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PERMEABILITY TEST-CONSTANT HEAD METHOD
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THEORY:

The rate of flow under laminar flow conditions through a unit cross sectional area of porous medium under unit hydraulic gradient is defined as coefficient of permeability.

NEED AND SCOPE*:*

Permeability is useful in solving problems involving yield of water bearing strata, seepage through earthen dams, stability of earthen dams, and embankments of canal bank affected by seepage, settlement etc.

The falling head method of determining permeability is used for soil with low discharge, whereas the constant head permeability test is used for coarse-grained soils with a reasonable discharge in a given time. Usually, permeability of soils is determined by two methods:

1. Constant Head Permeability method
2. Falling Head Permeability method

Constant head method is elaborated in this section.

PREPARATION OF THE SPECIMEN:

The preparation of the specimen for this test is important. There are two types of specimens, the undisturbed soil sample and the disturbed or remolded soil sample.

A. Undisturbed soil specimen

1. Note down-sample no., borehole no., depth at which sample is taken.
2. Remove the protective cover (wax) from the Shelby tube.
3. Place the Shelby tube in the sample extractor and push the plunger to get a cylindrical shaped specimen not larger than 95 mm diameter and height equal to that of the permeameter mould.
4. This specimen is placed centrally over the porous stone of base plate.
7. Porous stone is also placed at the top of the sample
8. The specimen is now ready for test.

B. Remolded specimen

The remolded specimen can be prepared by static compaction or by dynamic compaction.

Preparation of Dynamically Compacted (Remolded) sample:

1. Take 2500 gms of representative soil and mix it with water to get O.M.C, if necessary.
2. Assemble the permeameter for dynamic compaction. Grease the inside of the mould and place it upside down on the dynamic compaction base. Weigh the assembly correct to a gm (w). Put the collar to the other end.
3. Now, compact the wet soil in 3 layers with 25 blows to each layer with a 2.6 kg dynamic tool. Remove the collar and then trim off the excess. Weigh the mould assembly with the soil.
4. Place the filter paper or fine wire mesh on the top of the soil specimen and fix the perforated base plate on it.
5. Turn the assembly upside down and remove the compaction plate. Insert the sealing gasket and place the top perforated plate on the top of soil specimen. And fix the top cap.
6. Now, the specimen is ready for test.

APPARATUS REQUIRED:

1. Permeameter mould of non-corrodible material having a capacity of 1000 ml, with an internal diameter of 100 ±0.1 mm and internal effective height of 127.3± 0.1 mm.
2. The mould shall be fitted with a detachable base plate and removable extension collar.
3. ***Compacting equipment*****:** 50 mm diameter circular face, weight 2.6 kg and height of fall 310 mm as specified in I.S 2720-part VII 1980.
4. ***Drainage bade*****:** A bade with 12 mm thick porous disc having its permeability 10 times of that for soil.
5. ***Drainage cap*****:** A porous disc of 12 mm thick having a fitting for connection to water inlet or outlet.
6. ***Constant head tank*****:** A suitable water reservoir capable of supplying water to the Permeameter under constant head.
7. Graduated glass cylinder to receive the discharge.
8. Stop watch to note the time, and a meter scale to measure the head differences and length of specimen.

PROCEDURE:

1. For the constant head arrangement, the specimen shall be connected through the top inlet to the constant head reservoir.
2. Open the bottom outlet.
3. Establish steady flow of water.
4. The quantity of flow for a convenient time interval may be collected.
5. Repeat three times for the same interval.

OBSERVATION AND RECORDING:

The flow is very low at the beginning, gradually increases and then stands constant. **Constant head permeability test is suitable for Cohesionless (Coarse and medium Sands) soils**.

PRESENTATION OF DATA:

The coefficient of permeability is reported in cm/sec at 27° C. The dry density, the void ratio and the degree of saturation shall be reported. The test results should be tabulated as shown in the following manner:

Test Record

Project: …… Tested By: ……..

Location: …….. Boring No. : …….. Depth: ……

Details of sample

Diameter of specimen ……. cm Length of specimen (L) …..…… cm

Area of specimen (A) …….…….cm^2 Specific gravity of soil G_s ……..

Volume of specimen (V) …….cm^3 Weight of dry specimen (W_s) ……. gm

Moisture content, w …..……..…… % Dry density, $\gamma_d = W_s / V$ = …….. gm /cc

Void Ratio, $e = (Gs.\gamma_w / \gamma_d) - 1$ = …….. Saturation, $S = Gs.w / e$ = …… %

Experiment No.		1	2	3
Discharge	Q (cm^3)			
Time t	(sec)			
Height of water	h(cm)			
Temperature	(^oC)			
Coefficient of Permeability at …… ^oC k = Q.L / (A.h.t)	cm/sec			
Average Permeability, k_t	cm/sec			
Permeability at 27 ^oC: $k_{27} = k_t \times \eta_t / \eta_{27}$	cm/sec			

Variation of η_t / η_{27} with temperature

Temperature	15	16	17	18	19	20	21	22
η_t / η_{27}	1.336	1.301	1.268	1.237	1.206	1.177	1.149	1.122
Temperature	23	24	25	26	27	28	29	30
η_t / η_{27}	1.096	1.071	1.046	1.023	1.000	0.979	0.958	0.938

GENERAL REMARKS:

1. During test there should be no volume change in the soil, there should be no compressible air present in the voids of soil i.e., soil should be completely saturated. The flow should be laminar and in a steady state condition.
2. Coefficient of permeability is used to assess drainage characteristics of soil, to predict rate of settlement of structure founded on the soil bed.
3. Coefficient of permeability:

   High permeability: $k > 10^{-4}$ cm/sec

   Medium permeability: 10^{-7} cm/sec $< k < 10^{-4}$ cm/sec

   Low permeability: $k < 10^{-7}$ cm/sec

4. General values of permeability for different types of soils are given below:

   a. Gravel: 10^{-3} to 1 cm/sec
   b. Medium and Coarse Sand: 1 to 10^{-3} cm/sec
   c. Fine Sand and Silt: 10^{-3} to 10^{-6} cm/sec
   d. Clay: less than 10^{-7} cm/sec
   e. Fly Ash: 1×10^{-4} to 5×10^{-4} cm/sec