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PERMEABILITY TEST-FALLING 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. For very fine-grained soil, capillarity permeability test is recommended. Usually, permeability of soils is determined by two methods:

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

Falling 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 disturbed 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 with its accessories
2. Standard soil specimen
3. Deaired water
4. Balance to weigh up to 1 gm
5. I.S sieves 4.75 mm and 2 mm
6. Mixing pan
7. Stop watch
8. Measuring jar
9. Meter scale
10. Thermometer
11. Container for water
12. Trimming knife

TEST PROCEDURE:

1. Prepare the soil specimen as specified.
2. Saturate the specimen preferably by using Deaired water.
3. Assemble the Permeameter (It is made of non-corrodible material with a capacity of 1000 ml, with an internal diameter of 100±0.1 mm and effective height of 127.3± 0.1 mm).
4. Inlet nozzle of the mould is connected to the stand pipe. Allow the water to flow until steady flow is obtained.
5. Note down the time interval 't' for a fall of head in the stand pipe 'h'.
6. Repeat step 5 three times to determine 't' for the same head.

For fine sands and silts, falling head method is suitable.

OBSERVATION & RECORDING:

Sample No. …… Molding water content: ……..

Dry Density: ……. Specific Gravity: ……..

Void ratio …….

S. No.	Description		1st set	2nd set	3rd set
1.	Area of stand pipe (dia. 5 cm)	a (cm)			
2.	Cross sectional area of soil specimen	A (cm^2)			
3.	Length of soil specimen	L (cm)			

4.	Initial reading of stand pipe	h_1 (cm)			
5.	Final reading of stand pipe	h_2 (cm)			
6.	Time	t (sec)			
7.	Test temperature	T (^oC)			
8.	Coefficient of permeability at …….. ^oC $k = 2.303.a.L.(\log_e (h_1/h_2))/ (A.t)$	k (cm/sec)			
9.	Average Permeability, k_t	k_t (cm/sec)			
10.	Coefficient of permeability at 27° C: $k_{27} = k_t \times \eta_t / \eta_{27}$	k_{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