February 17, 2011

GDT 1

A. SCOPE:

This test method covers procedures for determining the relative permeability (also referred to as coefficient of permeability, based on Darcy's law) of water saturated laboratory compacted specimens or field cores of compacted bituminous paving mixtures using a flexible wall permeameter.

B. APPARATUS:

1. Permeameter

a) A graduated cylinder, having an inner diameter of 31.75 +/- 0.5mm (1.25 +/- 0.02 in), graduated in centimeters and capable of dispensing 500 ml of water.
b) A sealing tube using a flexible latex membrane 0.635 mm (0.025 in) thick and capable of confining asphalt concrete specimens up to 152.4 mm (6.0 in) in diameter and 80.0 mm (3.15 in) in height.
c) A cap assembly for supporting the graduated cylinder and expanding an o-ring against the sealing tube. The opening in the cap shall be of the same diameter as the outer diameter of the graduated cylinder. The underside of the cap assembly should be tapered at an angle of 10 +/- 1˚.
d) O-rings of sufficient diameter and thickness for maintaining a seal against the sealing tube.
e) A frame and clamp assembly for supplying a compressive force to the cap assembly and pedestal plate necessary to expand the o-rings.
f) An air pump capable of applying 103kPa (15 psi) pressure to the specimen as well as vacuum to evacuate the air from the sealing tube/membrane cavity.
g) A pressure gage with range 0 to 103 kPa (15 psi) with +/- 2% accuracy.
h) Quick connects for both vacuum and pressure lines.
i) An outlet pipe, 50.8 mm (2.0 in) long with an inside diameter of 18 mm (0.71 in).
j) Valve positioned upstream of the outlet pipe.

2. Water Bath

The water bath shall be at least 152.4 mm (6 in) deep and have a perforated false bottom or be equipped with a shelf for supporting specimens 25.4 mm (1 in) above the bottom of the bath.

3. Balance

Use a balance having a capacity of 10 lb (4.5 kg) or more and sensitive to 0.1 g or less. The balance should conform to the requirements of AASHTO M 231.

4. Vacuum Pump

Use a pump that can produce a pressure drop of 26in (660.4mm) of mercury (a gauge vacuum of 26in (660.4mm) Hg) for use in water-saturating the test specimen.

5. Additional Apparatus

Stop watch, Caliper, Thermometer, and apparatus as listed in Test Methods AASHTO T-166 and T-312.

C. SAMPLE SIZE AND PREPARATION:

Lab Created Specimens

Compact the 6 inch (152.4mm) diameter specimens using AASHTO T-312. The recommended specimen height is 75mm. Compact the specimen to 6.0% +/- 1.0% air voids. Measure the height of the specimen in 3 locations around the circumference of the specimen to record the average height. Use AASHTO T-166 for void determination

Roadway Cores

Isolate the asphalt lift for permeability testing using a saw. Wash the core before inserting the specimen into the permeameter for testing. Measure the height of the specimen in 3 locations around the circumference of the specimen to record the average height. Use AASHTO T-166 for void determination.

Note: It is not recommended to test specimens below 25.4 mm (1 in) height. Shorter specimens have shown variability in permeability results as the height decreases to 25.4 mm (1 in).

Saturation of test specimens

Vacuum saturate the specimens before testing.

1. Place the specimen in the vacuum chamber.
2. Cover the specimen with at least 1 in (25.4 mm) of tap water.
3. Drop the pressure in the chamber by 26 in (660.4 mm) of mercury for 5 minutes.
4. Release the vacuum and let the specimen remain in the water undisturbed for another 2 minutes.

Specimen sealing

1. Seal the specimen if the first series of permeability measurements fail. Use silicone caulk to seal only the sides of the specimen. This sealing should aid the function of the latex bladder of the permeameter to prevent short cutting on the sides of the pill by the water. This sealing should not impede water flow through the top or bottom surface area of the specimen.

D. PROCEDURE:

1. Disassemble the permeameter specimen cylinder from the permeameter base.
2. Connect the pressure line of the permeameter to the vacuum side of the pump. Use the pump toapply a vacuum to the flexible wall to remove entrapped air and collapse the membrane to the inside diameter of the cylinder. This will facilitate loading of the specimen.
3. With the flow control valve open, fill the outlet pipe with water until the taper in the base plate pedestal overflows.
4. Expeditiously reassemble the permeameter making sure that all connections and clamps are tightened.
5. Disconnect the pressure line from the vacuum side of the pump and connect it to the pressure side.
6. Apply a confining pressure of 96.5 +/- 7.0 kPa (14 +/- 1 psi).
7. Fill the permeameter graduated cylinder until water (65˚- 80˚F) begins to flow from the outlet tube. Exercise care when filling to minimize the incorporation of air bubbles.
8. Close the flow control valve.
9. Fill the graduated cylinder above the upper timing mark (h_1).
10. Commence the water flow by opening the flow control valve of the permeameter. Start the timing device when the bottom of the meniscus of the water reaches the upper timing mark. Allow water to flow until the water level reaches the lower timing mark (h_2). Once the water level reaches the lower timing mark, stop the timing device and close the valve. Record the elapsed time to the nearest second.
11. If the test time is approaching thirty minutes during the first test run without the water reaching the lower timing mark, then the test may be terminated at the thirty minute mark and the water level at this time recorded. In this case, the test should be conducted one additional time by allowing water to flow for thirty minutes and recording the water mark at this time with the average of the two elapsed time measurements being recorded for use in calculating the permeability.
12. Measure and record the temperature of the permeate water in the system to the nearest 0.5˚C.
13. Release the pressure from the permeameter, remove the clamp assemblies, upper platen and specimen. Wipe clean any excess sealant off of the latex membrane.
14. If the first series of permeability measurements fail, it may be necessary to seal the sides of the specimen as described in the sample preparation section C above.

