MIDDLE EAST TECHNICAL UNIVERSITY

CIVIL ENGINEERING DEPARTMENT

# Soil Mechanics Lab Report

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| Course No: CE363 | DATE OF TESTING: 25.11.2011 |
| NO. AND TITLE OF THE TEST: SML 21 | |
| Constant Head Permeameter | |
| Year & Section : 3, 04 | Lab Group: 03 |
| Surname, Name: | |

# SML 21- Constant Head Permeameter

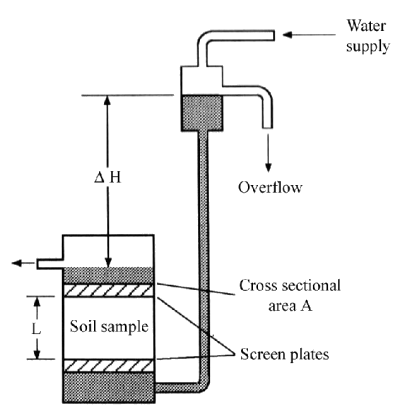
## Object of the Experiment

The objects of this experiment are;

* To verify Darcy’s law and analyze the range over which it applies
* To observe how and when the boiling occurs and the conditions under which boiling takes place
* To find the coefficient of permeability and its variation with void ratio.

## Apparatus

The system is like the following picture ( not same, but similar);



The system consists of porous stones, soil sample, water tank, tapings, water inlet and water outlet.

## Theory

* Darcy’s Law describes fluid’s flow through a porous and it is based on the results of the sand experiments. This law is proportional relationship between the discharge rates at that moment through a porous.
* Coefficient of permeability represents the slope of a linear dependence of water flow velocity on the hydraulic gradient and it can be found by using Darcy’s Law. Seepage is the ability of porous rocks and soils to transport water of given properties. At the point that boiling occurs, the hydraulic gradient, i, gets its critical value Icr.

## Procedure (Method of Test)

1. Determine the specific gravity and the initial water content of the sand.
2. Weigh out enough sand to fill the permeameter up to a level of about 5 cm below the top of the permeameter. Stir this sand thoroughly in water in a tray to drive out all free air bubbles.
3. Make sure that no air bubbles are trapped in the plastic tubing. Then fill the permeameter with water with the porous base plate in position. Using a suitably sized plastic tube, siphon the sand-water mixture into permeameter, allowing the samd to settle uniformly in the cylinder while the excess water overflows into a large tray placed under the permeameter. Pour more water into the tray containing the sand sample if necessary. The sand so deposited is in a very loose state. Compact this sand as far as possible using the steel rule. Measure the height of the sample and the internal diameter of the Lucite cylinder.
4. Allow air-free water to flow upwards through the sample at a slow rate so as not to disturb the sand, and wait until uniform discharge is taking place through the outlet. Measure the rate of discharge and record the temperature of the water at intervals of about 2 cm of difference, h, in head between the stand-pipe tapping point and the top of the sample. Carry on up to a hydraulic gradient of about 0.8, and thereafter, take readings at smaller intervals of difference in head up to the critical gradient, Icr.
5. After boiling has been observed, measure the height of the sample, then reduce the head until the sand settles back and re-measure the height. Reduce the head at wider intervals, measuring the rate of flow and the temperature as before. At the end of the test, take a final measurement of the height of the sample.
6. Measure the distance, d, between the stand-pipe tapping point and the top of the porous stone, for determining the effective length, L, of the sample at various stages of the test form a knowledge of the total height, H, of the sample.

## Calculations

* Mass of sand placed in permeameter, M= 820 gr
* Initial moisture content of sand, m= 0
* Dry mass of sand in permeameter, MD=M/(1+m)= 820 gr
* Specific gravity of sand, GS= 2.65
* Volume of solid particles, Vs=MD/GS= 820/2.65= 309.434 ml
* Internal diameter of permeameter= 6.25 cm
* Area of sample,A = π(internal diameter of permeameter)2= π(6.25/2 cm)2= 30.680 cm2
* Distance between tapping point and base of sample, d= 2 cm

