as theoretical problems. Each problems explains solving approach so that at the end, so the reader is well equipped to be able to apply any type of problem solving requirement and distinctly choose one strategy or type from the other.

We hope this book will be proved an important tool to succeed in BSNL, DRDO, ISRO, BARC, ECIL, TTA, RRB-JE, State and Public Sector Engineering Examinations.

It is earnestly hoped that with the extensive additions and revisions, the present edition will facilitate the students not only in preparing themselves for competitive examinations but also in preparing for their regular examinations and prove more useful to the students than the earlier editions.

Even though, enough readings were given for correcting the error and printing mistakes, due to human tendency there could be some minor types in the book. If any such types found, they will be highly appreciated and in corporated in the next edition. Also, please provide your valuable suggestions at : engineers.academy.india@gmail.com

Wish you all the best. Have a nice reading.

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CONTENTS

UNIT-I

SOIL MECHANICS & FOUNDATION

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CHAPTER 1

PROPERTIES OF SOILS

OBJECTIVE QUESTIONS

1. Match List I (Name of person) with List II (Field of contribution) and select the correct answer using the codes given below the list

List I	List-II
A. Stoke	1. Flow through capillary
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	B	C	D
(a)	5	4	1	3
(b)	4	1	5	2
(c)	1	5	4	2
(d)	3	2	1	5

2. 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%

3. Swelling potential of a soil is indicated by :

(a) Activity of the soil

(b) Sensitivity of the soil

(c) Permeability of the soil

(d) Compressibility of the soil

4. Consider the following statements

Clay 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

5. 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

6. For a soil, if the sensitivity value from 2.0 to 4.0 then such a soil is classified as

(a) Extra sensitive

(b) Moderately sensitive

(c) Little sensitive

(d) Sensitive

[DFCCIL - 2018]

7. 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

8. 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%

9. 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

10. 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 solids

(c) Greater than specific gravity of soil

(d) Independent of specific gravity of soil

11. Liquidity index (in%) is equal to

(a) $\frac{w_p - w}{I_p} \times 100$ (b) $\frac{w_L - w_p}{I_p} \times 100$

(c) $\frac{w_L - w}{I_p} \times 100$ (d) $\frac{w - w_p}{I_p} \times 100$

12. The height of capillary rise is maximum in

(a) Fine gravel (b) Colloids

(c) Silt (d) Fine sand

[Punjab. JE-2014]

13. If the soil sample has water content = 20 % ; specific gravity = 2.70; and void ratio = 0.75 then degree of saturation of the given sample is–

(a) 68% (b) 13.8%

(c) 54% (d) None of these

[RPSC.VPITI-2016]

14. If the void ratio (e) of a given soil sample is 0.77 then its porosity (n) is : –

(a) 0.435%

(b) 43.50%

(c) 23.3%

(d) Data given are insufficient to calculate porosity

[RPSC.VPITI - 2016]

15. Which of the following statements is incorrect in respect to capillarity in soils : –

(a) Gravitational water may be removed from soils by drainage.

(b) At the water table, the pore water pressure is greater than zero.

(c) Capillary water is held above the water table by 'surface tension'

(d) Capillary rise is controlled by pore size and not the grain size, and that the same soil mass with the same D_{10} can have different pore size distributions depending upon structure and fabric, geological history etc.

[RPSC.VPITI - 2016]

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

(a) 10% (b) 30%

(c) 50% (d) 70%

17. Density index of soil is denoted by

e_{max} = max. void ratio

e_{min} = min. void ratio

e = natural void ratio

(a) $(e_{max} - e)/(e_{max} - e_{min})$

(b) $(e - e_{max})/(e_{max} - e_{min})$

(c) $(e_{max} + e)/(e_{max} - e_{min})$

(d) $(e + e_{max})/(e_{max} + e_{min})$

18. The relationship between discharge velocity V and seepage velocity V_s is

(a) $V_s = V/n$ (b) $V_s = V/e$

(c) $V_s = Vn$ (d) $V_s = Ve$

19. Number of phases in soil mass is : –

(a) 1 (b) 2

(c) 3 (d) 4

[RPSC - 2016]

20. For determination of water content, the wet soil is dried in oven for 24 hours at

(a) 50°C (b) 100°C

(c) 105°C (d) 155°C

21. 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 (d) **1.**5

[LMRC.JE - 2017]

22. You are given a sample of soil containing coarse grains to determine its water content. What will you use for this purpose ?

