



## Standard Specification for Asphalt-Rubber Binder<sup>1</sup>

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### 1. Scope

1.1 This specification covers asphalt-rubber binder, consisting of a blend of paving grade asphalt cements, ground recycled tire (that is, vulcanized) rubber and other additives, as needed, for use as binder in pavement construction. The rubber shall be blended and interacted in the hot asphalt cement sufficiently to cause swelling of the rubber particles prior to use.

NOTE 1—It has been found that at least 15 % rubber by weight of the total blend is usually necessary to provide acceptable properties of asphalt-rubber.

1.2 The values stated in SI units are to be regarded as the standard. The inch-pound units given in parentheses are for information only.

1.3 The following precautionary caveat pertains to the test method portions only, Sections 4 and 5 of this Specification: *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.* Specific precautionary statements are given in 4.3.2.

### 2. Referenced Documents

#### 2.1 ASTM Standards:

- D 5 Test Method for Penetration of Bituminous Materials<sup>2</sup>
- D 36 Test Method for Softening Point of Bitumen (Ring and Ball Apparatus)<sup>3</sup>
- D 93 Test Methods for Flash-Point by Pensky-Martens Closed Cup Test<sup>4</sup>
- D 140 Practice for Sampling Bituminous Materials<sup>2</sup>
- D 946 Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction<sup>2</sup>
- D 1754 Test Method for Effect of Heat and Air on Asphaltic Materials (Thin Film Oven Test)<sup>2</sup>
- D 1864 Test Method for Moisture in Mineral Aggregate

#### Used on Built-Up Roofs<sup>3</sup>

- D 2196 Test Methods for Rheological Properties of Non-Newtonian Materials by Rotational (Brookfield Type) Viscometer<sup>5</sup>
- D 2872 Test Method for Effect of Heat and Air on a Moving Film of Asphalt (Rolling Thin-Film Oven Test)<sup>2</sup>
- D 3381 Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction<sup>2</sup>
- D 5329 Test Methods for Sealants and Fillers, Hot-Applied, for Joints and Cracks in Asphaltic and Portland Cement Concrete Pavements<sup>2</sup>
- D 5644 Test Method for Rubber Compounding Materials — Determination of Particle Size Distribution of Recycled Vulcanizate Particulate Rubber<sup>6</sup>

### 3. Materials

3.1 *Asphalt Cement*—The asphalt cement shall meet the requirements of Specification D 946 or Table 1 or 3 of Specification D 3381. Acceptable grades shall be able to produce the properties of Table 1 of this specification when interacted with ground recycled tire rubber.

#### 3.2 *Ground Recycled Tire Rubber*:

3.2.1 The ground recycled tire rubber shall contain less than 0.75 % moisture by weight and shall be free flowing. The specific gravity of the rubber shall be  $1.15 \pm 0.05$ . The ground recycled tire rubber shall contain no visible nonferrous metal particles and no more than 0.01 % ferrous metal particles by weight.

3.2.2 For use in hot mix binders, the fiber content shall not exceed 0.5 % by weight of ground recycled tire rubber. However for use in binders for spray applications, fiber content shall not exceed 0.1 % by weight. Up to 4 % by weight of mineral powder (such as talc) is permitted to prevent sticking and caking of the rubber particles. Other foreign contaminating materials (see Note 2) shall be less than 0.25 % by weight.

NOTE 2—Other foreign contaminants include, but are not limited to, materials such as glass, sand, wood, etc.

3.2.3 It is recommended that no rubber particles should be retained on the 2.36 mm (No. 8) sieve. Rubber gradation should be agreed upon between purchaser and asphalt-rubber supplier for the specific mixture applications (see Note 3).

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 04.03.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 04.04.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 05.01.

<sup>5</sup> *Annual Book of ASTM Standards*, Vol 06.01.

<sup>6</sup> *Annual Book of ASTM Standards*, Vol 09.01.

