Designation: D3910 – 21

Standard Practices for Design, Testing, and Construction of Slurry Seal[1]

This standard is issued under the fixed designation D3910; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 These practices cover the design, testing, and construction of mixtures for surface treatment of pavements. It is written as a guide and should be used as such. End-use specifications should be adapted to conform to job and user requirements.

1.2 The values stated in SI units are to be regarded as the standard. The non-SI units used in this standard are allowed by the subcommittee for clarification in the use of the standard.

1.3 The text of this standard references notes and footnotes that provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

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

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C128 Test Method for Relative Density (Specific Gravity) and Absorption of Fine Aggregate

D8 Terminology Relating to Materials for Roads and Pavements

D242/D242M Specification for Mineral Filler for Asphalt Mixtures

D977 Specification for Emulsified Asphalt

D1073 Specification for Fine Aggregate for Asphalt Paving Mixtures

D2397/D2397M Specification for Cationic Emulsified Asphalt

D2419 Test Method for Sand Equivalent Value of Soils and Fine Aggregate

D3666 Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials

2.2 *Other Documents:*[3]

ISSA A105 Recommended Performance Guidelines for Emulsified Asphalt Slurry Seal

ISSA Technical Bulletin No. 106 Test Method for Measurement of Slurry Seal Consistency

3. Terminology

3.1 *Definitions*—For definitions of terms used in this standard, refer to Terminology D8.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *emulsified asphalt slurry seal mixtures*—as related to these practices, mixtures of fine aggregate with or without mineral filler, with or without mixing water, uniformly mixed with emulsified asphalt.

4. Significance and Use

4.1 These slurry seal practices are written as a guide and should not be construed as specifications.

4.2 End-use specifications should be adopted to conform to job and user requirements.

NOTE 1—The quality of the results produced by this standard are dependent on the competence of the personnel performing the procedure and the capability, calibration, and maintenance of the equipment used. Agencies that meet the criteria of Specification D3666 are generally considered capable of competent and objective testing, sampling, inspection, etc. Users of this standard are cautioned that compliance with Specification D3666 alone does not completely ensure reliable results. Reliable results depend on many factors; following the suggestions of Specification D3666 or some similar acceptable guideline provides a

[1] These practices are under the jurisdiction of ASTM Committee D04 on Road and Paving Materials and are the direct responsibility of Subcommittee D04.24 on Asphalt Surface Treatments.

Current edition approved Nov. 1, 2021. Published November 2021. Originally approved in 1980. Last previous edition approved in 2015 as D3910 – 15. DOI: 10.1520/D3910-21.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from the International Slurry Surfacing Association, 800 Roosevelt Road, Building C, Suite 312, Glen Ellyn, IL 60137, http://www.slurry.org.

TABLE 1 Grading Requirements for Aggregate

Sieve Size	Amount Passing Sieve, weight %		
	Type I	Type II	Type III
⅜ in. (9.5 mm)	100	100	100
No. 4 (4.75 mm)	100	90 to 100	70 to 90
No. 8 (2.36 mm)	90 to 100	65 to 90	45 to 70
No. 16 (1.18 mm)	65 to 90	45 to 70	28 to 50
No. 30 (600 µm)	40 to 60	30 to 50	19 to 34
No. 50 (300 µm)	25 to 42	18 to 30	12 to 25
No. 100 (150 µm)	15 to 30	10 to 21	7 to 18
No. 200 (75 µm)	10 to 20	5 to 15	5 to 15

means of evaluating and controlling some of those factors.

5. Design

5.1 *Aggregates:*

5.1.1 The fine aggregate shall consist of natural or manufactured sand, slag, crushed fines, or other mineral aggregate that conforms to the quality requirements of Specification D1073.

5.1.2 Recommended grading requirements are shown in Table 1. These requirements are taken from those given in ISSA A105.

5.1.3 Smooth-textured sand of less than 1.25 % water absorption shall not exceed 50 % of the total combined aggregate. (For heavy duty surface requirements, use 100 % crushed material.)

5.1.4 When tested by Test Method D2419, the combined aggregate prior to the addition of any chemically active mineral fillers shall have a sand equivalent of not less than 45.