(a) Pycnometer

(b) Oven-drying method

(c) Calcium carbide method

(d) Alcohol method

[LMRC.JE - 2016]

23. The smallest water content below which soil sample will not reduce its volume any further is known

(a) Plasticity limit (b) Plasticity index

(c) Drying limit (d) Shrinkage limit

[PEB-SUB ER. - 2017]

24. The ratio of unconfined compressive strength of an undisturbed sample of soil to that of a remoulded sample, at the same water content, is known as

(a) Activity (b) Damping

(c) Plasticity (d) Sensitivity

25. Clay whose activity coefficient is more than 1.2 is termed as ___.

(a) Fine clay (b) Inactive clay

(c) Active clay (d) Normal clay

[PEB-SUB ER - 2017]

26. Which one of the following relations is NOT correct?

Where, e = voids ratio, n = porosity, w = water content, S = degree of saturation,

γ_{sat} = saturated unit weight, γ_w = unit weight of water

(a) $e = \frac{n}{1-n}$ (b) $e = \frac{wG}{S}$

(c) $n = \frac{e}{1-e}$ (d) $\gamma_{sat} = \frac{(G+e)\gamma_w}{1+e}$

[PEB-SUB ER - 2017]

27. For a soil having L.L. = 54%, P.L. = 25% and natural moisture content of 29%, liquidity index is given by-

(a) 0.138 (b) 2.76

(c) 0.862 (d) 7.250

28. Relative density of coarse grained soil is given by the relation-

(a) $\frac{e_{max}-e}{e_{max}-e_{min}} \times 100$

(b) $\frac{e_{max}+e}{e_{max}-e_{min}} \times 100$

(c) $\frac{e_{max}-e}{e_{max}+e_{min}} \times 100$

(d) $\frac{e_{max}+e}{e_{max}+e_{min}} \times 100$

[DFCCIL - 2018]

29. If the porosity of soil is close to 33%, then its void ratio will be closer to ___.

(a) 0.33 (b) 0.5

(c) 0.8 (d) 1

[PEB-SUB ER - 2017]

30. What is plastic limit of soil?

(a) The minimum water content at which the soil just begins to crumble when rolled into threads 3 mm in diameter

(b) The maximum water content at which the soil just begins to crumble when rolled into threads 3 mm in diameter

(c) The exact water content at which the soil just begins to crumble when rolled into threads 3 mm in diameter

(d) None of the above

[GESCOM.AE - 2016]

31. Which of the following is a property of black cotton soil?

(a) It does not retain moisture

(b) It swells excessively when wet and shrinks excessively when dry

(c) It becomes soft when dry

(d) It is very rocky

[KPSC-JE, GESCOM.AE - 2016]

32. Which of the following is an example of collapsible soils ?

(a) Black cotton (b) Gravel

(c) Loess (d) Halite

[KPSC.JE - 2016]

33. Which one of the following statements is true?

(a) Clays are more porous than sands

(b) Presence of organic matter in a soil decreases the bearing capacity of the soil

(c) Both (a) and (b)

(d) None of the above

[KPSC.JE - 2016]

34. The ratio of the weight of given volume of soil solids to the weight of an equal volume of distilled water at the given temperature, is called

(a) Porosity (b) Specific gravity

(c) Void ratio (d) Water content

[KPSC.JE - 2016]

35. Which of the soils is transported through wind

(a) Loess (b) Talus

(c) Drift (d) Sand dunes

[PHED.RAJ - 2017]

36. 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%

[PHED.RAJ - 2016]

37. 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

[PHED.RAJ - 2017]

38. A dry soil has a specific mass of 1.35. If specific gravity of solids is 2.7, then voids ratio is

(a) 0.5 (b) 1.0

(c) 1.5 (d) 2.0

[PHED.RAJ - 2016]

39. In a soil mass, the volume of solids is equal to volume of voids. The values of porosity and void ratio

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

(c) 0.5 and 1.0 (d) 1.0 and 0.5

40. If the consistency index of a natural soil is zero, then the natural water content of the soil is equal to its

(a) Liquid limit (b) Plastic limit

(c) Plasticity index (d) Shrinkage limit

41. The soil which is deposit in sea water

(a) Loess (b) Glacial

(c) Alluvial (d) Marine

[TSPSC.AE - 2015]

42. Drift is the soil transported by

(a) Wind (b) Water

(c) Glacier (d) Gravitational force

[LBS-ASST.PROF - 2017]

43. The ratio of volume of voids to volume of soil solids in a given soil mass is known as

(a) Void ratio (b) Porosity

(c) Air content (d) Water content

44. A soil has liquid limit = 32, plastic limit = 18, shrinkage limit = 8 and natural moisture content = 22%. What will be its liquidity index and plasticity index?