**TABLE 1 Physical Requirements for Asphalt-Rubber Binder**

| Binder Designation <sup>A</sup>  |       | Type I         | Type II        | Type III       |
|--|-------|----------------|----------------|----------------|
| Apparent Viscosity, 175°C (347°F):cP<br>Modified Test Method D 2196, Method<br>A, (see 5.4) <sup>B,C</sup> | min   | 1500           | 1500           | 1500           |
|  | max   | 5000           | 5000           | 5000           |
| Penetration, 25°C (77°F) 100g, 5 s:  | min   | 25             | 25             | 50             |
| 1/10 mm (Test Method D 5)  | max   | 75             | 75             | 100            |
| Penetration, 4°C (39.2°F), 200g, 60 s:   | min   | 10             | 15             | 25             |
| 1/10 mm (Test Method D 5)  |       |                |                |                |
| Softening Point: °C (°F)<br>(Test Method D 36)   | min   | 57.2<br>(135)  | 54.4<br>(130)  | 51.7<br>(125)  |
| Resilience, 25°C (77°F): %<br>(Test Method D 5329)   | min   | 25             | 20             | 10             |
| Flash Point: °C (°F)<br>(Test Method D 93)   | min   | 232.2<br>(450) | 232.2<br>(450) | 232.2<br>(450) |
| Thin-Film Oven Test Residue (Test Method<br>D 1754) <sup>D</sup>   | ..... | .....          | .....          | .....          |
| Penetration Retention, 4°C (39.2°F):<br>% of original (Test Method D 5)                                    | min   | 75             | 75             | 75             |

<sup>A</sup> See Appendix for recommended climate guidelines for usage.

<sup>B</sup> Either digital or dial reading Brookfield viscometers may be used - record peak measurement.

For LV series models, use spindle 3 at 12 rpm.

For RV and HA series models, use spindle 3 at 20 rpm.

<sup>C</sup> Rion or Haake-type high range rotational viscometers may also be used (with Rotor No. 1) when correlated with Brookfield measurements, as may other rotational viscometers. However Brookfield shall be the referee method.

<sup>D</sup> RTFO Residue (See Test Method D 2872) may be substituted for TFOT Residue, except TFOT shall be the referee method in cases of dispute.

NOTE 3—It has been found that rubber gradation may affect the physical properties and performance of hot paving mixtures using asphalt-rubber binder.

### 3.3 Asphalt-Rubber:

3.3.1 The asphalt-rubber shall be an interacted blend of paving grade asphalt cement and ground recycled tire rubber. Other additives not cited herein including other types of scrap rubber are permitted.

3.3.2 The asphalt-rubber shall not foam when heated to 175°C (347°F).

3.3.3 The asphalt-rubber blend shall conform to the physical requirements of Table 1. This table was developed to provide a reference for specifying asphalt-rubber binder. The tests are intended to measure the degree of modification of the asphalt cement by the ground recycled tire rubber. Table 1 is not intended to be a performance-based specification.

## 4. Procedure

### 4.1 Ground Recycled Tire Rubber:

4.1.1 Determine moisture content according to Test Method D 1864, except that oven temperature shall be 105 ± 5°C (221 ± 9°F).

4.1.2 Detect and separate out ferrous metal particles by thoroughly stirring a magnet through a 50 g sample. Weigh captured particles. Determine nonferrous metal content by visual inspection.

4.1.3 Perform sieve analysis according to Test Method D 5644

4.1.4 The method of determining fiber content shall be specified as agreed between the supplier and user.

### 4.2 Asphalt-Rubber Sampling:

4.2.1 Sample containers and handling shall be in accordance with Practice D 140.

4.2.2 Representative samples shall be taken from a sample valve or tap on the agitated tank in accordance with Practice D 140, unless otherwise directed.

4.3 Preparation of Pre-Blended Asphalt-Rubber Samples for Acceptance Testing:

4.3.1 *Sample Melting and Heating*—Loosen the cover of the original sample container to relieve pressure, then place the container in a preheated forced-draft oven and maintain oven temperature as required to heat sample to test temperature (see Note 4). After 1 h or when the asphalt-rubber material begins to liquify, remove cover. Stir with a spatula as required to avoid localized overheating of sample and to achieve uniform sample temperature. Replace cover and repeat these steps as needed.

NOTE 4—Only those samples which will be tested for viscosity at 175°C (347°F) need to be heated to 175°C (347°F). To provide specimens for other Table 1 acceptance tests, it is sufficient to thoroughly liquify the pre-blended asphalt-rubber.

4.3.2 Immediately prior to testing or pouring test specimens, stir the sample thoroughly with a spatula to achieve visually uniform distribution of rubber particles within the binder. Pour the asphalt-rubber into suitable molds and containers for making such tests as desired. Prepare and condition acceptance specimens according to the respective selected test methods (see Table 1). (**Warning**—The sample may contain ground rubber particles that tend to float or settle. It is therefore very important that samples be poured or tested as soon as possible after stirring to provide representative test specimens throughout which the rubber particles are uniformly dispersed.)