5.2 *Mineral Filler:*

5.2.1 Mineral fillers are of two types, chemically active and chemically inactive. Both shall conform to Specification D242/D242M.

5.2.2 Chemically active mineral fillers such as portland cement, hydrated lime, and aluminum sulfate are used to improve the workability, regulate the setting time and, in some cases, to alter the aggregate gradation.

5.2.3 Chemically inactive mineral fillers such as limestone dust, fly ash, and rock dust are used mainly to alter aggregate gradation.

5.3 *Emulsified Asphalt*—The Slow Set (SS-1, CSS-1, SS-1h, and CSS-1h) or Quick Set (QS-1, CQS-1, QS-1h, and CQS1h) grades of emulsified asphalt used in the design shall conform to one of the emulsified asphalt grades fitted for slurry seal applications as found in Specification D977 or Specification D2397/D2397M.

5.4 *Composition of Slurry Seal Mixtures:*

5.4.1 A job mixture shall be selected that conforms to the specification limits, and that is suitable for the traffic, climatic conditions, curing conditions, and final use. All materials to be used shall be pretested for their suitability in the mixture as described in Section 6.

5.4.2 The mixture shall attain an initial set in not less than 15 min nor more than 12 h. The setting time may be regulated by the addition of mineral fillers or chemical agents.

5.4.3 The mixture shall be one of three types whose combined aggregates conform to the gradation requirements of Table 1.

5.4.3.1 Type I is suitable to seal cracks, fill voids, and correct surface erosion conditions. The residual asphalt content shall be from 10 to 16 weight % of dry aggregate. It shall be applied at a rate of 3.3 to 5.4 kg/m^2 (6 to 10 lb/yd^2).

NOTE 2—This type is used on airfields, parking lots, and urban and rural streets where surface sealing and skid resistance are the primary needs.

5.4.3.2 Type II is suitable to fill surface voids, correct severe surface erosion conditions, and provide a minimum wearing surface. The residual asphalt content shall be from 7.5 to 13.5 weight % of dry aggregate. It shall be applied at a rate of 5.4 to 8.2 kg/m^2 (10 to 15 lb/yd^2).

NOTE 3—This type is used on airfields and pavements that are severely eroded or have numerous cracks. It may also be used as wearing surface on bituminous base courses or soil-cement bases, or as a sealer on stabilized base courses.

5.4.3.3 Type III is suitable to provide a new wearing surface or build up a crown. The residual asphalt content shall be from 6.5 to 12 weight % of dry aggregate. It shall be applied at a rate of 8.2 or more kg/m^2 (15 or more lb/yd^2).

5.4.4 *Consistency Test*—This test is used to determine optimum mix design for aggregate, filler, water, and emulsified asphalt. A flow of 2 to 3 cm is considered to be the consistency normally required for a workable field mix (see 6.1).

5.4.5 *Set Time*—This test determines the time required for slurry seal to reach initial set with paper blot method. A properly mix-designed slurry seal should be set at the end of 12 h. A 1-h set time is considered acceptable for a quick-setting slurry seal (see 6.2).

5.4.6 *Cure Time*—This test is used to determine initial cohesion of slurry seal mat and resistance to traffic. A properly designed slurry seal mix should be completely cured at the end of 24 h after placement (see 6.3).

5.4.7 *Wet Track Abrasion Test*—This test method covers measurement of the wearing qualities of slurry seal under wet abrasion conditions.

NOTE 4—As a guide, slurry seal shall not show a loss of more than 75 g/ft^2.

6. Test Methods for Emulsified Asphalt Slurry Seal

6.1 *Consistency Test:*

6.1.1 This test method is used to determine the proper consistency (mix formulation) for a slow-setting slurry seal mixture.

6.1.2 The consistency test should be performed as a method of determining the optimum mix formulation (proper ratio of aggregate, filler, water, and emulsified asphalt) as related to proper mixture consistency for pavement surface placement. Several mixes are made using dried aggregate and various ratios of portland cement, or hydrated lime or chemical modifier, or both, water, and emulsified asphalt.

NOTE 5—Ideal relative humidity for this test is 50 ± 5 %. Results will vary at different relative humidity values.

