



Designation: D3910 – 11

Standard Practices for Design, Testing, and Construction of Slurry Seal¹

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 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 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:²

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

D242 Specification for Mineral Filler For Bituminous Paving Mixtures

D977 Specification for Emulsified Asphalt

D1073 Specification for Fine Aggregate for Bituminous Paving Mixtures

D2397 Specification for Cationic Emulsified Asphalt

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

E145 Specification for Gravity-Convection and Forced-Ventilation Ovens

2.2 Other Documents:³

ISSA Technical Bulletin No. 139 Test Method to Classify Emulsified Asphalt/Aggregate Mixture Systems by Modified Cohesion Tester Measurement of Set and Cure Characteristics.

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 Bituminous Surface Treatments.

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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, 3 Church Circle, PMB 250, Annapolis, MD 21401.

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *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.

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.

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.

5.2.2 Chemically active mineral fillers such as portland cement, hydrated lime, and ammonium 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, flyash, and rock dust are used mainly to alter aggregate gradation.

5.3 *Emulsified Asphalt*—The emulsified asphalt shall conform to Grade SS-1h of Specification D977, for emulsified asphalt, or Grade CSS-1h of Specification D2397, for cationic emulsified asphalt.

TABLE 1 Grading Requirements for Aggregate

Sieve Size	Amount Passing Sieve, weight %		
	Type 1	Type 2	Type 3
¾ 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

5.3.1 Quick-Set emulsified asphalts, QS-1h and CQS-1h may also be used. They conform to Specifications **D977** and **D2397** respectively, except that the test requirements for cement mixing and storage stability shall not apply. Refer to the International Slurry Surfacing Association (ISSA) Bulletin No. 139.

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 1 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/m² (6 to 10 lb/yd²). This type is used on airfields where surface sealing and skid resistance are the primary needs.

5.4.3.2 Type 2 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/m² (10 to 15 lb/yd²). 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 3 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/m² (15 or more lb/yd²).

5.4.4 *Consistency Test*—This test is used to determine optimum mix design for aggregate, filler, water, and emulsion. A flow of 2 to 3 cm (1 in.) 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 to reach initial set with paper blot method. A properly mix-designed slurry should be set at the end of 12 h. **C128-h** set time is considered acceptable for a quick setting slurry (see 6.2).

5.4.6 *Cure Time*—This test is used to determine initial cohesion of slurry mat and resistance to traffic. A properly designed slurry 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 1—As a guide, slurry shall not show a loss of more than 807.44 g/m² (75 g/ft²).

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 design) for a slurry seal mixture.

6.1.2 The consistency test should be performed as a method of determining the optimum mix design (proper ratio of aggregate, filler, water, and emulsion) as related to proper consistency for pavement surface placement. Several mixes are made using dried aggregate and various ratios of portland cement, or hydrated lime and or chemical modifier, water and asphalt emulsion. Mix time shall be for no less than 1 min and not longer than 3 min when mixed at 25 ± 1°C (77 ± 3°F).

NOTE 2—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** and **Fig. 1**).

6.1.4 The center of a 228 by 228-mm (9 by 9-in.) piece of 3-mm (⅛-in.) thick metal plate is inscribed with a circle 89 mm (3½ in.) in diameter. Three to four additional circles, each 13 mm (½ in.) greater in diameter than the preceding circle, are inscribed on the metal plate around the center circle.

NOTE 3—Plastic plates are subject to eventual crazing and abrasion loss of the inscribed circles.

6.1.5 The mold as described in 6.1.3 is loosely filled with a test slurry mix and struck off. The mold and contents are then inverted in the center of the metal plate as described in 6.1.4 by placing the inscribed surface of the metal plate on the slurry-filled cone which, while holding cone and plate firmly together, is quickly inverted. The mold is removed and the contents allowed to flow over the inscribed circles until flow of the slurry stops. Project aggregate and emulsion grade are considered essential for proper relevancy of the method.

NOTE 4—Referenced ISSA Technical Bulletin No. 106 titled “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 mat to reach initial set (resistance to paper blot).

6.2.2 The slurry mix or mixtures that provide the desired consistency shall be repeated to determine their setting characteristics. A mix passing the consistency test is poured onto a 152 by 152-mm (6 by 6-in.) asphalt felt pad (13.6 kg (30 lb) roofing felt) and screeded to 6 mm (¼ in.) thickness using a 6-mm template. At the end of 15 min, at 25 ± 1°C (77 ± 3°F) and 50 ± 5 % relative humidity, a white paper towel or tissue is lightly pressed or blotted on the slurry surface. If no brown

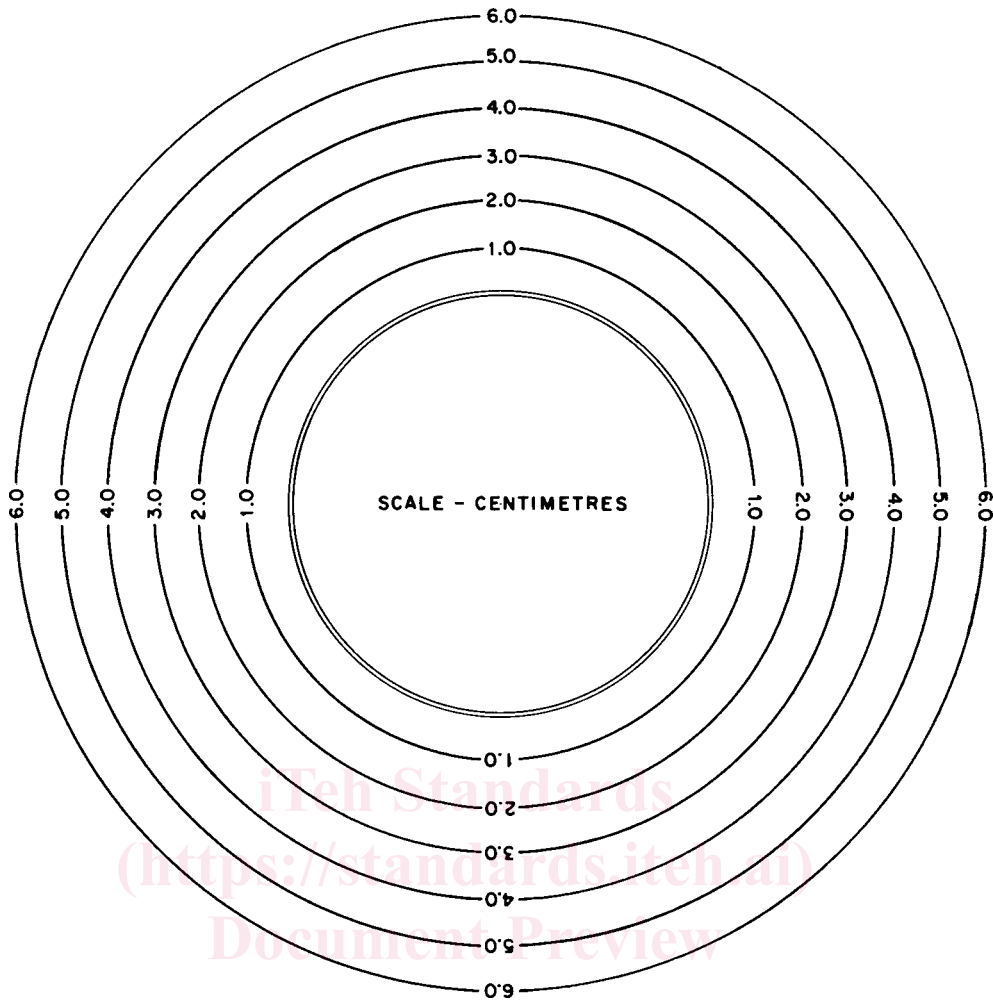


FIG. 1 Cone Consistency Test

stain is transferred to the paper, the slurry 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 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 mix 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 slurry 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 193 kPa (28⁵ psi) is considered to be equivalent to that exerted by an average automobile. The rubber foot is twisted by means of a hand torque tester (see 6.3.4) which

reads in inch pounds or inch ounces (see Table 2). The torque procedure is repeated at 15–30 min intervals until the highest torque reading obtainable remains constant. An undisturbed site on the slurry 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 slurry mat without any aggregate particles being dislodged, is recorded as the cure time.

6.3.4 Cohesion tester is a lightweight, portable device which can be adjusted to apply varying pressure to a slurry pad (see Figs. 2 and 3). Torque can be applied with a torquemeter. 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, asphalt emulsion, and water is prepared to a homogeneous flowing consistency (see consistency test). The slurry is formed into a disk by pouring in the circular opening of a poly(methyl) methacrylate (PMMA) template resting on a larger circlet of 13.62-kg (30-lb) roofing felt.

⁴ A suitable rubber foot, having a durometer hardness range of 50 to 70, can be cut from a used automobile tire.

TABLE 2 Pneumatic Cohesion Tester Chart

psi (on gage)	psi (on foot)	kPa (psi on foot) multiplied by 6.894
4.5	5	34.5
8.9	10	68.9
13.3	15	103.4
17.7	20	137.9
22.1	25	172.4
24.8	28	193.0
26.6	30	206.8
31.0	35	241.3
35.4	40	275.8
39.9	45	310.2
44.3	50	344.7

6.4.1.2 After removal of the template, the disk-shaped specimen is dried to constant weight at 60°C (140°F). The cured slurry 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 (140°F) 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 5 000 g to within ± 1.0 g.

6.4.2.2 *Planetary Type Mechanical Stirrer*, (such as the Hobart Model N-50, Model C-100 or Model A-120 made by the Hobart Manufacturing Co., Troy, Ohio) equipped with a (5-lb) weighted rubber hose holding device (abrasion head) with about 12.7-mm (½-in.) free up-and-down movement in the shaft sleeve (Fig. 4).

6.4.2.3 *Heavy*—(⅛-in.) Flat-Bottom Metal Pan, approximately 330 mm (13 in.) in diameter with 51-mm (2-in.) vertical side walls (20 gage or heavier) having four equispaced screw clamps capable of securing 285 mm (11¼ in.) diameter specimen to bottom of pan (Fig. 5).

6.4.2.4 *Suitable Heavy Gage Round Bottom Bowl*, to contain the sample during mixing.

6.4.2.5 *Long-Handled Serving Spoon*, of sufficient length to project 101 mm (4 in.) or more out of the round bottom bowl during stirring.

6.4.2.6 *Disks*, supply of 286-mm (11¼-in.) diameter, cut from 13.62-kg (30-lb) roofing felt.

6.4.2.7 *Equipment*, used in specimen preparation such as a special circular poly(methyl) methacrylate (PMMA) template 6 mm (¼ in.) thick with a 279-mm (11-in.) diameter circular opening (Fig. 6) and a 305 to 355-mm (12 to 14-in.) short handled window squeegee.

6.4.2.8 *Oven*, forced-draft constant temperature thermostatically controlled at 60 ± 3°C (140 ± 5°F) see Specification E145 Type II B.

6.4.2.9 *Water Bath*, constant-temperature, controlled at 25 ± 1°C (77 ± 2°F).

6.4.2.10 *Reinforced Rubber Hose*,⁵ with a 19-mm (¾-in.) inside diameter and 31-mm (1½-in.) outside diameter (two braid, 300 psi, green oil-resistant cover). The hose shall be cut into 127-mm (5-in.) lengths and drilled with two paired 9-mm (⅜-in.) holes aligned on 102-mm (4-in.) centers. 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 (see Fig. 7 and Fig. 8).

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 asphalt emulsion 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 spoon, dry mix the mineral filler into the aggregate for 1 min 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 emulsion 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 (11¼-in.) diameter disk of smooth roll roofing. Immediately pour the slurry onto the smooth roll roofing disk.

6.4.3.5 Squeegee the slurry level with the top of the template with minimum of manipulation (excessive squeegeeing contributes to segregation). Scrape off excess material and discard.

6.4.3.6 Remove the template. Place the molded specimen in the 60°C (140°F) oven and dry to constant weight (minimum 15 h drying time).

NOTE 5—It should be noted that if the slurry mix is air-cured prior to oven-drying to a constant weight, the presence of portland cement in the mix could cause the physical properties of the mix to be affected by the relative humidity of the curing environment. A humid environment could increase the degree of hydration of the portland cement and change the physical properties of the mix. When practical, it is suggested that the slurry pad be allowed to cure at a minimum of 50 % relative humidity if optimum effect of the portland cement is desired.

6.4.4 *Procedure:*

6.4.4.1 Remove the dried specimen from the 60°C (140°F) oven. Allow to cool to room temperature and weigh.

6.4.4.2 After weighing, place the specimen in the 25°C (77°F) 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.