



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

This standard is issued under the fixed designation D6114/D6114M; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 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 either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

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:<sup>2</sup>

- D5 Test Method for Penetration of Bituminous Materials
- D36 Test Method for Softening Point of Bitumen (Ring-and-Ball Apparatus)
- D92 Test Method for Flash and Fire Points by Cleveland Open Cup Tester

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee D04 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.40 on Asphalt Specifications.

Current edition approved June 1, 2009. Published July 2009. Originally approved in 1997. Last previous edition approved in 2002 as D6114 – 97 (2002). DOI: 10.1520/D6114\_D6114M-09.

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

- D140 Practice for Sampling Bituminous Materials
- D946 Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction
- D1754 Test Method for Effects of Heat and Air on Asphaltic Materials (Thin-Film Oven Test)
- D1864 Test Method for Moisture in Mineral Aggregate Used on Built-Up Roofs
- D2196 Test Methods for Rheological Properties of Non-Newtonian Materials by Rotational (Brookfield type) Viscometer
- D2872 Test Method for Effect of Heat and Air on a Moving Film of Asphalt (Rolling Thin-Film Oven Test)
- D3381 Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction
- D5329 Test Methods for Sealants and Fillers, Hot-Applied, for Joints and Cracks in Asphaltic and Portland Cement Concrete Pavements
- D5644 Test Methods for Rubber Compounding Materials—Determination of Particle Size Distribution of Recycled Vulcanizate Particulate Rubber
- D6373 Specification for Performance Graded Asphalt Binder

### 3. Materials

3.1 *Asphalt Cement*—The asphalt cement shall meet the requirements of Specifications D946, D3381 or D6373. 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.



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]: Pa·s [cP]	min	1.5 [1500]	1.5 [1500]	1.5 [1500]
Modified Test Method D2196, Method A, (see 5.4) <sup>B,C</sup> Pa·s [cP]	max	5.0 [5000]	5.0 [5000]	5.0 [5000]
Penetration, 25°C [77°F] 100g, 5 s:	min	25	25	50
units (Test Method D5)	max	75	75	100
Penetration, 4°C [39°F], 200g, 60 s:	min	10	15	25
units (Test Method D5)				
Softening Point: °C [°F]	min	57	54	52
(Test Method D36)		[135]	[130]	[125]
Resilience, 25°C [77°F]: %	min	25	20	10
(Test Method D5329)				
Flash Point: °C [°F]	min	232	232	232
(Test Method D92)		[450]	[450]	[450]
Thin-Film Oven Test Residue (Test Method D1754) <sup>D</sup>	.....	.....	.....	.....
Penetration Retention, 4°C [39.2°F]: % of original (Test Method D5)	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 revolutions per minute.

For RV and HA series models, use spindle 3 at 20 revolutions per minute.

<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 D2872) may be substituted for TFOT Residue, except TFOT shall be the referee method in cases of dispute.

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).

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 D1864, except that oven temperature shall be  $105 \pm 5^\circ\text{C}$  [221  $\pm$  9°F].

4.1.2 Detect and separate out ferrous metal particles by thoroughly stirring a magnet through a 50 g [0.10 lb] sample. Weigh captured particles. Determine nonferrous metal content by visual inspection.

4.1.3 Perform sieve analysis according to Test Method D5644

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 D140.

4.2.2 Representative samples shall be taken from a sample valve or tap on the agitated tank in accordance with Practice D140, 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 hour 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 hours 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 **D2196**, 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>3</sup>

<sup>3</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).



## D6114/D6114M – 09

*ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.*

*This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.*

*This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or [service@astm.org](mailto:service@astm.org) (e-mail); or through the ASTM website ([www.astm.org](http://www.astm.org)). Permission rights to photocopy the standard may also be secured from the ASTM website ([www.astm.org/COPYRIGHT/](http://www.astm.org/COPYRIGHT/)).*