6.1.3 Mold, metal or plastic, in the form of a frustum of a cone 38 mm (1½ in.) in diameter at the top, 89 mm (3½ in.) in diameter at the bottom, and 76 mm (3 in.) in height (see Test Method C128).

6.1.4 The center of a 228 by 228-mm piece of 3-mm thick metal plate is inscribed with a circle 89 mm in diameter. Three to four additional circles, each 13 mm greater in radius than the preceding circle, are inscribed on the metal plate around the center circle. In lieu of the metal plate, a paper version of a flow scale may be used as found in ISSA Technical Bulletin 106 (see Note 6).

6.1.5 The mold as described in 6.1.3 is placed over the center circle of the metal plate or flow scale paper. A 400 g to 600 g test mixture (based on dry mass of aggregate) is prepared and after 30 s of mixing, it is poured into the mold, completely filling it, and struck off to be level-full. The mold is quickly removed and the contents allowed to flow over the scale until flow of the mixture stops. Four flow measurements (in centimeters) are made at 90° points along the flow scale. The average value of the four measurements is to be taken and reported as the "flow." Project aggregate and emulsified asphalt grade are considered essential for proper relevancy of the method.

NOTE 6—Referenced ISSA Technical Bulletin No. 106 titled "Test Method for Measurement of Slurry Seal Consistency."[3]

6.2 *Set Time:*

6.2.1 This test method is used to determine the time required for the slurry seal mat to reach initial set (resistance to paper blot).

6.2.2 The slurry mixture or mixtures that provide the desired consistency shall be repeated to determine their setting characteristics. A mixture passing the consistency test is poured onto a 152 by 152-mm asphalt felt pad (30-lb roofing felt) and screeded to 6 mm thickness using a 6-mm template. At the end of 15 min, at 25 ± 1 °C and 50 ± 5 % relative humidity, a white paper towel or tissue is lightly pressed or blotted on the mixture surface. If no brown stain is transferred to the paper, the mixture is considered set. If a brown stain does appear, repeat the blot procedure at 15-min intervals. After 3 h of blotting, 30-min (or longer) blot intervals would be suitable. Record and report the time required to obtain a stain-free blot as the set time.

6.3 *Cure Time:*

6.3.1 Total cure of a slurry mixture mat is obtained when complete cohesion between asphalt-coated aggregate particles occurs. A cohesion testing device is used to measure cure time.

6.3.2 A slurry mixture of optimum design obtained from use of the consistency test (see 5.4.4) is screeded onto a roofing felt pad to a thickness not exceeding the height of the largest aggregate fragment present in the mix. A template is recommended to obtain uniform thickness of the slurry mat.

6.3.3 After set of the mixture mat has occurred (5.4.5), the mat is placed beneath the pneumatically actuated rubber foot (25.4 mm (1 in.) in diameter) of the cohesion tester (see 6.3.4).[4] A pressure of 200 kPa (28.5 psi) is considered to be equivalent to that exerted by an average automobile. The rubber foot is twisted by means of a handheld torque tester (see 6.3.4) which reads in kilogram-centimetres. The torque procedure is repeated at 15 to 30-min intervals until the highest torque reading obtainable remains constant. An undisturbed site on the mixture pad should be selected for each time-interval test. The time required to reach a constant maximum torque or until the rubber foot rides freely over the mixture mat without any aggregate particles being dislodged, is recorded as the cure time.

6.3.4 A cohesion tester is a lightweight, portable device which can be adjusted to apply varying pressure to a mixture pad (see Figs. 1 and 2). Torque can be applied with a handheld torque tester. The cohesion tester can be used in the laboratory or field and can be pressured with in-house air, a portable compressor, or a simple bicycle tire pump.

6.4 *Wet Track Abrasion Test:*

6.4.1 *Summary of Test Method:*

6.4.1.1 A slurry mixture of fine graded aggregate, emulsified asphalt, and water is prepared to a homogeneous flowing consistency (see consistency test). The mixture is formed into a disk by pouring in the circular opening of a specimen mold or template resting on a larger circlet of 30-lb roofing felt.

