# 11
# Falling Head Permeability Test in Sand

## Introduction

The procedure for conducting the constant head permeability tests in sand were discussed in the preceding chapter. The falling head permeability test is another experimental procedure to determine the coefficient of permeability of sand.

## Equipment

1. Falling head permeameter
2. Balance sensitive to 0.1 g
3. Thermometer
4. Stop watch

## Falling Head Permeameter

A schematic diagram of a falling head permeameter is shown in Fig. 11–1. This consists of a specimen tube essentially the same as that used in the constant head test. The top of the specimen tube is connected to a burette by plastic tubing. The specimen tube and the burette are held vertically by clamps from a stand. The bottom of the specimen tube is connected to a plastic funnel by a plastic tube. The funnel is held vertically by a clamp from another stand. A scale is also fixed vertically to this stand.

## Procedure

Steps 1 through 9: Follow the same procedure (i.e., Steps 1 through 9) as described in Chapter 10 for the preparation of the specimen.

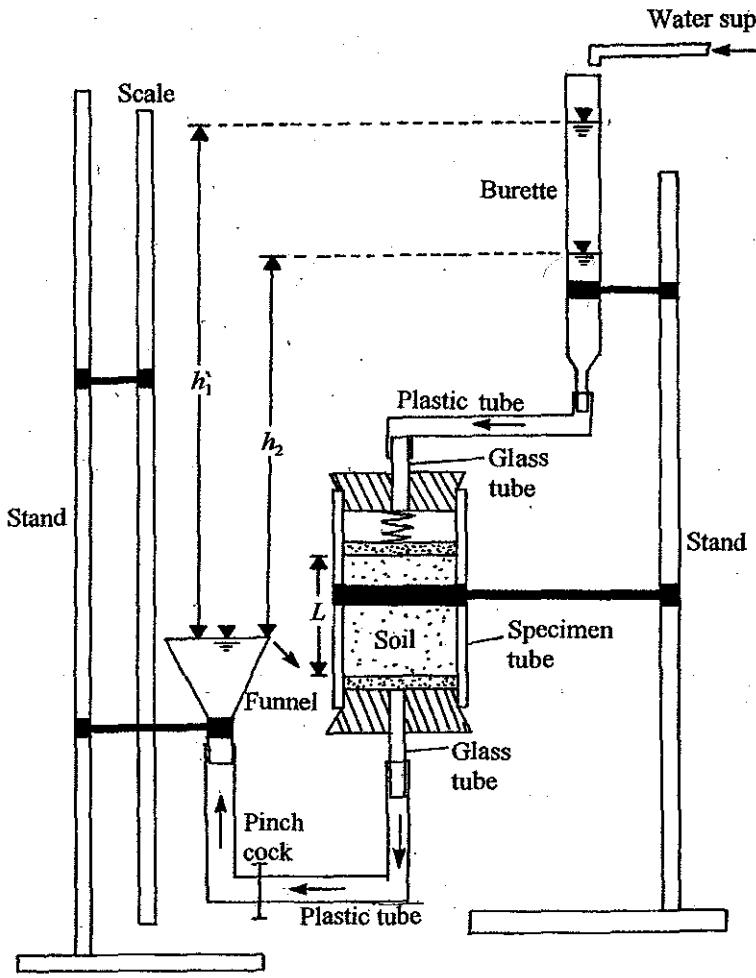


**Figure 11–1.** Schematic diagram of falling head permeability test setup.

10. Supply water using a plastic tube from the water inlet to the burette. The water will flow from the burette to the specimen and then to the funnel. Check to see that there is no leak. Remove all air bubbles.
11. Allow the water to flow for some time in order to saturate the specimen. When the funnel is full, water will flow out of it into the sink.
12. Using the pinch cock, close the flow of water through the specimen. The pinch cock is located on the plastic pipe connecting the bottom of the specimen to the funnel.
13. Measure the head difference, $h_1$ (cm) (see Fig. 11–1).
    *Note: Do not* add any more water to the burette.
14. Open the pinch cock. Water will flow through the burette to the specimen and then out of the funnel. Record time ($t$) with a stop watch until the head difference is equal to $h_2$ (cm) (Fig. 11–1). Close the flow of water through the specimen using the pinch cock.

15. Determine the volume ($V_w$) of water that is drained from burette in $cm^3$.
16. Add more water to the burette to make another run. Repeat Steps 13, 14 and 15. However, $h_1$ and $h_2$ should be changed for each run.
17. Record the temperature, $T$, of the water to the nearest degree (°C).

## Calculation

The coefficient of permeability can be expressed by the relation

$$k = 2.303 \frac{aL}{At} \log \frac{h_1}{h_2} \tag{11.1}$$

where $a$ = inside cross-sectional area of the burette
[For an example for derivation, see Das (1994) under "References" at the back of the book.]

$$a = \frac{V_w}{(h_1 - h_2)} \tag{11.2}$$

Therefore

$$k = \frac{2.303 V_w L}{(h_1 - h_2)tA} \log \frac{h_1}{h_2} \tag{11.3}$$

where $A$ = area of the specimen
As in Chapter 10

$$k_{20°C} = k_{T°C} \frac{\eta_{T°C}}{\eta_{20°C}} \tag{11.4}$$

Sample calculations are shown in Tables 11–1 and 11–2.

**Table 11–1.** Falling Head Permeability Test

Determination of Void Ratio of Specimen

Description of soil *Uniform sand* Sample No. _____

Location _____

Length of specimen, $L$ *13.2* cm Diameter of specimen, $D$ *6.35* cm

Tested by _____ Date _____

| | |
|---|---|
| Volume of specimen, $V = \frac{\pi}{4} D^2 L \ (\text{cm}^2)$ | *418.03* |
| Specific gravity of soil solids, $G_s$ | *2.66* |
| Mass of specimen tube with fittings, $W_1$ (g) | *238.4* |
| Mass of tube with fittings and specimen, $W_2$ (g) | *965.3* |
| Dry density of specimen, $\rho_d = \frac{W_2 - W_1}{V} \ (\text{g/cm}^3)$ | *1.74* |
| Void ratio of specimen, $e = \frac{G_s \rho_w}{\rho_d} - 1$ (*Note:* $\rho_w =$ | *0.53* |

**Table 11–2.** Falling Head Permeability Test
Determination of Coefficient of Permeability

| Test No. | 1 | 2 | 3 |
|---|---|---|---|
| Diameter of specimen, $D$ (cm) | *6.35* | *6.35* | *6.35* |
| Length of specimen, $L$ (cm) | *13.2* | *13.2* | *13.2* |
| Area of specimen, $A$ ($cm^2$) | *31.67* | *31.67* | *31.67* |
| Beginning head difference, $h_1$ (cm) | *85.0* | *76.0* | *65.0* |
| Ending head difference, $h_2$ (cm) | *24.0* | *20.0* | *20.0* |
| Test duration, $t$ (s) | *15.4* | *15.3* | *14.4* |
| Volume of water flow through the specimen, $V_w$ ($cm^3$) | *64* | *58* | *47* |
| $k = \frac{2.303 V_w L}{(h_1 - h_2) t A} \log \frac{h_1}{h_2}$ (cm/s$^2$) | *0.036* | *0.038* | *0.036* |
| Average $k$ = *0.037* cm/s | | | |
| $k_{20°C} = k_{T°C} \frac{\eta_{T°C}}{\eta_{20°C}}$ = *(0.037)(0.889)* = *0.033* cm/s | | | |