4.3.3 The pre-blended sample shall be raised to temperature, stirred, tested for viscosity or poured for other acceptance tests, or both, within 4 h of time of placement in heated oven.

## 5. Testing

5.1 Note that the presence of discrete rubber particles in the asphalt-rubber may influence test procedures and results, and may increase variation in measurements. Additional replicate samples may be prepared or measurements may be repeated, as appropriate. Precision of respective tests has not been determined and may vary with asphalt-rubber formulation.

5.2 *Table 1 Acceptance Tests*—Perform Table 1 acceptance tests according to the standard test methods referenced in Table

1, except for apparent viscosity which shall be modified as follows:

5.3 *Apparatus*—HA series Brookfield viscometers are recommended for testing apparent viscosity of asphalt-rubber binders, but LV and RV series models may also be used with the appropriate spindles and rotation rates indicated in Table 1. Calibrate instrument according to the manufacturer's recommendations or as needed, but not necessarily before each test.

5.3.1 Other types of rotational viscometers may be used when correlated with Brookfield measurements. However, Brookfield shall be the referee.

5.4 *Apparent Viscosity*—Measure according to Method A of Test Method D 2196, with the following modifications:

5.4.1 After the entire sample reaches 175°C (347°F), adjust oven to maintain sample temperature at 175°C (347°F).

5.4.2 Prepare sample in accordance with 4.3. Do not shake

and rest. Remove sample from oven to preheated hot plate or heating mantle and stir it vigorously and thoroughly.

5.4.3 Make all apparent viscosity measurements at a temperature of 175° ± 1°C (347° ± 2°F). Acclimate the appropriate spindle in the sample for at least 1 min before testing. Stir again immediately before starting spindle rotation at the appropriate rate according to Table 1 of this specification. Record the peak dial or digital reading to measure apparent viscosity of the asphalt-rubber system. If additional measurements are desired, stop spindle rotation and stir sample thoroughly first.

## 6. Keywords

6.1 asphalt; crm; crumb rubber modified; ground-tire rubber; rubber; wet process

## APPENDIX

### (Nonmandatory Information)

#### X1. CLIMATE GUIDELINES TO ACCOMPANY TABLE 1

X1.1 This appendix covers suggested climate guidelines for usage of the three types of asphalt-rubber (A-R) binders in Table 1. However, no restrictions are implied or intended for use of the respective A-R binders in the climate ranges presented in this appendix. These guidelines may be modified as justified by the familiarity and experience of the engineer with asphalt-rubber as well as with local paving materials and construction practices. For example, modifications of the suggested guidelines may be made dependent on traffic and roadway conditions and usage types: highways; major arterial, collector, industrial, or residential streets; or parking lots. Other considerations may include, but are not restricted to, chemical and rheological properties of the base asphalt cement and of the asphalt-rubber binder. Keeping in mind these considerations and that no restrictions are intended on the climate ranges at which a specific type of asphalt-rubber must be used, the following guidelines are provided to maximize performance of the asphalt-rubber binders.

X1.1.1 Type I binders typically include stiffer base asphalt cements. Type I binders are generally recommended for use in hot climate areas, defined as the following:

X1.1.1.1 Average monthly maximum ambient temperature is 43°C (110°F) or greater.

X1.1.1.2 Average monthly minimum ambient temperature is -1°C (30°F) or greater.

X1.1.2 Type II binders typically include softer grades of asphalt cement than Type I binders.

Type II binders are generally recommended for use in moderate climate areas, defined as the following:

X1.1.2.1 Average monthly maximum ambient temperature is 43°C (110°F) or lower.

X1.1.2.2 Average monthly minimum ambient temperature is -9°C (15°F) or greater.

X1.1.3 Type III binders typically include the softest grades of asphalt cements available, and may require softening additives to achieve the specified physical properties. Type III binders are generally recommended for use in cold climate areas, defined as the following:

X1.1.3.1 Average monthly maximum ambient temperature is 27°C (80°F) or lower.

X1.1.3.2 Average monthly minimum ambient temperature is -9°C (15°F) or lower.

NOTE X1.1—Descriptions of average monthly temperatures can be found in *Climatic Atlas of the United States*.<sup>7</sup>

<sup>7</sup> *Climatic Atlas of the United States*, originally published by U.S. Department of Commerce, Environmental Science Services, Environmental Data Service and reprinted by National Oceanic and Atmospheric Administration (NOAA).

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