The University of Iowa
Department of Civil & Environmental Engineering
53:030 Soil Mechanics
Fall Semester, 2003

Lab Experiment No. 5: Constant Head Permeability Test

Equipment: constant head permeameters, glass beakers or graduated cylinders, timers, and a thermometer.

A. Objective

In this laboratory experiment, the constant head test will be employed to measure the hydraulic conductivities of three different soil types:

- A sandy soil (FI-6);
- A crushed limestone aggregate (CLA-2); and
- A gravel (GRA-1).

You measured the grain-size distributions for soil FI-6 in Lab 2, and the GSD for CLA-2 AND GRA-1 are provided below in Figure 1. In addition, you should observe the relative impermeability of soil FI-10 whose GSD you measured in Lab 2. (For this soil, quantitative measurements are not required, just an observation that the flow rates through this soil are much smaller than those through the sandy and gravelly soils. Please consider why this is so.)

B. Experimental Procedure

Since the experimental apparatus for these tests has already been set up the procedure for this experiment involves only performing the flow rate measurements through the soils FI-6, CLA-2 and GRA-1.

1. The hydraulic gradient through the soil sample can be measured by taking the piezometric heads at the locations of the two manometers and dividing their difference Δh by the flow distance L between the manometers. The hydraulic gradient across the sample (and thus the flow rate) can controlled by varying the elevation of the outflow location.
2. Establish a steady flow for a fixed hydraulic gradient. Collect the water flowing out of the outflow tube over a time interval of six minutes. During each six minute interval, take readings at t = 2 min, 4 min, and 6 min. For each reading, record the incremental volume Q of water collected.
3. Compute the volumetric flow rate q for each measurement as the volume of the water collected divided by the time interval Δt over which the collection was performed.
4. Change the hydraulic gradient *i* through the sample, and repeat Steps 1—3 again for two different hydraulic gradients.
5. Repeat Steps 1--4 for all three soils, and collect the experimental data in Tables 1-3.

C. Permeability Computations

The suggested format for permeability computations is shown in Tables 1-3. This format includes a temperature correction $k_{20^o C} = k_\theta \, {}^{\mu_\theta}\!/_{\mu_{20}}$ such that the conductivities reported are those at 20^{o}C. (Please recall that the viscosity of water as a function of temperature was provided in the Lab 1 handout.) Hazen's formula for permeability of clean sands is $k(mm \cdot s^{-1}) = C\left(\mathrm{D}_{10}\right)^2$ in which D_{10} is in millimeters. Based on your results, estimate the coefficient C in Hazen's formula for the three soils.

Table 1. Permeability computations for soil FI-6.

Reading No.	1	2	3	4	5	6	7	8	9
L(cm)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
A(cm^2)	7.45	7.45	7.45	7.45	7.45	7.45	7.45	7.45	7.45
Δh(cm)									
i = Δh/L									
Δt(sec)									
θ(°C)									
Q(cm^3)									
q=Q/t (cm^3/s)									
$k_\theta = q/iA$									
$k_{20^o C}$									

Table 2. Permeability computations for soil CLA-2.

Reading No.	1	2	3	4	5	6	7	8	9
L(cm)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
A(cm^2)	7.45	7.45	7.45	7.45	7.45	7.45	7.45	7.45	7.45
Δh(cm)									
i = Δh/L									
Δt(sec)									
θ(°C)									
Q(cm^3)									
q=Q/t (cm^3/s)									
$k_\theta = q/iA$									
$k_{20^o C}$									

Table 3. Permeability computations for soil GRA-1.

Reading No.	1	2	3	4	5	6	7	8	9
L(cm)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
A(cm^2)	7.45	7.45	7.45	7.45	7.45	7.45	7.45	7.45	7.45
Δh(cm)									
i = Δh/L									
Δt(sec)									
θ(°C)									
Q(cm^3)									
q=Q/t (cm^3/s)									
$k_\theta = q/iA$									
$k_{20^o C}$									

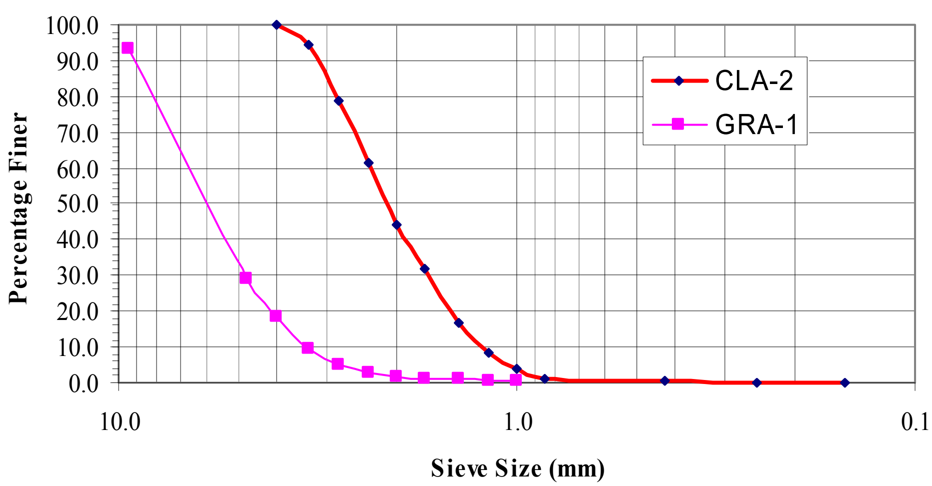

Figure 1. Grain size distributions for CLA-2 and GRA-1.