Designation: D 3637 – 84 (Reapproved 1991)

Standard Test Methods for Permeability of Bituminous Mixtures[1]

This standard is issued under the fixed designation D 3637; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 These test methods cover procedures for determining the permeability of bituminous mixtures. These methods measure the rate at which air can be forced (pressure system) or drawn (vacuum system) at low pressure through bituminous mixtures.

1.2 These test methods cover four different procedures: two laboratory tests and two field tests. Field and laboratory tests can be performed by using either the pressure system or the vacuum system.

1.3 The values stated in inch-pound units are to be regarded as the standard. The metric equivalents are rationalized, rather than exact mathematical conversions. (To rationalize is to round completely a converted value to a popular standard figure compatible with noncritical components, interchangeable parts, or other normal sizes in a series).

1.4 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 1559 Test Method for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus[2]

D 1560 Test Methods for Resistance to Deformation and Cohesion of Bituminous Mixtures by Means of Hveem Apparatus[2]

D 1561 Method for Preparation of Bituminous Mixture Test Specimens by Means of California Kneading Compactor[2]

D 2234 Test Method for Collection of a Gross Sample of Coal[3]

E 105 Practice for Probability Sampling of Materials[4]

E 122 Practice for Choice of Sample Size to Estimate the Average Quality of a Lot or Process[4]

E 141 Recommended Practice for Acceptance of Evidence Based on the Results of Probability Sampling[4]

3. Significance and Use

3.1 These methods may be used for a laboratory test for mix design purposes or for a field test for construction control. When testing hot mixes, the pressure system has to be used in order to avoid corrections required to take into account the expansion and contraction of the air within the tubing and pipets.

3.2 The following ideal test conditions are prerequisites for the laminar flow of air through porous medium under constant-head conditions:

3.2.1 Continuity of flow with no volume change during a test,

3.2.2 Flow with the voids fully saturated with the air,

3.2.3 Flow in the steady state with no changes in pressure gradient, and

3.2.4 Direct proportionality of velocity of flow with pressure gradients below certain values, at which turbulent flow starts.

3.3 All other types of flow involving partial saturation of mix, turbulent flow, and unsteady state of flow are transient in character and yield variable and time-dependent permeability; therefore, they require special test conditions and procedures.

3.4 The use of air for measuring permeability does not alter site conditions (or laboratory samples), thus allowing other measurements on the same site (or the same samples). Furthermore, full saturation is more easily attained with air than water and implies much lower pressures. These lower pressures eliminate the risks of turbulent flow and reduce the possibility of any volume change during test.

3.5 Through this permeability test, it is possible to evaluate rapidly the voids content and the compaction of a bituminous mixture even while spreading the mixture; that is, when the mix is still hot and there is possibility for further compaction.

3.6 Scatter in the test results seems to be mainly due to the nonhomogeneity of the material rather than the permeameter itself.

3.7 These methods may also be used for determining permeability of alike bituminous materials.

4. Sampling

4.1 In sampling for mix design, select the same samples that will be prepared according to procedures in Methods D 1559, D 1560, or D 1561.

4.2 In sampling for control on roadway, select the units to be tested by a random method from the material in place after compaction.

[1] These test methods are under the jurisdiction of ASTM Committee D-4 on Road and Paving Materials and are the direct responsibility of Subcommittee D04.23 on Plant-Mix Bituminous Surfaces and Bases.

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[2] *Annual Book of ASTM Standards*, Vol 04.03.

[3] *Annual Book of ASTM Standards*, Vol 05.05.

[4] *Annual Book of ASTM Standards*, Vol 14.02.