6.4.1.2 After removal of the template, the disk-shaped specimen is dried to constant weight at 60 °C. The cured mixture is placed in a water bath for 1 h, then mechanically abraded under water with a rubber hose for 5 min. The abraded specimen is washed free of debris, dried at 60 °C, and weighed. The loss in weight expressed as grams per square metre (or square foot) is reported as the wear value (WTAT loss).

6.4.2 *Apparatus:*

6.4.2.1 *Balance,* capable of weighing 5000 g to within ±1.0 g.

6.4.2.2 *Planetary Type Mechanical Stirrer,* equipped with a 2.27 ± 0.06 kg (5 ± 0.13 lb) abrasion head (holding device) with 12.7 ± 0.5 mm (0.5 ± 0.02 in.) free up-and-down movement in the shaft sleeve (Fig. 3). The mass of the abrasion head shall not include the mass with the rubber hose attached.

NOTE 7—Examples of planetary mixers would be Hobart Model N-50, C-100, or A-120.

6.4.2.3 *Heavy Flat-Bottom Metal Pan*—approximately 3.2 mm thick, 330 mm in diameter, with 51-mm vertical side walls (20 gage or heavier) having either four equally spaced screw clamps capable of securing 285-mm diameter specimen to bottom of pan or a quick-clamp mounting plate (Fig. 4).

NOTE 8—The dimensions on the pan are specific to the C-100 machine. Dimensions may vary with machine type. The quick-clamp mounting plate is shown on an N-50 machine.

6.4.2.4 *Mixing Bowl,* durable with smooth bottom, made of non-absorptive material, large enough to contain the sample during mixing.

6.4.2.5 *Mixing Spoon or Spatula,* made of non-absorptive material, of sufficient length to adequately mix the sample.

6.4.2.6 *Specimen Disks,* minimum diameter of 286 mm and prepared from 30-lb roofing felt.

6.4.2.7 *Equipment,* used in specimen preparation such as a specimen template 6 mm thick with a 279-mm diameter circular opening (Fig. 5) and a 305 to 355-mm short-handled window squeegee or a 1-in. wooden dowel of similar length.

6.4.2.8 *Oven,* forced-draft, constant temperature, thermostatically controlled at 60 ± 3 °C.

[4] A suitable rubber foot, having a durometer hardness range of 50 to 70.