(a) 0.67 and 15 (b) 0.285 and 14

(c) 0.67 and 25 (d) 0.33 and 20

[ISRO - 2015]

45. A cohesive soil yields a maximum dry density of 18 kN/m^3 during a Standard Proctor Compaction test. If the specific gravity is 2.65, what would be its void ratio?

(a) 0.552 (b) 0.444

(c) 0.712 (d) 0.583

[ISRO - 2015]

46. What will be the dry unit weight (in-kN/m^3) for a saturated soil, given that moisture content (w) =35% and specific gravity of soil (γ_s) =2.5 ?

(a) 12.08 kN/m^3 (b) 13.58 kN/m^3

(c) 11.08 kN/m^3 (d) 10.68 kN/m^3

[DFCCIL - 2018]

47. The plasticity index may be defined as the numerical difference between :

(a) Liquid limit and plastic limit

(b) Plastic limit and shrinkage limit

(c) Liquid limit and shrinkage limit

(d) None of the above

[NBCC - 2017]

48. The soil type which have significant influence of water content in compaction process is :

(a) Clay of high plasticity

(b) Silty clay

(c) Sandy silty clay

(d) Silty sandy clay

[NBCC - 2017]

49. Water content of soils can be accurately determined by :

(a) Calcium carbide (b) Sand bath

(c) Alcohol method (d) Oven drying method

[RPSC-ACF-2011, NBCC - 2017, DDA.JE - 2018]

50. The bulk density of a material depends on

(a) Void ratio (b) Moisture content

(c) Porosity (d) All of these

[Chandigarh .JE - 2016]

51. The ratio of volume of water present in a given soil mass to the total volume of its voids is known as

(a) Porosity (b) Void ratio

(c) Percentage voids (d) Degree of saturation

[ISRO - 2018]

52. A soil sample is partially saturated. Its natural moisture content was found to be 22% and bulk density 2 gms/cc. If the specific gravity of the solid particles is 2.65 and the density of water is 1 gms/cc, the void ratio of the sample is

(a) 0.3825 (b) 0.6165

(c) 0.8188 (d) 0.9122

[ISRO - 2018]

53. Uniformity coefficient of a well graded soil is

(a) Equal to 1 (b) Less than 2

(c) Equal to 3 (d) Greater than 5

[ISRO - 2018]

54. The water content of a soil at which the soil volume becomes constant is called

(a) Plastic limit (b) Liquid limit

(c) Solid limit (d) Shrinkage limit

[ISRO - 2018]

55. A partially saturated soil is classified as

(a) One phase soil (b) Two phase soil

(c) Three phase soil (d) Four phase soil

[ISRO - 2018]

ANSWERS SHEET

1. ***Ans. (a)***

2. ***Ans. (d)***

In casagrande's liquid limit test the liquid limit is the water content corresponding to N = 25, as obtained from plot.

$$w = 20 - \log_{10}25 = 18.6\%$$

3. ***Ans. (a)***

4. ***Ans. (d)***

5. ***Ans. (d)***

6. ***Ans. (c)***

7. ***Ans. (b)***

Void ratio is same so dry density will also same

$$\gamma_{d_1} = \gamma_{d_2}$$

$$\frac{\gamma_{b_1}}{1+w_1} = \frac{\gamma_{b_2}}{1+w_2}$$

$$\Rightarrow \quad \frac{1.8}{1+0.05} = \frac{\gamma_{b_2}}{1+0.1}$$

$$\Rightarrow \quad \gamma_{b_2} = 1.8\times\frac{1.1}{1.05} = 1.88 \text{ g/cm}^3$$

8. ***Ans. (a)***

9. ***Ans. (c)***

10. ***Ans. (b)***

11 ***Ans. (d)***

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

13. ***Ans. (d)***

$$w = 20\ \%$$

$$G = 2.70$$

$$e = 0.75$$

$$eS = wG$$

$$0.75 \times S = 20 \times 2.70$$

$$S = 72\ \%$$

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

$$n = \frac{e}{1+e} = \frac{0.77}{1+0.77} = 0.435 \times 100$$

$$n = 43.50\%$$

15. ***Ans. (b)***

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

Given

$$G = 2.6,\ e = 0.78,$$

$$S = 100\%\ W = ?$$

$$Se = Gw$$

$$w = \frac{100\times0.78}{2.6}$$

$$w = 30\ \%$$

17. ***Ans. (a)***

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

19. ***Ans. (c)***

air
water
solid

20. ***Ans. (c)***

21. ***Ans. (c)***

$$e = \frac{V_v}{V_s},\ V_a = \frac{V}{6},\ V_w = \frac{V}{3}$$

$$V_V = V_a + V_w$$

$$= \frac{V}{6}+\frac{V}{3} = \frac{V}{2}$$

$$V = V_a + V_w + V_s$$

$$V_s = V - \frac{V}{6} - \frac{V}{3} = \frac{V}{2}$$

$$e = \frac{V/2}{V/2} = 1$$

$$e = 1$$

22. ***Ans. (a)***

Pycnometer is used for coarse grain soil. If use in fine grain soil kerosene is use as a standard fluid.

