TABLE 6

PERMEAMETERS

State or Country	Organization	Type of Apparatus		Contributor
		Head	Container	
New York	Brooklyn Polytechnic Institute	C		Prof. L. F. Rader
		V	I, P	
		H		
New York	Columbia University	V	I	Prof. D. M. Burmister
Connecticut	Connecticut Highway Dept. (Yale)	C	I	Dr. D. P. Krynine
		V	I	
New Hampshire	Dartmouth College	V	I	Prof. W. P. Kimball
		H		
Pennsylvania	Engineer Office, U. S., Pittsburgh	V	I	R. R. Philippe
Dist. of Col.	George Washington University	V	C, P	C. A. Hogentogler, Jr.
Massachusetts	Harvard University	V	I, C	Dr. A. Casagrande
Hawaii	Hawaii, University of	V	C	Prof. C. B. Andrews
Idaho	Idaho, University of	C	P	Prof. A. S. Janssen
Illinois	Illinois, University of	V	I	Prof. E. E. Bauer
Kansas	Kansas State College	V	P	Prof. C. H. Scholer
Louisiana	Lousiana Highway Commission	V	C	H. L. Lehmann
Maine	Maine Highway Commission	V	C, P	E. F. Bennett
		H		
Michigan	Michigan Highway Department	C	I	Prof. W. S. Housel
Montana	Montana Highway Commission	C	I	G. J. Johnson
New Hampshire	New Hampshire Highway Dept.	V	P	P. S. Otis
Oregon	Oregon State College			Prof. S. H. Graf
Dist. of Col.	Park Service, National	C	I	E. F. Preece
		V	I, C, P	
New Jersey	Princeton University	C	I	Prof. G. P. Tschebotareff
		V	I, C	
		H		
Dist. of Col.	Public Roads, U. S. Bureau of	V	I, C, P	C. A. Hogentogler
Dist. of Col.	Reclamation, U. S. Bur. of	C	I	J. C. Page
Utah	Utah State Road Commission	C	P	Levi Muir
Washington	Washington Dept. of Highways	V	C	Bailey Tremper
Washington	Washington, Univ. of	V	I	Prof. R. G. Hennes
West Virginia	West Virginia Road Commission			A. M. Miller
Wisconsin	Wisconsin, University of	V	P	Prof. H. F. Janda
Dist. of Col.	Yards & Docks, U. S. Bureau of	V	C	C. H. Bramhall
Canada	University of Toronto	V	C	Prof. C. R. Young
Denmark	Royal Tech. College	V	C	Axel Riis
Denmark	Danish Geological Survey			Mrs. E. L. Mertz
Germany	Prussian Research Station	C	I, C	Prof. R. Seifert
Netherlands	Lab. for Soil Mech., Delft	V	I, C	Dr. T. K. Huizinga
Switzerland	Testing Institute of Dr. Bendel	C	I	Dr. L. Bendel

V. Variable (or falling) head, Figure 61.

H. Horizontal capillarity, Figure 62.

The sample containers are divided into three groups:

I. Individual.

C. Consolidometer.

P. Proctor mold.

CONSTANT HEAD PERMEAMETERS

Dr. D. P. Krynine: Figure 63 shows a permeameter with constant hydraulic head for determining the permeability of sand. The water level in the container, C, is kept constant, and if the stopcock, S, is closed, the level in the standpipe, P, is practically the same as in the container. As soon as the stopcock, S, is opened, the level in the standpipe, P, drops, because a part of the pressure, H, is spent to make water travel through the sample. The experiment is repeated several times using different values of H, which is regulated by the stopcock, S.