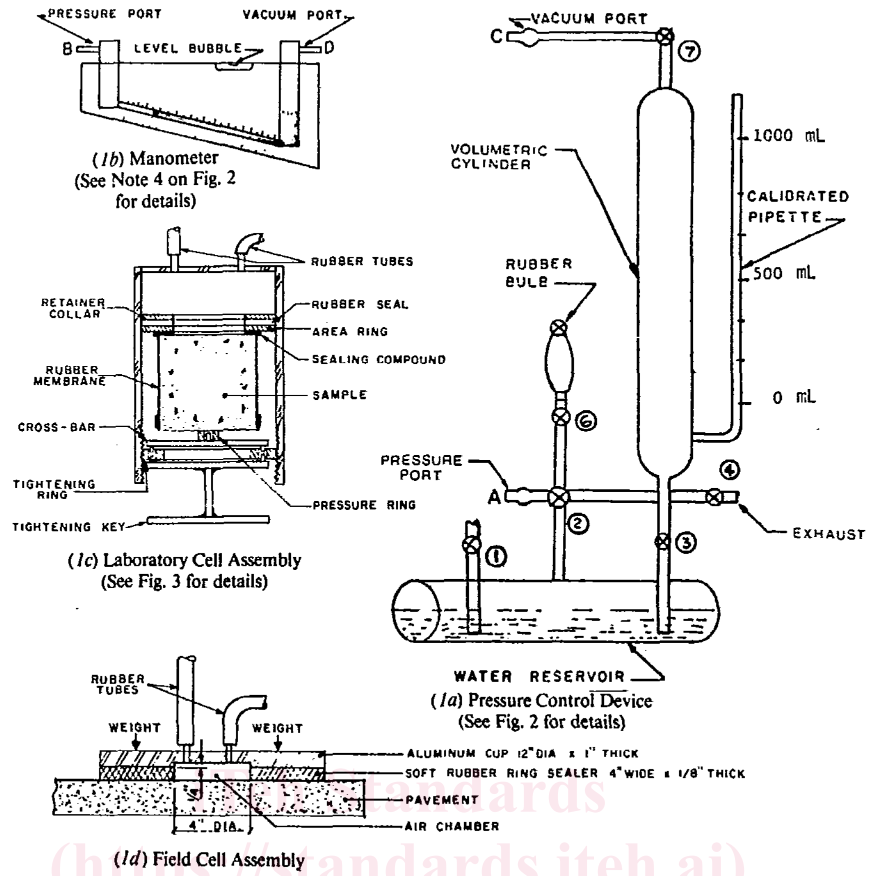


FIG. 1 General Layout of Permeameter

4.3 *Number and quantities of samples*—The number of samples required depends on the criticality of, and variation in, the properties to be measured. Designate each unit from which a field test is to be obtained prior to sampling. The number of field tests from the production should be sufficient to give the desired confidence in test results.

NOTE 1—Guidance for determining the number of samples required to obtain the desired level of confidence in test results may be found in Method D 2234, and Recommended Practices E 105, E 122, and E 141.

5. Apparatus

5.1 *Permeameter*, capable of measuring air-flow rates of up to 5000 mL/min at low-pressure differentials. The general layout of the permeameter as shown in Fig. 1 is composed of four main parts:

5.1.1 *Pressure Control Device* (see Fig. 1(*a*) and Fig. 2), made with a water reservoir of a capacity of 2000 mL, two cylinders (one having a capacity of 500 mL and the other with a capacity of 1000 mL), a rubber pressure bulb, valves, and calibrated sight tubes (pipets). One sight tube is graduated in 25-mL increments for dense pavements and the other in 500-mL increments for permeable pavements.

5.1.2 *Stationary Manometer*, solid, plastic-inclined style, with a range from 0.10 to 1.0 in. H_2O and calibrated to 0.01 in. H_2O (2.5 Pa) (see Fig. 1(*b*)).

