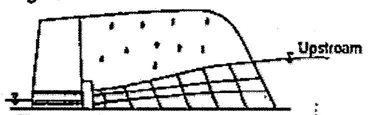
6
CHAPTER

Seepage Analysis

Q.1 The upstream slope of an earth dam under steady seepage condition is
(a) equipotential line (b) phreatic line
(c) flow line (d) seepage line

Q.2 Consider the flow net shown in the following figure.



The ratio of number of flow channels to the number of potential drops is
(a) 3/8 (b) 3/7
(c) 4/7 (d) 4/8

Q.3 From a flow net which of the following information can be obtained?
1. Rate of flow
2. Pore water pressure
3. Exit gradient
4. Permeability

Select the correct answer using the codes given below:
(a) 1, 2, 3 and 4 (b) 1, 2 and 3 only
(c) 2, 3 and 4 only (d) 1 only

Q.4 For design of filter, the criteria usually adopted is

(a) $\dfrac{D_{15} \text{ of filter}}{D_{85} \text{ of base material}} < 4 \text{ to } 5$

(b) $\dfrac{D_{15} \text{ of base material}}{D_{85} \text{ of filter}} < 4 \text{ to } 5$

(c) $\dfrac{D_{15} \text{ of filter}}{D_{85} \text{ of base material}} > 40$

(d) $\dfrac{D_{85} \text{ of filter}}{\text{Maximum opening of pipe of drain}} < 2$

Q.5 In an earthen dam the phreatic line is
(a) straight (b) circular
(c) parabolic (d) zigzag

Q.6 If the permeability of soil does not depend on its mineral content but depends on orientation of particles then the void space is known as
(a) Pore (b) Micro-pore
(c) Capillary (d) Floc

Q.7 Consider the following statements:
1. Seepage force is applied by flowing water to the soil skeleton through frictional drag.
2. The magnitude of seepage force per unit volume of soil at any point is equal to γ_w/i, where γ_w is the unit weight of water and i is the hydraulic gradient at that point.
3. In a soil mass subjected to upward flow of water, quick sand condition develops when pore pressure is equal to the total stress.

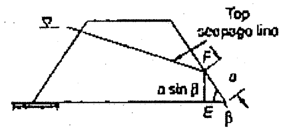
Which of these statement/s is/are correct?
(a) 1 and 2 (b) 1 and 3
(c) 1 only (d) 2 and 3

Q.8 Consider the following statements:
1. Hydraulic gradient required to initiate "quick" conditions 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 the above statements, the correct ones are
(a) 1, 2 and 3 (b) 1 and 2
(c) 1 and 3 (d) 2 and 3

Q.9 Which of the following statement is correct regarding quick sand condition?
(a) It occurs in fine sand and clays
(b) It occurs in downward flow condition
(c) The value of specific gravity of soil is approximately equal to 2.7
(d) Humans and animals cannot float into it.

Q.10 A homogeneous earth dam with no horizontal drainage filter at downstream is shown in figure. 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 $a \sin\beta$ is assumed to be (k = coefficient of permeability of soil)



(a) $ka \sin\beta \cos\beta$ (b) $ka \sin\beta \tan\beta$
(c) $ka \sin^2\beta$ (d) $ka \sin^2 \cos^2\beta$

Q.11 Study of seepage of water through soils is important for the following engineering problems
1. Ground water flow towards wells and drainage of soils
2. Determination of rate of settlement of a saturated compressive soil layer
3. Calculation of seepage through body of earth dams and stability of slopes
4. Calculation of uplift pressure under hydraulic structure and their safety against slopes

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, 3 and 4

Q.12 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.
(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

Q.13 Assertion (A): The phenomenon of quick sand occurs mostly in coarse sands and gravels.
Reason (R): Quick sand condition does not occur in clayey soils as their cohesion holds the grains together even under upward flow at critical hydraulic gradient.
(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

Q.14 A sand deposit 10 m thick overlies an impervious soil. A vertical sheet pile penetrates half way into the sand deposit. The water level on one side of sheet is 3.0 m and on the other side, it is 0.6 m above the ground level. The sand stratum has a vertical permeability of 1.5 m per day, and the horizontal permeability of 9 times the permeability in the vertical direction. A flow net construction reveals that there are 12 flow channels and 24 potential drops. The seepage flow per day per unit length is
(a) 5.63 (b) 4.70
(c) 5.40 (d) 5.70

Q.15 A coarse grained soil has a void ratio of 0.75 and specific gravity of 2.75. The critical gradient at which quick sand condition occurs is
(a) 0.75 (b) 0.50
(c) 1.0 (d) 0.25

Q.16 At a given location, 8 m of thick saturated clay is underlain by sand and the sand layer is under artesian pressure equal to 3 m head of water. It is proposed to make an open excavation in the clay. How deep can this excavation be made before the bottom heaves, if water content is 30%? (G = 2.7). ________.

Answers **Seepage Analysis**

1. (a) 2. (b) 3. (b) 4. (a) 5. (c) 6. (a) 7. (b) 8. (d) 9. (c) 10. (b)
11. (d) 12. (a) 13. (a) 14. (c) 15. (c) 16. (6.45)

Explanations **Seepage Analysis**

2. (b)

$$N_f = 3$$
$$N_D = 7$$

3. (b)
Discharge, seepage pressures, uplift pressures, exit gradient and pore-water pressure can be obtained from a flow net.

4. (a)

$$\frac{D_{15}(f)}{D_{85}(b)} < 4 \text{ to } 5$$

and $\dfrac{D_{85}(f)}{\text{Size of opening}} \geq 2$

where f is filter material and b is base materials

7. (b)
Seepage force is due to frictional drag and its magnitude is given by $i\gamma_w$ per unit volume of soil. For quick condition during upward flow,
Effective stress = total stress – pore pressure
So statements 1 and 3 is correct.

9. (c)
Quick sand is a viscous liquid having unit weight equal to twice the unit weight of water.

14. (c)

$$k = \sqrt{k_H \cdot k_V} = \sqrt{9k_V \cdot k_V}$$
$$= \sqrt{9}k_V = 3 \times 1.5 = 4.5\text{m/day}$$
$$q = kH_L \frac{N_f}{N_d}$$
$$= 4.5 \times (3 - 0.6) \times \frac{12}{24} \text{m}^3\text{/day/m}$$
$$= 5.4 \text{ m}^3\text{/day/m}$$

15. (c)
Critical gradient

$$i_c = \frac{G-1}{1+e} = \frac{2.75-1}{1+0.75} = 1$$

16. (6.45)

$$s = 1 \qquad e = \frac{wG}{S} = 0.3 \times 2.7 = 0.81$$

$$\gamma_{sat} = \frac{G+e}{1+e}\gamma_w = \left(\frac{2.7+0.81}{1+0.81}\right)9.81$$
$$= 19.02 \text{ kN/m}^2$$

Now, $\Sigma F_{V_b} = 0$

$$\Rightarrow (8 - x)\gamma_{sat} = 3\,\gamma_w$$
$$\Rightarrow \qquad x = 6.45 \text{ m}$$

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