UNIT II – EFFECTIVE STRESS AND PERMEABILITY

Part A -2 Mark Questions & Answers

1. What are assumptions made to derive the equation governing two dimensional steady state seepage?

Several assumptions are required to derive the equation governing two dimensional steady state seepage.

- The soil is completely saturated
- There is no change in void ratio of the porous medium
- The hydraulic conductivity is isotropic
- Darcy's law is valid
- The water is incompressible

2. What are the steps in the construction of a flow net?

Steps in Drawing a Flow Net

1) Define and clearly mark a datum.
2) Identify the boundary conditions (EP, FL, LCP).
3) Draw intermediate equipotentials and flow lines - draw coarse mesh with a few EPs and FLs
4) Verify the coarse mesh is correct.
   - Are the boundary conditions satisfied?
   - Are all flow tubes continuous?
   - Are EPs z FLs?
   - Mostly "squares" ?
5) Add additional EPs and FLs for suitable refinement of the flow net.
6) Calculate desired quantities of flow and heads.

3. Define Seepage velocity.

The actual velocity of water flowing through the voids is termed as seepage velocity.

4. What are the factors that affect the permeability of a soil mass?

Some of the factors, which influence permeability are

- Grain size
- Viscosity
- Temperature
- Void ratio

5. Give the formulae to determine the vertical stress, radial stress Tangential stress, & shear stress under a point load.

Vertical Stress $\sigma_z = \frac{3Pz^3}{2\pi R^5}$

Radial Stress $\sigma_r = \frac{P}{2\pi R^2} - \left[\frac{3r^2 z}{R^5} - \frac{(1-2v)R}{R+z}\right]$

Tangential stress $\sigma_\theta = \frac{P(1-2v)}{2\pi R^2}\left[\frac{R}{R+z} - \frac{z}{R}\right]$

Shear stress $\tau_{rz} = \frac{3Prz^2}{2\pi R^5}$

6. Define Permeability.

The ease with which water can flow through a soil mass is termed as permeability

7. What is laminar flow?

Flow of fluids is described as laminar if a fluid particles flow follows a definite path and does not cross the path of other particles.

8. Define quick sand

Sand is said to be quick sand condition when the flow is upward under a hydraulic gradient, which reduces the effective stress to zero.

9. What is Frost Heave?

Water migrates upward from the water table to the capillary fringe. When the atmospheric temperature falls to the freezing point & the ice is formed. This results in an increase in the volume of the soil. This is known as frost heave.

10. Give the Allen Hazens Formula

$K=cD10^2$

K - Co-efficient of permeability
D10 - Effective size (cm)
C - Constant with a value between 100& 500.

11. Estimate the value of k of a soil with an effective diameter of 0.2 mm.

$K=cD10^2$

C= 125, K= 125 x 0.02^2 = 0.05 cm/sec

12. What is Darcy's law?

For laminar flow in a homogeneous soil the velocity of flow (v) is given by

V= Ki

K = co-efficient of permeability

I - hydraulic gradient.

13. Define seepage.

Seepage is the flow of water under gravitational forces in a permeable medium. The flow is generally laminar.

14. List the assumptions made in the Laplace's equation

The following assumptions are made in the derivation of the Laplace equation.

- The flow is laminar.
- Water & soil are incompressible.
- Soil is isotropic & homogeneous.
- The soil is fully saturated.
- The flow is steady ie. flow condition do not
- Change with time.
- Darcy's law is valid.

15. Define soil water.

Water present in the voids of soil mass is called soil water.

16. What is meant by gravitational or free water?

It is the subsurface water that fills the voids continuously and is subjected to no forces other than the gravity. Hence this water also known as ground water.

17. Write the mode of occurrence of water in soil.

- Ground water
- Capillary water
- Adsorbed water
- Infiltrated water
- Pore water
- Solvate water
- Structural water

18. Define capillary.

It is the phenomenon of movement of water in the interstices of a soil due to capillary force is called capillary.

19. Briefly explain capillary force.

The minute pores of soil serve as capillary fuses through which the moisture rises above the ground water table. The capillary forces depends upon various factors such as

surface tension of water, pressure in water in relation to atmosphere and the size and conformation of soil pores.

20. Define surface tension.

It is the property which exists in the surface film of water tending to contract the contained volume into a form having minimum superficial area possible. The molecules on a surface of a liquid attracted by other molecules on a surface and inside the body of the liquid.

21. What are the rules to be followed while construction of flow net?

Rules for flow net construction

- When materials are isotropic with respect to permeability, the pattern of flow lines and
- Equipotentials intersect at right angles. Draw a pattern in which square figures are formed between flow lines and equipotentials
- Usually it is expedient to start with an integer number of equipotentials drops, dividing total head by a whole number, and drawing flow lines to conform to these equipotentials. In the general case, the outer flow path will form rectangular rather then square figures. The shape of these rectangles (ratio b/l) must be constant.
- The upper boundary of a flow net that is at atmospheric pressure is a "free water surface". Integer equipotentials intersect the free water surface at points spaced at equal vertical intervals.
- A discharge face through which seepage passes is an equipotentials line if the discharge is submerged or a free water surface if the discharge is not submerged. if it is a free water surface, the flow net figures adjoining the discharge face will not be squares.
- In a stratified soil profile where ratio of permeability of layers exceeds 10, the flow in the more permeable layer controls. That is, the flow net may be drawn for more permeable layer assuming the less permeable layer to be impervious. The head on the interface thus obtained is imposed on the less pervious layer for construction of the flow net within it.
- In a stratified soil profile where ratio of permeability of layers is less than 10, flow is deflected at the interface.
- When materials are anisotropic with respect to permeability, the cross section may be transformed by changing scale as shown above and flow net drawn as for isotropic materials. in computing quantity of seepage, the differential head is not altered for the transformation.
- Where only the quantity of seepage is to be determined, an approximate flow net suffices. If pore pressures are to be determined, the flow net must be accurate.

Part B-12 Mark Questions

1. Explain different modes of occurrences of water in soil.
2. Explain the term with a neat sketch surface tension.
3. Explain the factors affecting soil suction.
4. Describe in detail shrinkage and swelling of soils.
5. How the frost action will occur in the water.
6. Write a short note on slaking of clay and bulking of sand.
7. Explain in detail on factors affecting permeability.
8. Write a note on quick sand condition of soil.
9. Explain the method of capillary permeability test.
10. Explain the properties, uses & application of flow net.