5.1.3 *Laboratory Cell Assembly* (see Fig. 1(*c*)), composed of the following parts:

5.1.3.1 *Laboratory Cell* (see Fig. 3, detail 3.1), made of a polymethyl methacrylate (PMMA)[5] cylinder 10 in. (254 mm) long, with an inside diameter of 6 in. (150 mm) and a wall thickness of ½ in. (13 mm). One end of the cylinder is closed by a ½ in. machined top plate with two ¼-in. (6.3-mm) copper fittings screwed to the top plate. A ½-in. thick PMMA retainer collar is fitted into the cylinder 2 in. (50 mm) from the closed end. The inside diameter of the retainer collar is 3 in. (75 mm). The ring is glued firmly and air-tight to the cylinder wall. The cylinder is threaded approximately 6 in. from the open end.

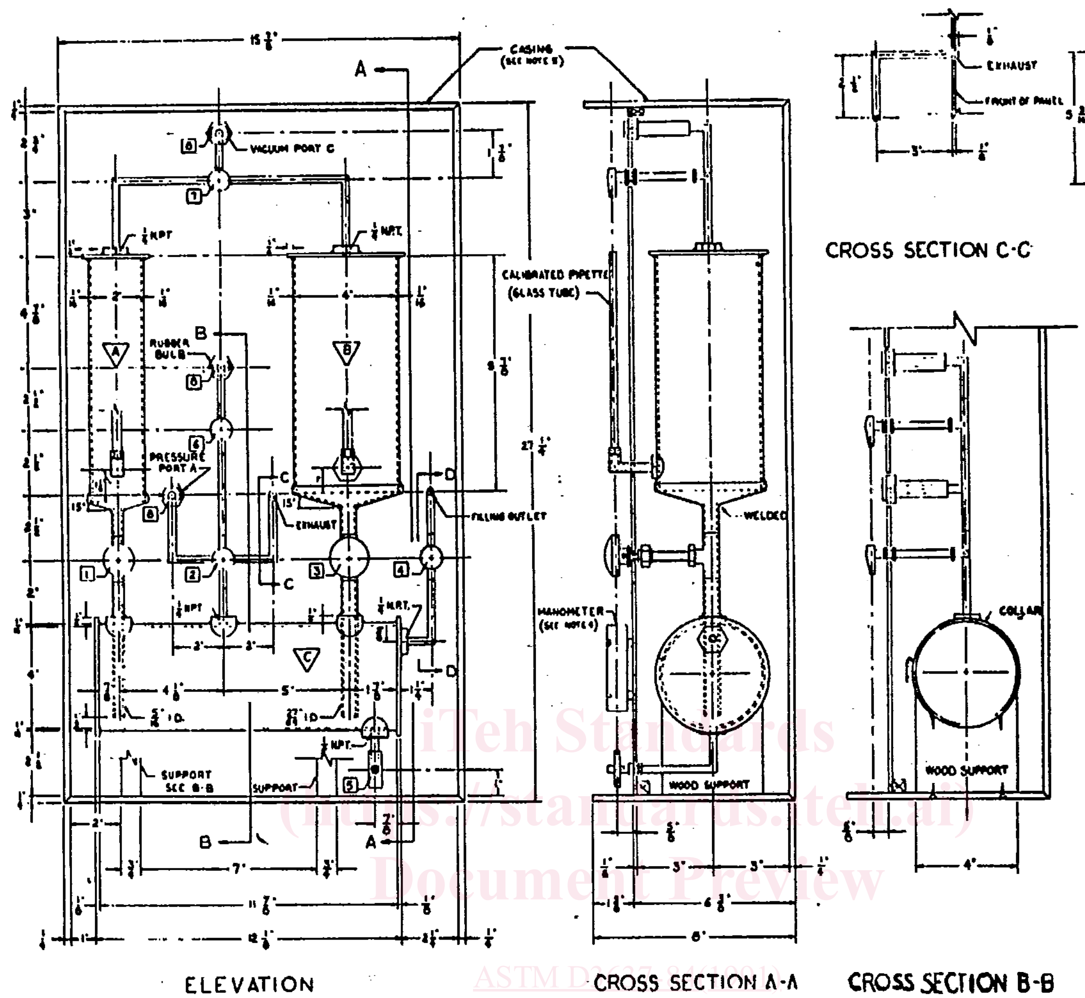
5.1.3.2 *Area Ring* (see Fig. 3, detail 3.4)—One PMMA ring, ½ in. (13 mm) thick, with an inside diameter of 3 in. (75 mm) must be machined to slide closely inside the cylinder.