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

24. ***Ans. (d)***

25. ***Ans. (c)***

26. ***Ans. (c)***

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

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

29. ***Ans. (b)***

$$e = \frac{n}{1-n} = \frac{0.33}{1-0.33}$$

$$e = 0.492$$

30. ***Ans. (a)***

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

32. ***Ans. (c)***

33. ***Ans. (c)***

34. ***Ans. (b)***

35. ***Ans. (d)***

36. ***Ans. (a)***

$$a_c = 1 - S$$

$$a_c = 1 - 0.60 = 0.40$$

$$a_c = 40\ \%$$

37. ***Ans. (a)***

38. ***Ans. (b)***

$$\text{Specific mass} = \frac{\gamma_d}{\gamma_w} = 1.35$$

$$G = 2.7$$

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

$$\frac{\gamma_d}{\gamma_w} = \frac{2.7}{1+e}$$

$$1.35 = \frac{2.7}{1+e}$$

$$1.35e + 1.35 = 2.7$$

$$e = \frac{2.7-1.35}{1.35} = 1$$

$$e = 1$$

39. ***Ans. (c)***

40. ***Ans. (a)***

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

42. ***Ans. (c)***

43. ***Ans. (a)***

44. ***Ans. (b)***

$w_L = 32\%$,

$w_P = 18\%$, $w_S = 8\%$, $w_N = 22\%$

$I_P = w_L - w_p = 32 - 18 = 14\%$

$$I_L = \frac{w_N - w_P}{I_P}$$

$$I_L = \frac{22-18}{I_p} = \frac{4}{14} = \frac{2}{7} = 0.285$$

45. ***Ans. (b)***

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

$$\Rightarrow \quad e = \frac{G\gamma_w}{\gamma_d} - 1$$

$$e = \frac{2.65 \times 9.81}{18} - 1$$

$$e = 0.44425$$

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

$$e = \frac{W.G}{S}$$

$$= \frac{0.35 \times 2.5}{1}$$

$$= 0.875$$

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

$$= \frac{2.5 \times 9.81}{1.875}$$

$$= 13.08 kN/m^3$$

47. ***Ans. (a)***

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

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

50. ***Ans. (d)***

51. ***Ans. (d)***

52. ***Ans. (b)***

$$W = 22\%$$

$$\gamma_b = 2 \text{ gm/cc}$$

$$G = 2.65$$

$$\gamma_w = 1 \text{ gm/cc}$$

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

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

$$e = \frac{2.65(1+0.22)}{2} - 1$$

$$e = 0.6165$$

53. ***Ans. (d)***

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

55. ***Ans. (c)***

56. ***Ans. (b)***

57. ***Ans. (d)***

$$I_D = \frac{e_{max} - e}{e_{max} - e_{min}}$$

$$e_{max} - e_{min} = 0.25,\ I_D = 0.6$$

$$0.6 = \frac{x - 0.4}{0.25}$$

$$x = 0.25 \times 0.6 + 0.4$$

$$x = 0.55$$

58. ***Ans. (b)***

59. ***Ans. (d)***

60. ***Ans. (b)***

$$\text{Sensitivity (S)} = \frac{\text{UCS of undisturbed sample}}{\text{UCS of remoulded sample}}$$

$$= \frac{200}{60} = 3.33$$

61. ***Ans. (d)***

62. ***Ans. (d)***

63. ***Ans. (d)***

$$\text{R.D.} = \frac{e_{loosest} - e_{natural}}{e_{loosest} - e_{densest}} = \frac{1-0.6}{1-0.5} = \frac{0.4}{0.5}$$

$$= 0.8$$

64. ***Ans. (b)***

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

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

$$= 1$$

65. ***Ans. (c)***

66. ***Ans. (c)***

67. ***Ans. (b)***

68. ***Ans. (c)***

69. ***Ans. (b)***

70. ***Ans. (a)***

71. ***Ans. (c)***

72. ***Ans. (b)***

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

73. ***Ans. (b)***

74. ***Ans. (d)***

75. ***Ans. (c)***

76. ***Ans. (c)***

77. ***Ans. (d)***

$$I_c = \frac{W_L - W_N}{I_P} = \frac{45-30}{45-25} = \frac{15}{20}$$