### *TABLE 1*

### INITIAL

Height of sample = 20.6 cm

Total Volume = A\*H= (30.680)(20.6)= 632.008 ml

Volume of voids= VV= V- VS= 632.008-309.434= 322.574 ml

Porosity = n= VV/V= 322.574/632.008= 0.510

### DURING BOILING

Height of sample = 21 cm

Total Volume = A\*H= (30.680)(21)= 644.280 ml

Volume of voids= VV= V- VS= 644.280 -309.434= 334.846 ml

Porosity = n= VV/V= 334.846 /644.280 =0.520

### AFTER BOILING

Height of sample = 20.6 cm

Total Volume = A\*H= (30.680)(20.6)= 632.008 ml

Volume of voids= VV= V- VS= 632.008-309.434= 322.574 ml

Porosity = n= VV/V= 322.574/632.008= 0.510

### AT THE END OF TEST

Height of sample = 20.6 cm

Total Volume = A\*H= (30.680)(20.6)= 632.008 ml

Volume of voids= VV= V- VS= 632.008-309.434= 322.574 ml

Porosity = n= VV/V= 322.574/632.008= 0.510

### *TABLE 2( to be recorded during test)*

### FIRST MEASUREMENT

Q1=35ml/20sec=1.75 ml/s

Velocity= V= Q/A= (1.75ml/s)/( 30.680 cm2)=0.057 cm/s

Head=h=5.3 cm

H=20.6 cm

L=H-d=20.6cm – 2cm= 18.6 cm

Hydraulic gradient, I=h/L=5.3/18.6=0.285

Kt=V/i= 0.057/0.285=0.200 cm/s

Temperature= 20celcius

k20= kt= 0.200 cm/s

### SECOND MEASUREMENT

Q1=34ml/10sec=3.4 ml/s

Velocity= V= Q/A= (3.4 ml/s)/( 30.680cm2)=0.111 cm/s

Head=h=9.4 cm

H=20.6 cm

L=H-d=20.6cm – 2cm= 18.6 cm

Hydraulic gradient, I=h/L=9.4/18.6=0.505

Kt=V/i= 0.111/0.505=0.220 cm/s

Temperature= 20celcius

k20= kt= 0.220 cm/s

### THIRD MEASUREMENT (BOILING)

Q1=61ml/10sec=6.1 ml/s

Velocity= V= Q/A= (6.1 ml/s)/( 30.680cm2)=0.199 cm/s

Head=h=14.4 cm

H=21 cm

L=H-d=21cm – 2cm= 19 cm

Hydraulic gradient, I=h/L=14.4/19=0.758

Kt=V/i= 0.199/0.758=0.263 cm/s

Temperature= 20celcius

k20= kt= 0.263 cm/s

### FORTH MEASUREMENT

Q1=30ml/10sec=3 ml/s

Velocity= V= Q/A= (3ml/s)/( 30.680cm2)=0.098 cm/s

Head=h=7.8 cm

H=20.6 cm

L=H-d=20.6cm – 2cm= 18.6 cm

Hydraulic gradient, I=h/L=7.8/18.6=0.419

Kt=V/i= 0.098/0.419=0.234 cm/s

Temperature= 20celcius

k20= kt= 0.234 cm/s

# k20 vs. n (porosity) diagram

# V(velocity) vs. i (hydraulic gradient) diagram

In this diagram, we can see both increasing and decreasing head. Increasing head is the left side of the curve.

i=0.758 boiling<0.

Theoretical hydraulic gradient :

I= (GS-1)/(1+e)

## Results

Results are given on the data sheet.

## Discussion of Results

* The hydraulic gradient at boiling is 0.758 which is the largest value of i. On the other hand, the initial value of hydraulic gradient has very small number, 0.285. Because in boiling situation, soil behaves like liquid and starts to boil then the difference with the heads become larger.
* Also the volume of voids becomes larger in boiling situation.
* As told above, in the diagrams we can see both increasing and decreasing head.
* There may be some errors due to human factor or engineering problems.

## Conclusion

In this experiment, constant head permeameter, the coefficient of permeability is found by the values that were obtained from the lab, such as discharges, and head differences. With these determinations, we can easily understand how the boiling occurs.

## References

1. Mirata ,T. (2009*). Laboratory Instructions for Soil Mechanics Students*
2. <http://www.ldeo.columbia.edu/~martins/hydro/lectures/darcy.html>