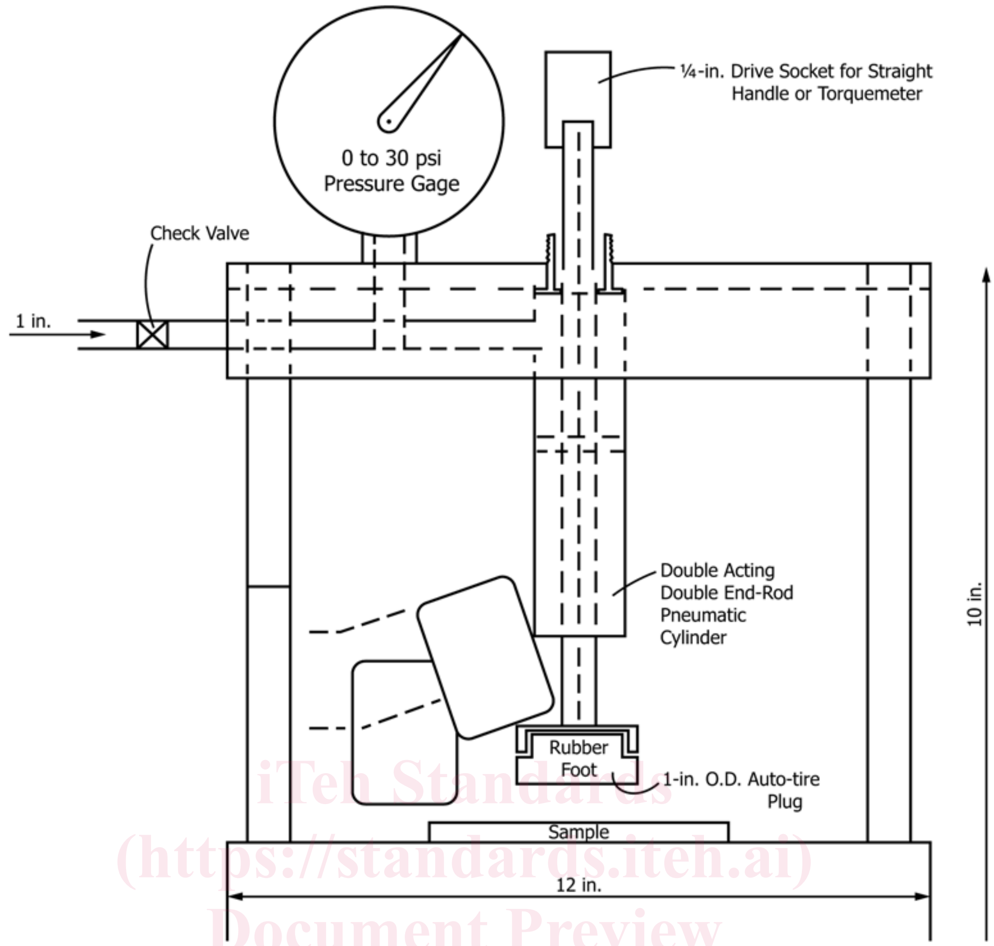

FIG. 1 Cohesion Tester (Front View)

6.4.2.9 *Water Bath,* constant-temperature, controlled at 25 ± 3 °C.

6.4.2.10 *Reinforced Rubber Hose,*[5] of 75 to 85 Shore A durometer hardness with a 19-mm inside diameter and 31-mm outside diameter. The hose shall be cut into 127-mm lengths and drilled with two paired 9-mm holes aligned on 102-mm centers, if necessary for your equipment. Drill holes through convex and concave sides of hose.

6.4.2.11 *Wooden Prop Block* or equivalent for supporting platform assembly into position during testing if necessary (see Figs. 6 and 7).

6.4.3 *Preparation of Test Specimen:*

6.4.3.1 The proper ratio of portland cement (or hydrated lime or other additives), water, and emulsified asphalt to the dry weight of the aggregate shall be predetermined in the laboratory or by a functional field mix design previously accepted by project engineer.

6.4.3.2 Quarter a sufficient amount of the air-dried aggregate passing No. 4 sieve to obtain at least 800 g in one quarter.

6.4.3.3 Weigh 800 g of aggregate into mixing bowl. Using the mixing device as described in 6.4.2.5, dry mix the mineral filler into the aggregate for 30 s or until uniformly distributed. Add the predetermined amount of water and mix again for 1 min or until all aggregate particles are uniformly wetted. Finally add the predetermined amount of emulsified asphalt and mix for a period of not less than 1 min and not more than 3 min.

6.4.3.4 Placing the opening in the template over the 286-mm diameter disk of smooth roll roofing felt, immediately pour the mixture onto the smooth roll roofing disk.

6.4.3.5 Squeegee the mixture level (using the squeegee or 1-in. wooden dowel) with the top of the template with minimum of manipulation (excessive squeegeeing contributes to segregation or an uneven surface). Scrape off excess material and discard.

6.4.3.6 Remove the template. Place the molded specimen in the 60 °C oven and dry to constant weight (minimum 15 h drying time).

6.4.4 *Procedure:*

6.4.4.1 Remove the dried specimen from the 60 °C oven. Allow to cool to room temperature and weigh.

6.4.4.2 After weighing, place the specimen in the 25 °C water bath for 60 to 75 min.

[5] The sole source of supply of the hose known to the committee at this time is Thaman Rubber Company, 6262 Wiene Road, Cincinnati, OH 45237. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