E. CALCULATIONS:

$$k = \frac{aL}{At} ln\left(\frac{h_1}{h_2}\right) t_c$$

k = coefficient of water permeability, cm/s
a = inside cross-sectional area of inlet standpipe, cm^2
L = average thickness of test specimen, cm
A = average cross-sectional area of test specimen, cm^2
t = average elapsed time of water flow between timing marks (h_1 and h_2), s
h_1 = hydraulic head on specimen at time t1, cm
h_2 = hydraulic head on specimen at time t2, cm
t_c = temperature correction for viscosity of water (see Appendix B)

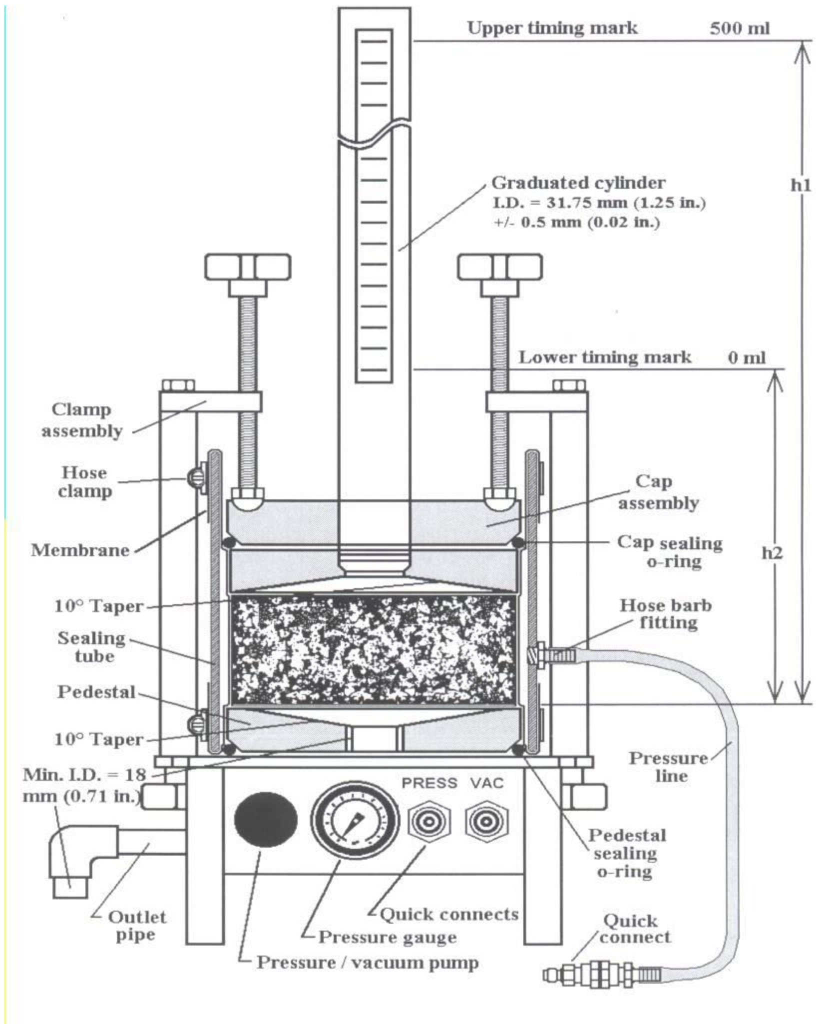
F. REPORT:

Specimen identification

1. Mixture type/description
2. Specimen type (lab prepared or roadway core)
3. Specimen heights
4. Specimen air voids
5. Water temperature
6. Coefficient of water permeability is reported to the nearest whole unit X 10^{-5} cm/s or as ft per day. (Report the average of the results for each individual specimen)

APPENDIX A

Diagram of Water Permeability Testing Apparatus (not to scale)



Note: A device manufactured by the Karol-Warner Company has been found to meet the requirements of this GDT. Also, the point of water exit from the system via the outlet has been changed with more current Karol-Warner devices. This height of the water exit point now matches the lower limit of h_2.

APPENDIX B

Temperature correction table for viscosity of water.

Fahrenheit	Correction
65	1.04
66	1.03
67	1.01
68	1.00
69	0.99
70	0.97
71	0.96
72	0.95
73	0.94
74	0.92
75	0.91
76	0.90
77	0.89
78	0.88
79	0.87
80	0.86