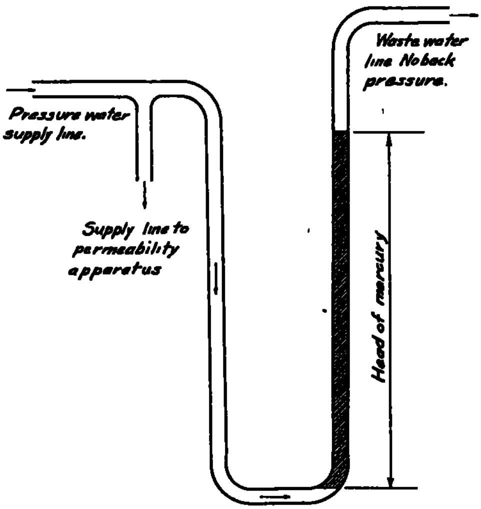

Figure 60. Mercury Relief Valve for Constant Head Permeameter

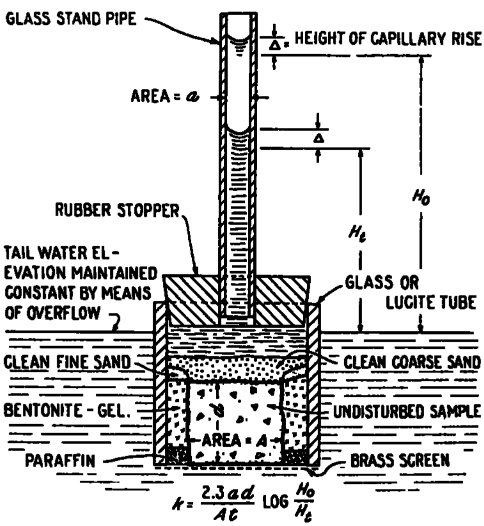

Figure 61. Testing of Undisturbed Sample in Falling Head Permeameter

Figure 62. Horizontal Capillarity Permeability Test

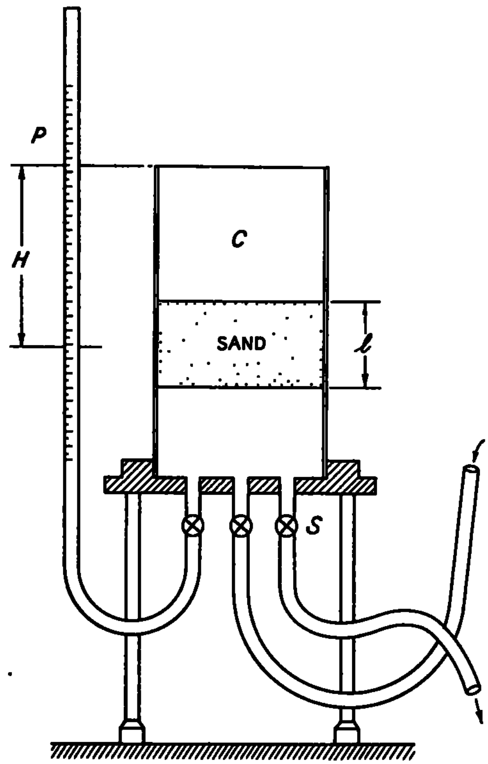

Figure 63. Constant Hydraulic Head Permeameter. Krynine

Prof. W. S. Housel: Figure 64 shows apparatus used in the permeability test. A constant head of water is supplied by the mercury relief valve sketched in Figure 60.

In operation soil is compacted in the 16 sq. in. cylinder to the desired density, the cylinder assembled and connected to the supply side of the mercury relief valve. Water is percolated through the sample under the constant head decided upon for 12 hours, after which time a discharge measurement and temperature reading are made. Repeated measurements are made at 12 to 24 hour intervals until the discharge attains a constant rate.

E. F. Preece: In apparatus used by the National Park Service air is percolated, the upstream and downstream pressures are determined by binometer, and the flow volume is determined by means of a calibrated orifice for particular down-stream pressure. Calibration of this apparatus has not yet been accomplished and it is not yet used as a routine test. The apparatus appears to have certain definite advantages in that permeabilities of very dense materials may be obtained readily and permeabilities may be determined at various stages of a progressive test without saturating the sample.

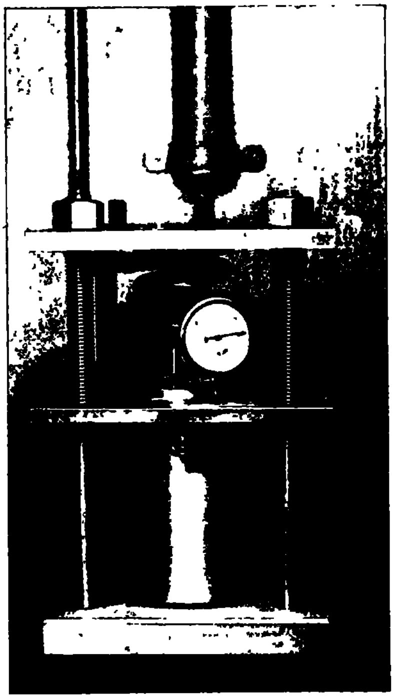

Figure 64. Permeability Cylinder. Housel

Prof. R. Seifert: Test borings, in their original undisturbed condition, are so placed in a sufficiently wide glass cylinder (Fig. 65) that the underside of the sample rests on a sand filter; the space between sample and glass wall being filled with sizing treated with Formalin. A layer of sand is placed over the soil sample and covered with a sieve plate which can be loaded. Using a container giving an unchanging head of water, the daily passage of water through the sample is measured.

If the soils are those to be used in dams or other consolidation works, the sample is compressed to the density it will have in the structure and to a height of about 10 cm. in a glass ring, the sides of which are coated with grease and beeswax. The daily water passage is then measured.

The oedometer of Terzaghi is a better and more thorough instrument. However, it is more involved and hence costlier. In this case the soil is placed in the apparatus in the form of a slurry. The water is then squeezed out under various loads and the consolidation of the soil measured. The test results are calculated through the use of Darcy's formula from the time, area and head of water.

Dr. L. Bendel: The construction of the apparatus used in Zurich is shown in Figure 66.

VARIABLE HEAD PERMEAMETERS

Prof. D. M. Burmister: The permeability device, illustrated in Figure 67, consists of a base and a top containing porous stones, and various lengths of 3-in. brass tubing into which the soil is placed in the desired degree of compactness. For undisturbed samples a length of the 3-in. sample is cut without removal from the sample tube, the filter heads being fitted and clamped into place, and a water-tight seal effected by means of a special sealing ring. The device is connected to a suitable stand-pipe in a bank of stand-pipe sizes ranging from gauge glass to capillary size, and the device is operated as a variable head permeameter. The scale for the stand-pipe is calibrated for head in centimeters and quantity in cubic centimeters. A correction curve for the loss of head through the system independent of the soil is determined for each stand-pipe.

Dr. D. P. Krynine: For coarse sands and gravels a very simple device is used, as shown in Figure 68. There are two