5.1.3.3 *Seal*—A ¼-in. (6.3-mm) thick rubber ring of the same dimension as the retainer collar is used between the area ring and the retainer collar for sealing purposes.

5.1.3.4 *Tightening Ring* (see Fig. 3, detail 3.5)—A 6-in. (150-mm) diameter, ½-in. (13-mm) thick metal ring is threaded to fit the threads of the open end of the laboratory cell. The ring has a 4-in. (100-mm) inside diameter with two 5/16-in. (7.8-mm) holes for receiving a tightening key.

5.1.3.5 *Cross Bar* (see Fig. 3, detail 3.3)—A ⅜ by ⅜-in. (10 by 10-mm) metal bar is provided with a ¼-in. (6.3-mm) pin at the center and two ¼-in. (6.3 mm) pins at the ends to

[5] Plexiglas®, a trademark of Rohm and Haas Co., has been used for this test.



Regulating and shut-off valve, Whitey Cat. No. B-1VF4 vee stem type, 0.250 in. (6.4 mm) orifice
Four-way valve for switching service, Whitey ball valve Cat. No. B-43YF2, 0.062 in. (1.6 mm) orifice
Regulating and shut-off valve, Whitey Cat. No. B-18VS8 vee stem type, 0.375 in. (9.5 mm) orifice.
Valves for on-off service, Whitey ball valves, Cat. No. B-44F6 0.281 in. (7.1 mm) orifice.
Drain valve, Premier Fastener Co., Cat. No. 65232, weatherhead type 6892.
Three-way valve for switching service, Whitey ball valve, Cat. No. B-44XS6 0.281 in. (7.1 mm) orifice.
Quick connect, bulkhead type, swagelock, Cat. No. B-QC6-B1-600.
Volumetric Cylinder (500 mL)
Volumetric Cylinder (1000 mL)
Water Reservoir (2000 mL)

NOTE 1—All tubes should be ¼ in. in diameter unless otherwise specified.
NOTE 2—All material should be brass unless otherwise specified.
NOTE 3—Pressure control device should be mounted on a tripod.
NOTE 4—Manometer available from Fisher Scientific Co., Catalogue No. 11-295-5, has been found suitable.
NOTE 5—Casing could be wood, stainless steel, or brass.

FIG. 2 Pressure Control Device

fit into the holes of the tightening ring.

5.1.3.6 *Pressure Ring*—The pressure ring could be a nut of ⅜-in. (10-mm) inside diameter, or equivalent.

5.1.3.7 *Tightening Key* (see Fig. 3, detail 3.2)—An H-shaped key is made of three ¼-in. (6.3-mm) thick by ¾-in. (19-mm) wide and 5¼-in. (133-mm) long, flat steel bars welded together. It is equipped with two pins approximately ¼-in. (6.3-mm) long to fit into the hole of the tightening ring.

5.1.3.8 *Latex Triaxial Membrane*—A latex membrane, 0.012 in. (0.3 mm) thick, 10 in. (250 mm) long, and 2.80 in. (70 mm) in diameter, is required to seal the lateral face of the specimen.

5.1.3.9 *Sealing Compound*[6]—A sealing compound that does not stick to the asphalt core is required to provide an adequate seal between the area ring and specimen.

5.1.4 *Field Cell Assembly* (see Fig. 1(*d*)), composed of the following parts:

[6] Butyl 440, available from Tremco Manufacturing Co., 10701 Shaker Blvd., Cleveland, OH 44104, or equivalent, has been found suitable for this purpose.