Shanghai Normal University
Tutorial (T05) - Groundwater

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1. The following results were obtained in a constant head permeameter test:

    Duration = 4.0 mins
    Quantity of water collected = 300 ml
    Head difference in manometer = 50 mm
    Distance between manometer tappings = 100 mm
    Diameter of test sample = 100 mm

    Determine k in m/s.

2. The following results were obtained in a falling head permeameter test:

    Initial head of water in stand-pipe = 1.6 m
    Final head of water = 0.99 m
    Duration of test = 480 s
    Sample length = 100mm
    Sample diameter = 100mm
    Area of stand-pipe = 7.0×10^{-5} m^2

    Determine k in m/sec.

3. Craig's Example 2.1

    In a falling-head permeability test the initial head of 1.00 m dropped to 0.35 m in 3 h, the diameter of the standpipe being 5 mm. The soil specimen was 200 mm long by 100 mm in diameter. Calculate the coefficient of permeability of the soil.

4. Craig's Example 2.2

    The section through a dam is shown in Figure 1. Determine the quantity of seepage under the dam and plot the distribution of uplift pressure on

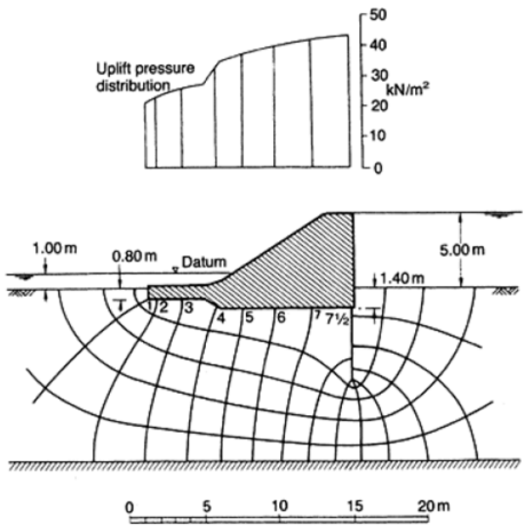

Figure 1: Dam section

the base of the dam. The coefficient of permeability of the foundation soil is 2.5 $\times 10^{-5}$ m/s

5. Craig's Example 2.3

   A river bed consists of a layer of sand 8.25 m thick overlying impermeable rock; the depth of water is 2.50 m. A long cofferdam 5.5 0m wide is formed by driving two lines of sheet piling to a depth of 6.00 m below the level of the river bed and excavation to a depth of 2.00 m below bed level is carried out within the cofferdam. The water level within the cofferdam is kept at excavation level by pumping. If the flow of water into the cofferdam is 0.25 m^3/h per unit length, what is the coefficient of permeability of the sand? What is the hydraulic gradient immediately below the excavated surface?

6. Craig's 2.5

   The section through part of a cofferdam is shown in Figure 2, the coefficient of permeability of the soil being 2.0×10^{-6} m/s. Draw the flow net and determine the quantity of seepage.

7. The flood-plain deposits of a river consist (from the surface downwards) of the following succession of soil layers: 1 m of coarse silt ($k = 3 \times 10^{-7}$ m/s), lying on 3 m of fine sand ($k = 3 \times 10^{-7}$ m/s), lying on 4 m of fine silty sand ($k = 1 \times 10^{-6}$ m/s). All these layers are underlain by a deep deposit of gravel. Upward flow is taking place as a consequence of artesian

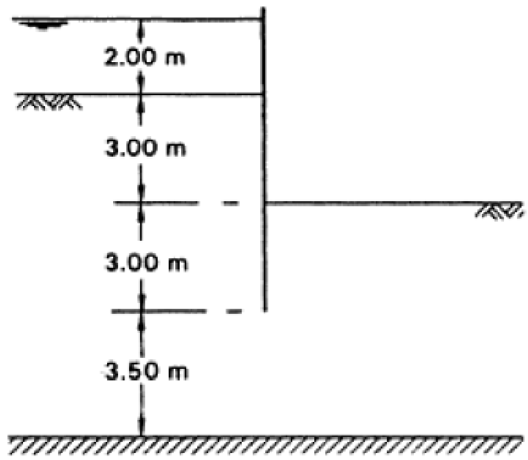

Figure 2: Cofferdam section

conditions in the gravel. Remembering that the flow velocity in all three layers must be the same, apply Darcy's Law to each layer and show that the hydraulic gradient will be the greatest in the upper layer. Then:

a) Determine the piezometric elevation in the underlying gravel which would just produce quick conditions in the layer above. Assume that the ground water level is at the surface of the flood plain, and that the unit weight of all layers are the same at $\gamma = 19.62$ kN/m^3. Note that it is now possible to determine the water pressure variation that must have existed in the three uppermost layers, just prior to the establishment of quick conditions. What are these pressures?

b) What are the equivalent vertical and horizontal permeabilities of the three uppermost layers? Assume that each layer is isotropic and homogeneous within itself.

8. The impermeable dam shown in Figure 3 below is 100 m long, and is founded on a permeable soil, which in turn overlies impermeable bedrock. If the soil has a horizontal permeability of $k = 2.8 \times 10^{-6}$ m/s and a vertical permeability of $k = 7 \times 10^{-7}$ m/s, what will be the total flow under the dam in one day? Assume that the same cross-section applies under the whole length of the dam. Note: Allow adequate space both upstream and downstream of the dam when drawing your flow net.

9. Figure 4 shows a retaining wall 6 m high resting on an impermeable horizontal boundary. The back of the wall is vertical, and is provided with a vertical filter drain to intercept the flow of water from the fill. The vertical

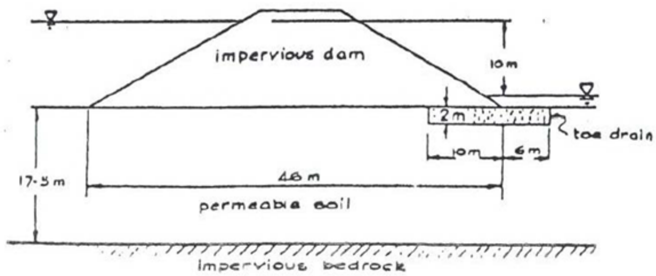

Figure 3: Flow underneath impervious dam

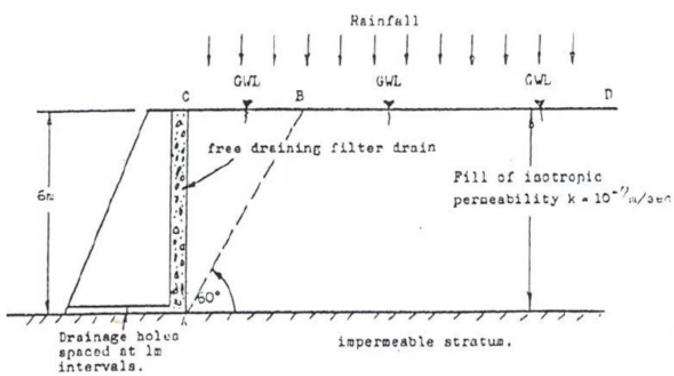

Figure 4: Retaining wall

filter drain discharges through drainage holes spaced at 1 m intervals in the base of the wall.

a) Draw a flow net for the fill, assuming (i) that sufficient rain falls to maintain the ground-water level at the upper level (CBD) of the fill, and (ii) that any water in the vertical filter drain is at atmospheric pressure.

b) Determine from the flow the water pressure distribution along a surface AB that is inclined at 60^o to the horizontal and passes through the toe of the fill.

c) Calculate the discharge from each drainage hole in m3/day, assuming the permeability of the fill to be $k = 10^{-7}$ m/s.