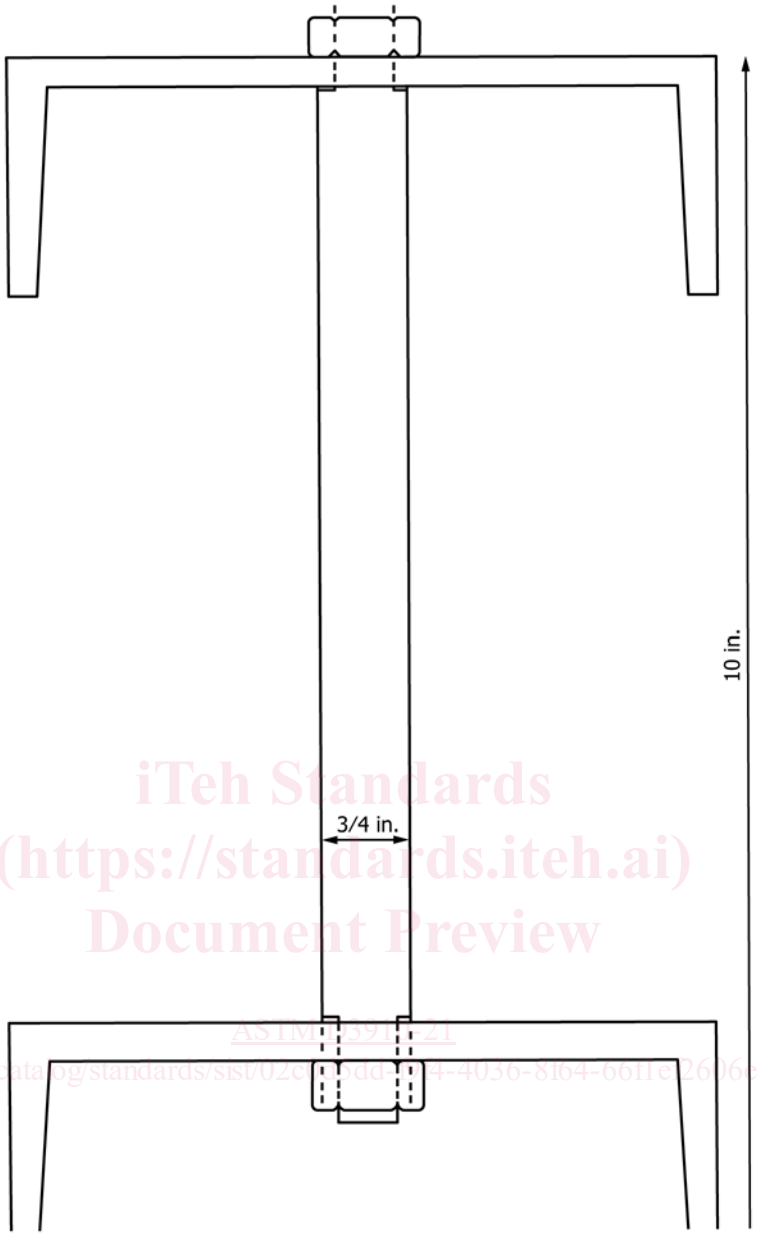

FIG. 2 Cohesion Tester (Side View)

6.4.4.3 Remove the specimen from the water bath and place in the 330-mm (13-in.) diameter flat bottom pan. Secure the specimen to the pan bottom using the screw clamps or quick-clamp mounting plate.

6.4.4.4 Completely cover the specimen with at least 6-mm (¼-in.) depth of water (temperature 25 °C (77 °F)).

6.4.4.5 Secure the pan containing the specimen on the platform of the device (Fig. 3). Lock the rubber hose abrasion head on the shaft of the H machine. Elevate the platform until the rubber hose bears on the surface of the specimen. Use the prop block to support the platform assembly during testing.

6.4.4.6 Switch to the low speed of the mixer. Operate the mixer for 5 min ± 2 s for Hobart Model C-100; 6.7 min ± 2 s for Hobart Model A-120; and 5.15 min ± 2 s for Hobart N-50.

NOTE 9—Install a fresh section of hose after completion of each test. It is permissible to rotate the hose one half-turn after each test run and obtain a fresh section for the next specimen.

6.4.4.7 Remove the specimen from the pan after the abrasion cycle and wash off debris. Place the washed test specimen in the 60 °C oven and dry to constant weight.

6.4.4.8 The dried specimen is removed from the 60 °C oven, allowed to reach room temperature, and weighed. The difference between this weight and the weight obtained in 6.4.4.4 is multiplied by the appropriate factor shown in Note 10 to express the loss in grams per square foot or grams per square meter (wear value). The wear value is multiplied by the correction factor to obtain a C-100 wear value for comparison to the limit stated in 5.4.7.

NOTE 10—The factors used to convert the loss for the actual abraded area to a 1-m^2 or 1-ft^2 basis with each Hobart mixer is: