Designation: D 3515 – ~~96~~01

Standard Specification for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures[1]

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1. Scope

1.1 This specification covers hot-mixed, hot-laid asphalt, tar, emulsified asphalt, and recycled bituminous paving mixtures for base, binder, leveling, and surface courses.

1.2 The values stated in ~~inch-pound~~ SI units are to be regarded as the standard. ~~The SI units~~ Combining values from the two systems may result in ~~parentheses are for information only.~~ nonconformance with the standard.

1.3 *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:*

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[1] This specification is under the jurisdiction of ASTM Committee ~~D-4~~ D04 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.23 on Plant-Mix Bituminous Surfaces and Bases.

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C 127 Test Method for Specific Gravity and Absorption of Coarse Aggregate[2]
C 128 Test Method for Specific Gravity and Absorption of Fine Aggregate[2]
C 136 Test Method for Sieve Analysis of Fine and Coarse Aggregates[2]
D 5 Test Method for Penetration of Bituminous Materials[3]
D 8 Terminology Relating to Materials for Roads and Pavements
D 75 Practice for Sampling Aggregates[3]
D 140 Practice for Sampling Bituminous Materials[3]
D 242 Specification for Mineral Filler for Bituminous Paving Mixtures[3]
D 448 Classification for Sizes of Aggregate for Road and Bridge Construction[3]
D 490 Specification for Road Tar[3]
D 546 Test Method for Sieve Analysis of Mineral Filler for ~~Road and~~ Bituminous Paving ~~Materials~~ Mixtures[3]
D 692 Specification for Coarse Aggregate for Bituminous Paving Mixtures[3]
D 946 Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction[3]
D 977 Specification for Emulsified Asphalt[3]
D ~~979 Test Methods~~ 979 Practice for Sampling Bituminous Paving Mixtures[3]
D 995 Specification for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures[3]
D 1073 Specification for Fine Aggregate for Bituminous Paving Mixtures[3]
D 1856 Test Method for Recovery of Asphalt from Solution by Abson Method[3]
D 2171 Test Method for Viscosity of Asphalts by Vacuum Capillary Viscometer[3]
D 2172 Test Methods for Quantitative Extraction of Bitumen from Bituminous Paving Mixtures[3]
D 2489 Test Method for Degree of Particle Coating of Bituminous-Aggregate Mixtures[3]
D 3203 Test Method for Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures[3]
D 3381 Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction[3]
D 4318 Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils[4]
D 4552 Practice for Classifying Hot-Mix Recycling Agents[3]

3. Terminology

3.1 Definitions are in accordance with Terminology D 8.

3.2 *Definitions:*

3.2.1 *bitumen aggregate for recycling*—bituminous pavement or paving mixture removed from its original location and reduced by suitable means to such particle size as may be required for use in hot-mixed, hot-laid recycled bituminous paving mixtures.

NOTE 1—Alternative terminology may be used for bitumen aggregate for recycling so long as the terms are defined or understood to refer to the same material. Reclaimed asphalt pavement (RAP) that has been removed from its original location and reduced in size as may be required.

3.2.2 *hot-mixed, hot-laid paving mixtures*—mixtures of coarse and fine aggregate or fine aggregate alone, with or without mineral filler, uniformly mixed with asphalt, tar, or emulsified asphalt.

3.2.3 *hot-mixed, hot-laid recycled bituminous paving mixtures*—mixtures of bitumen aggregate for recycling with or without mineral aggregates and mineral filler, mixed at elevated temperatures with or without additional bitumen.

4. Ordering Information

4.1 Orders for bituminous paving mixtures under this specification shall include the following information:

4.1.1 Type of bitumen (asphalt cement, tar cement, emulsified asphalt),

4.1.2 Grade of bitumen,

4.1.3 The composition of the bituminous paving mixture (dense mixture and mix designation; open mixture and mix designation; open graded friction course mixture and mix designation),

4.1.4 The maximum percentage of bitumen aggregate for recycling permitted in the mixture when limited, and

4.1.5 The percentage of crushed particles required in the aggregate if different from that specified in Specification D 692.

5. Aggregates

5.1 The aggregates shall be crushed stone, crushed slag, crushed gravel, and natural or manufactured sand conforming to the quality and crushed particle requirements of the appropriate ASTM specifications as follows:

5.1.1 *Coarse Aggregate*—Specification D 692.

5.1.2 *Fine Aggregate*—Specification D 1073.

NOTE 2—Other mineral aggregates, such as uncrushed gravel, crushed shell, and various synthetic aggregates, may be specified, provided that local experience or tests have demonstrated their ability to produce satisfactory bituminous paving mixtures.

[2] *Annual Book of ASTM Standards*, Vol 04.02.
[3] *Annual Book of ASTM Standards*, Vol 04.03.
[4] *Annual Book of ASTM Standards*, Vol 04.08.

5.2 Recommended grading requirements for coarse and fine aggregate may be selected from ~~Specifications~~ Classification D 448 and Specification D 1073, respectively. Other aggregate gradations may be used, provided that the combined coarse and fine aggregates, and filler, when used, produce a mixture that conforms to the requirements for grading of total aggregate prescribed in Table 1.

5.3 When hot-mixed, hot-laid recycled bituminous mixtures are produced, aggregates conforming to 5.1 may be blended with the bitumen aggregate for recycling as necessary to produce the result required by 5.2.

6. Mineral Filler

6.1 The mineral filler shall conform to Specification D 242.

7. Bitumen

7.1 When asphalt cement is used, it shall conform to either Specifications D 3381 or ~~Specification~~ D 946.

NOTE 3—The viscosity grade or the penetration grade to be used depends on the type of construction, climatic conditions, and amount and nature of traffic. The required viscosity grade or penetration grade should be specified.

7.2 When tar cement is used, it shall conform to Specification D 490.

NOTE 4—The grade to be used shall be RT-10, RT-11, or RT-12, depending upon the type of construction, climatic conditions, and the amount and nature of traffic. The required grade should be specified.

7.3 When emulsified asphalt is used it shall conform to Specification D 977, Grade HFMS-2h or MS-2h.

7.4 When specifically approved by the purchaser, other types of emulsified asphalt may be used, if experience has shown that satisfactory performance will result.

7.5 When hot-mixed, hot-laid recycled bituminous paving mixtures are produced, bitumen conforming to Specifications D 946, D 977, or D 3381 or recycling agents with or without bitumen conforming to Practice D 4552 shall be added to the asphalt bitumen for recycling as necessary.

8. Composition of Bituminous Paving Mixtures

8.1 The mixture shall conform to one of the compositions by weight given in Table 1 or Table 2.

NOTE 5—The mix designation selected should be determined by the intended use, thickness of paving courses, and desired texture.

8.1.1 Compositions shown in Table 1 or Table 2 are based on the use of fine and coarse aggregates having approximately the same bulk specific gravities; grading of the total aggregate, therefore, would be the same on either a weight or bulk volume basis. If the bulk specific gravities of coarse and fine aggregates differ by more than 0.20, it may be necessary to adjust the job mix aggregate grading slightly to account for the differences in volume.

8.2 A job mixture shall be selected that comes within the specification limits and that is suitable for the traffic, climatic conditions, and specific gravities of the aggregates used. Below the ~~No. 8 (2.36-mm)~~ 2.36-mm (No. 8) sieve size, the job-mix formula grading curve shall be reasonably parallel to the curves of the grading limits as selected from Table 1.

8.3 Any variation from the job-mix formula in the grading of the aggregate, as shown by the sieve analyses of materials in the plant (Note 6) or, any variation from the job-mix formula in the bitumen content, as indicated by extraction tests of the finished mixture, greater than the percentage shown in Table 3, shall be investigated, and the conditions causing such variation shall be corrected (Note 7).

NOTE 6—It is recognized that the extraction test is a generally accepted and approved method for determining the composition of a bituminous concrete mixture. However, due to the relatively wide difference in the bitumen content and aggregate gradation sometimes found in individual samples of mixture taken from the same batch, as shown by extraction tests, it is recommended that the extraction test results on individual small samples be used as an indication of the mix composition, and not as the sole basis for acceptance or rejection of the product. Unless the mixing plant has automatic batching and recording equipment, it may be necessary to determine both aggregate gradation and bitumen content from extraction test samples.

NOTE 7—Application of tolerances may result in a gradation outside the composition limits in Table 1 or Table 2. This will not be cause for investigation.

9. Mixing Plant

9.1 The mixing plant shall conform to Specification D 995. When emulsified asphalt is used, the pugmill shall be adequately vented to allow for the escape of steam.

10. Mixing Plant Operation

10.1 *Aggregate Storage*—Aggregates furnished in different sizes or from different sources shall be kept separate, and adequate provision shall be made to keep them from becoming mixed or otherwise contaminated. Stockpiles shall be built and the materials removed therefrom in such a manner as to minimize size segregation.

10.2 *Old Bituminous Pavement*—Bitumen aggregate for recycling shall be reduced in size so that the maximum aggregate particle size conforms with 8.1 and shall be kept separate from aggregate stockpiles. Adequate provisions shall be made to keep bitumen aggregate for recycling from being mixed with aggregates or otherwise contaminated.

TABLE 1 Composition of Bituminous Paving Mixtures

Sieve Size	*Dense Mixtures*								
	Mix Designation								
	D-1	D-2	D-3	D-4	D-5	D-6	D-7	D-8	D-9
	~~2 in. (50 mm)~~	~~1½ in. (37.5 mm)~~	~~1 in. (25.0 mm)~~	~~in. (19¾.0 mm)~~	~~in. (12½.5 mm)~~	~~in. (9⅜.5 mm)~~	~~No.4 (4.75 mm) (Sand Asphalt)~~	~~No. 8 (2.36 mm)~~	~~No.16 (1. 18 mm) (Sheet Asphalt)~~
50 mm (2 in.)	37.5 mm (1½ in.)	25.0 mm (1 in.)	19.0 mm (¾ in.)	12.5 mm (½ in.)	9.5 mm (⅜ in.)	4.75 mm (No. 4) (Sand Asphalt)	2.36 mm (No. 8)	1.18 mm (No. 16) (Sheet Asphalt)	
	Grading of Total Aggregate (Coarse Plus Fine, Plus Filler if Required) Amounts Finer Than Each Laboratory Sieve (Square Opening), Weight %								
~~2½ in. (63-mm)~~	~~100~~	...	...	...	...	...	...	...	...
63-mm (2½ in.)	100	...	...	...	...	...	...	...	...
~~2 in. (50-mm)~~	~~90 to 100~~	~~100~~	...	...	...	...	...	...	...
50-mm (2 in.)	90 to 100	100	...	...	...	...	...	...	...
~~1½ in. (37.5-mm)~~	...	~~90 to 100~~	~~100~~	...	...	...	...	...	...
37.5-mm (1½ in.)	...	90 to 100	100	...	...	...	...	...	...
~~1 in. (25.0-mm)~~	~~60 to 80~~	...	~~90 to 100~~	~~100~~	...	...	...	...	...
25.0-mm (1 in.)	60 to 80	...	90 to 100	100	...	...	...	...	...
~~¾ in. (19.0-mm)~~	...	~~56 to 80~~	...	~~90 to 100~~	~~100~~	...	...	...	...
19.0-mm (¾ in.)	...	56 to 80	...	90 to 100	100	...	...	...	...
~~½ in. (12.5-mm)~~	~~35 to 65~~	...	~~56 to 80~~	...	~~90 to 100~~	~~100~~	...	...	...
12.5-mm (½ in.)	35 to 65	...	56 to 80	...	90 to 100	100	...	...	...
~~⅜ in. (9.5-mm)~~	...	...	...	~~56 to 80~~	...	~~90 to 100~~	~~100~~	...	...
9.5-mm (⅜ in.)	...	...	...	56 to 80	...	90 to 100	100	...	...
~~No.4 (4.75-mm)~~	~~17 to 47~~	~~23 to 53~~	~~29 to 59~~	~~35 to 65~~	~~44 to 74~~	~~55 to 85~~	~~80 to 100~~	...	~~100~~
4.75-mm (No. 4)	17 to 47	23 to 53	29 to 59	35 to 65	44 to 74	55 to 85	80 to 100	...	100
~~No. 8 (2.36-mm)~~[A]	~~10 to 36~~	~~15 to 41~~	~~19 to 45~~	~~23 to 49~~	~~28 to 58~~	~~32 to 67~~	~~65 to 100~~	...	~~95 to 100~~
2.36-mm (No. 8)[A]	10 to 36	15 to 41	19 to 45	23 to 49	28 to 58	32 to 67	65 to 100	...	95 to 100
~~No.16 (1.18-mm)~~	...	...	...	...	...	...	~~40 to 80~~	...	~~85 to 100~~
1.18-mm (No. 16)	...	...	...	...	...	...	40 to 80	...	85 to 100
~~No. 30 (600-µm)~~	...	...	...	...	...	...	~~25 to 65~~	...	~~70 to 95~~
600-µm (No. 30)	...	...	...	...	...	...	25 to 65	...	70 to 95
~~No. 50 (300-µm)~~	~~3 to 15~~	~~4 to 16~~	~~5 to 17~~	~~5 to 19~~	~~5 to 21~~	~~7 to 23~~	~~7 to 40~~	...	~~45 to 75~~
300-µm (No. 50)	3 to 15	4 to 16	5 to 17	5 to 19	5 to 21	7 to 23	7 to 40	...	45 to 75
~~No.100 (150-µm)~~	...	...	...	...	...	...	~~3 to 20~~	...	~~20 to 40~~
150-µm (No. 100)	...	...	...	...	...	...	3 to 20	...	20 to 40
~~No. 200 (75-µm)~~[B]	~~0 to 5~~	~~0 to 6~~	~~1 to 7~~	~~2 to 8~~	~~2 to 10~~	~~2 to 10~~	~~2 to 10~~	...	~~9 to 20~~
75-µm (No. 200)[B]	0 to 5	0 to 6	1 to 7	2 to 8	2 to 10	2 to 10	2 to 10	...	9 to 20

Sieve Size	*Open Mixtures*								
	Mix Designation								
	0-1	0-2	0-3	0-4	0-5	0-6	0-7	0-8	0-9
	~~2 in. (50 mm)~~	~~1½ in. (37.5 mm)~~	~~1 in. (25.0 mm)~~	~~in. (19¾.0 mm)~~	~~in. (12½.5 mm)~~	~~in. (9⅜.5 mm)~~	~~No.4 (4.75 mm) (Sand Asphalt)~~	~~No. 8 (2.36 mm)~~	~~No.16 (1. 18 mm) (Sheet Asphalt)~~
50 mm (2 in.)	37.5 mm (1½ in.)	25.0 mm (1 in.)	19.0 mm (¾ in.)	12.5 mm (½ in.)	9.5 mm (⅜ in.)	4.75 mm (No. 4) (Sand Asphalt)	2.36 mm (No. 8)	1.18 mm (No. 16) (Sheet Asphalt)	
	Base and Binder Courses					Surface and Leveling Courses			
~~2½ in. (63-mm)~~	~~100~~	...	...	...	...	...	...	...	...
63-mm (2½ in.)	100	...	...	...	...	...	...	...	...
~~2 in. (50-mm)~~	~~90 to 100~~	~~100~~	...	...	...	...	...	...	...
50-mm (2 in.)	90 to 100	100	...	...	...	...	...	...	...
~~1½ in. (37.5-mm)~~	...	~~90 to 100~~	~~100~~	...	...	...	...	...	
37.5-mm (1½ in.)	...	90 to 100	100	...	...	...	...	...	
~~1 in. (25.0-mm)~~	~~40 to 70~~	...	~~90 to 100~~	~~100~~	...	...	...	...	...
25.0-mm (1 in.)	40 to 70	...	90 to 100	100	...	...	...	...	...
~~¾ in. (19.0-mm)~~	...	~~40 to 70~~	...	~~90 to 100~~	~~100~~	...	...	...	...
19.0-mm (¾ in.)	...	40 to 70	...	90 to 100	100	...	...	...	...
~~½ in. (12.5-mm)~~	~~18 to 48~~	...	~~40 to 70~~	...	~~85 to 100~~	~~100~~	...	...	...
12.5-mm (½ in.)	18 to 48	...	40 to 70	...	85 to 100	100	...	...	...
~~⅜ in. (9.5-mm)~~	...	~~18 to 48~~	...	~~40 to 70~~	~~60 to 90~~	~~85 to 100~~	...	...	...
9.5-mm (⅜ in.)	...	18 to 48	...	40 to 70	60 to 90	85 to 100	...	...	...
~~No.4 (4.75-mm)~~	~~5 to 25~~	~~6 to 29~~	~~10 to 34~~	~~15 to 39~~	~~20 to 50~~	~~40 to 70~~	...	~~100~~	...
4.75-mm (No. 4)	5 to 25	6 to 29	10 to 34	15 to 39	20 to 50	40 to 70	...	100	...
~~No. 8 (2.36-mm)~~[A]	~~0 to 12~~	~~0 to 14~~	~~1 to 17~~	~~2 to 18~~	~~5 to 25~~	~~10 to 35~~	...	~~75 to 100~~	...
2.36-mm (No. 8)[A]	0 to 12	0 to 14	1 to 17	2 to 18	5 to 25	10 to 35	...	75 to 100	...
~~No.16 (1.18-mm)~~	...	...	...	...	~~3 to 19~~	~~5 to 25~~	...	~~50 to 75~~	...
1.18-mm (No. 16)	...	...	...	...	3 to 19	5 to 25	...	50 to 75	...
~~No. 30 (600-µm)~~	~~0 to 8~~	~~0 to 8~~	~~0 to 10~~	~~0 to 10~~	...	...	...	~~28 to 53~~	...
600-µm (No. 30)	0 to 8	0 to 8	0 to 10	0 to 10	...	...	...	28 to 53	...
~~No. 50 (300-µm)~~	...	...	...	...	~~0 to 10~~	~~0 to 12~~	...	~~8 to 30~~	...
300-µm (No. 50)	...	...	...	...	0 to 10	0 to 12	...	8 to 30	...
~~No.100 (150-µm)~~	...	...	...	...	...	...	...	~~0 to 12~~	...
150-µm (No. 100)	...	...	...	...	...	...	...	0 to 12	...
~~No. 200 (75-µm)~~[B]	...	...	...	...	...	...	...	~~0 to 5~~	...

TABLE 2 Composition of Open Graded Friction Course Mixtures

Sieve Size	Mix Designation	
	Type I	Type II
	Percent Passing	
~~¾ in. (19.0 mm)~~	~~100~~	~~100~~
19.0 mm (¾ in.)	100	100
~~½ in. (12.5 mm)~~	~~100~~	~~90 to 100~~
12.5 mm (½-in.)	100	90 to 100
~~⅜ in. (9.5 mm)~~	~~90 to 100~~	~~60 to 100~~
9.5 mm (⅜-in.)	90 to 100	60 to 100
~~No.4 (4.75 mm)~~	~~30 to 50~~	~~15 to 40~~
4.75 mm (No. 4)	30 to 50	15 to 40
~~No. 8 (2.36 mm)~~[A]	~~5 to 15~~	~~4 to 12~~
2.36 mm (No. 8)[A]	5 to 15	4 to 12
~~No. 200 (75µ m)~~[B]	~~2 to 5~~	~~2 to 5~~
75 µm (No. 200)[B]	2 to 5	2 to 5
	Bitumen, weight % of total mixture[C]	
	5–8½	4½ –8
	Suggested Aggregate Sizes from Specification D 448	
	8 and 9 or 89	7 and 89 or 7 and 8

[A] In considering the total grading characteristics of the bituminous paving mixture, the amount passing the No. 8 (2.36-mm ~~(No. 8)~~ sieve is a significant and convenient field control point between fine and coarse aggregate. In open-graded friction course mixtures, the amount passing the No. 8 shall be limited to that required to provide a chocking of the coarser particles.

[B] The material passing the 75-µm (No. 200 ~~(75-µm~~) sieve may consist of fine particles of the aggregates or mineral filler, or both but shall be free of organic matter and clay particles. The blend of aggregates and filler, when tested in accordance with Test Method D 4318, shall have a plasticity index of not greater than 4, except that this plasticity requirement shall not apply when the filler material is hydrated lime or hydraulic cement.

[C] The quantity of bitumen is given in terms of weight % of the total mixture and is applicable to a variety of aggregates of conventional specific gravities, approximately 2.50–2.80. The wide difference in the specific gravity of some aggregates, as well as a considerable difference in absorption, may require bitumen contents outside the range shown. The amount of bitumen required for a given mixture should be determined by appropriate laboratory testing or on the basis of past experience with similar mixtures, or by a combination of both.

TABLE 3 Tolerances from Job-Mix Formula

Sieve Size	Tolerances,%
~~½ in. (12.5 mm) and larger~~	~~± 8~~
12.5 mm (½ in.) and larger	± 8
~~⅜ in. (9.5 mm) and No. 4 (4.75 mm)~~	~~± 7~~
9.5 mm (⅜ in.) and 4.75 mm (No. 4)	± 7
~~No. 8 (2.36 mm) and No. 16 (1.18 mm)~~	~~± 6~~
2.36 mm (No. 8) and 1.18 mm (No. 16)	± 6
~~No. 30 (600 µm) andNo. 50 (300 µm)~~	~~± 5~~
600 µm (No. 30) and 300 µm (No. 50)	± 5
~~No. 200 (75 µm)~~	~~± 3~~
75 µm (No. 200)	± 3
Bitumen content, weight % of total mixture	± 0.5

10.3 *Preparation of Bitumen*—The bitumen shall be maintained at a temperature at which it can be properly handled through the pumping system and uniformly distributed throughout the mixture. At no time during the processing, from storage to mixing, will temperature of the bitumen be allowed to exceed the following:

	Temperature	
Bitumen	~~°F~~	~~°C~~
Asphalt cement	~~350~~	~~176.6~~
Tar cement	~~225~~	~~107.2~~
Emulsified asphalt	~~180~~	~~82.2~~

10.4 *Preparation and Handling of Mineral Aggregates*—Each size aggregate shall be separately fed by feeders to the cold elevator or elevators in proper proportion and at a rate to permit correct and uniform temperature control of the heating and drying operation. The aggregate shall be dried and delivered to the mixer at a temperature such that the mixture will be produced at a temperature within the range suited to the bitumen used, as follows:

Temperature Range

~~Bitumen~~	~~°F~~	~~°C~~	
Bitumen	°C	°F	
~~Asphalt cement (conventional mixes)~~	~~250 to 325~~	~~121.1 to 162.7~~	250 to 325
		162.7	
Asphalt cement (conventional mixes)	121.1 to ~~325~~	~~121.1 to 162.7~~	250 to 325
		162.7	
Asphalt cement (open graded friction mixes)	~~220–260~~	~~104.5–126.6~~	104.5 to 126.6
Tar cement	~~175~~	79.4 to ~~225~~	~~79.4 to 107.2~~ 107.2
Emulsified asphalt	~~220 to 260~~	104.5 to 126.6	220 to 260

The temperature between those limits shall be regulated according to the grade and viscosity characteristics of the bitumen, ambient temperature, and workability of the mixture. Aggregates in the hot bins shall not contain moisture to such an extent as to cause the mixture to foam, slump, or segregate during hauling and placing operations.

10.5 *Preparation and Handling of Bitumen Aggregate for Recycling*—Bitumen aggregate for recycling shall be fed into the plant in proper proportion at a location and rate to permit correct and uniform temperature control of the heating and drying operation. It shall be delivered to the mixer at a temperature such that the mixture will be produced within the range specified in 10.4.

10.6 *Preparation of Mixture*—The proportions of the components of the mixture, within the limits specified, shall be regulated so as to produce a satisfactory mixture. The sequence in which the several aggregates or the several aggregates and asphalt aggregate for recycling shall be drawn or weighed may vary under different conditions. The bitumen shall be added in an evenly spread sheet over the length of the mixer box in a batch plant, or shall be spread evenly across the mixer box in a continuous mix plant.

10.6.1 The mixing shall be accomplished in the shortest time that will produce a satisfactory mixture. Mixing time shall be specified within the following limits, except that the minimum may be determined as provided in 10.6.2 and the maximum dry mixing time may be determined as provided by 10.6.3~~:~~.

10.6.1.1 *Batch Plants*—0 to 10-s dry mixing followed by 25 to 50-s additional mixing after the addition of the bitumen.

10.6.1.2 *Continuous Mix Plants*—25 to 60 s based on the following equation:

$$\text{Mix time, s} = \frac{\text{pugmill capacity, lb (kg)}}{\text{pugmill output, lb/s (kg/s)}} \quad (1)$$

$$\text{Mix time, s} = \frac{\text{pugmill capacity, (kg) lb}}{\text{pugmill output, (kg/s) lb/s}} \quad (1)$$

10.6.2 Minimum mixing time may be established on the percentage of coated particles as determined by Test Method D 2489. The minimum values for percentage of coated particles used to establish the minimum mixing time shall be set by the engineer. These values will vary with aggregate gradation, particle shape, and surface texture, and with the bitumen content and use for which the mix is intended.

10.6.3 When any component of the mixture except bitumen is not heated in the dryer, the dry mixing period may be extended as necessary so that the mixture will be produced at a uniform temperature within the range specified in 10.4.

10.7 *Mixing Plant Inspection*—The engineer or his authorized representatives shall have access at any time to all parts of the mixing plant in order to ensure the manufacture of the mixture in strict accordance with this specification. In order that accurate and sufficiently large samples of aggregate may be obtained from the hot aggregate bins, easy and safe access shall be provided to the location on the plant where such samples may be taken.

10.8 *Special Requirements for Asphalt Mix from Surge or Storage Bins*—Asphalt cement recovered from the mix shall comply with Alternative 1 or 2 as follows:

Alternative 1
for Penetration Graded Asphalt Cement, Specification D 946

Grade	Penetration Equal to or More Than
200–300	74
120–150	50
85–100	40
60–70	31
40–50	22

Alternative 2
for Viscosity Graded Asphalt Cement, Specification D 3381

Grade	Viscosity 140°F(60°C), P Equal to or Less Than
AC-2.5 and AR-1000	1 250
AC-5 and AR-2000	2 500
AC-10 and AR-4000	5 000
AC-20 and AR-8000	10 000
AC-40 and AR-16000	20 000

Samples for these tests shall be taken from trucks loaded from the bin. The addition of solvent according to procedures of Test Methods D 2172 shall be started within 4 h of sampling or the samples shall be placed in a cold storage facility and maintained

at ~~32°F (0°C)~~ 0°C (32°F) or lower until testing is started. Where delivery to cold storage will take more than 4 h, one of the following procedures shall be used:

(*a*) Chill the samples by placing in plastic coolers containing dry ice. Maintain dry ice in coolers during delivery to the laboratory.

(*b*) Place the sample in a gallon can containing dry ice. Cap the can immediately with a lid that has a pinhole in it. When pressure buildup ceases, solder the pinhole. Keep the can tight during delivery to laboratory.

10.8.1 The following storage times will be permitted until the results of tests on the recovered asphalt are available. The times may be increased or decreased on the basis of the test results.

	Time, h	
	Fine Mix[A]	Coarse Mix[B]
Untreated asphalt, air in bin	12	6
Treated asphalt,[C] air in bin; untreated asphalt, inert gas in bin	36	18
Treated asphalt,[C] inert gas in bin	96	72

[A] Dense Mixtures: ¾ in., ½ in., ⅜ in., No. 4, and No. 16.
[B] Dense Mixtures: 2 in., 1½ in., and 1 in.
[C] Treated with Dow-Corning Fluid DC-200 at rate of approximately ~~1 oz (30~~ 30 cm^3)/~~5000 gal (18.93~~ (1 oz)/18.93 m^3 (5000 gal) of asphalt.

NOTE 8—An arbitrary separation point has been made above, based on ASTM Composition Requirements for Dense Mixtures, between the coarse and fine mixes. It has been observed that the coarser mixes undergo a faster rate of hardening when stored due to a higher volume of voids in those mixes. In addition, "open mixtures" generally harden faster than "dense mixtures" and, therefore, the storage time limits given above for coarse mixes should also be used for "open mixtures." The arbitrary separation point should be adjusted as data on percent air voids of laboratory compacted specimens become available. A value of 10 % air void content is suggested as an arbitrary separation point between coarse and fine mixes, with coarse mixes having an air void content above 10 % and fine mixes having an air void content less than 10 %. This value is arbitrary and may also require adjustment as additional mix design data becomes available.

11. Methods of Sampling and Testing

11.1 Sample all material and determine the properties enumerated in this specification in accordance with the following ASTM standards:

11.1.1 *Sampling Mineral Aggregates*—Practice D 75.

11.1.2 *Sampling Bituminous Mixtures* ~~—Methods~~—Practice D 979.

11.1.3 *Sieve Analysis of Aggregates*—Test Method C 136.

11.1.4 *Sieve Analysis of Mineral Filler*—Test Method D 546.

11.1.5 *Determination of Bitumen Content*—Test Methods D 2172. Determine the tar content in accordance with explanatory note appended to Test Methods D 2172.

11.1.6 *Sampling Bituminous Materials* ~~—Methods~~—Practice D 140.

11.1.7 *Specific Gravity of Coarse Aggregate*—Test Method C 127.

11.1.8 *Specific Gravity of Fine Aggregate*—Test Method C 128.

11.1.9 *Plasticity Index*—Test Method D 4318.

11.1.10 *Percentage of Coated Particles*—Test Method D 2489.

11.1.11 *Recovery of Extracted Asphalt*—Test Method D 1856.

11.1.12 *Penetration of Recovery Asphalt*—Test Method D 5.

11.1.13 *Air Voids*—Test Method D 3203.

11.1.14 *Absolute Viscosity of Asphalts*—Test Method D 2171.

12. Keywords

12.1 aggregates; bitumen; bituminous mixtures; hot-laid; hot-mixed; mixing plant; sampling; specification; testing