Standard Specification for

Performance-Graded Asphalt Binder

AASHTO Designation: M 320-17

Technical Section: 2b, Liquid Asphalt

Release: Group 3 (August 2017)

AASHTO

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1. SCOPE

1.1. This specification covers asphalt binders graded by performance. Grading designations are related to the average seven-day maximum pavement design temperature and the minimum pavement design temperature. This specification contains Table 1 and Table 2. If no table is specified, the default is Table 1.

1.2. Table 2 incorporates R 49 for determining the critical low cracking temperature using a combination of T 313 and T 314 test procedures.

Note 1—For asphalt cements graded by viscosity at 60°C, see M 226.

Note 2—R 29 provides information for determining the performance grade of an asphalt binder.

Note 3—For specifying performance-graded asphalt binder using Multiple Stress Creep Recovery (MSCR), see M 332.

2. REFERENCED DOCUMENTS

2.1. *AASHTO Standards*:

- M 226, Viscosity-Graded Asphalt Cement
- M 323, Superpave Volumetric Mix Design
- M 332, Performance-Graded Asphalt Binder Using Multiple Stress Creep Recovery (MSCR) Test
- R 28, Accelerated Aging of Asphalt Binder Using a Pressurized Aging Vessel (PAV)
- R 29, Grading or Verifying the Performance Grade (PG) of an Asphalt Binder
- R 35, Superpave Volumetric Design for Asphalt Mixtures
- R 49, Determination of Low-Temperature Performance Grade (PG) of Asphalt Binders
- R 66, Sampling Asphalt Materials
- T 44, Solubility of Bituminous Materials
- T 48, Flash and Fire Points by Cleveland Open Cup
- T 240, Effect of Heat and Air on a Moving Film of Asphalt Binder (Rolling Thin-Film Oven Test)
- T 313, Determining the Flexural Creep Stiffness of Asphalt Binder Using the Bending Beam Rheometer (BBR)
- T 314, Determining the Fracture Properties of Asphalt Binder in Direct Tension (DT)
- T 315, Determining the Rheological Properties of Asphalt Binder Using a Dynamic Shear Rheometer (DSR)
- T 316, Viscosity Determination of Asphalt Binder Using Rotational Viscometer

2.2. *ASTM Standards*:

- D8, Standard Terminology Relating to Materials for Roads and Pavements
- D95, Standard Test Method for Water in Petroleum Products and Bituminous Materials by Distillation
- D5546, Standard Test Method for Solubility of Asphalt Binders in Toluene by Centrifuge

3. TERMINOLOGY

3.1. *Definitions*:

3.1.1. Definitions for many terms common to asphalt binder are found in ASTM D8.

3.1.2. *asphalt binder*—an asphalt-based cement that is produced from petroleum residue either with or without the addition of nonparticulate organic modifiers.

4. ORDERING INFORMATION

4.1. When ordering under this specification, include in the purchase order the performance grade (PG) of asphalt binder required and the table used (e.g., (1) M 320, PG 52-16, Table 1, or (2) M 320, PG 64-34, Table 2). If no table is specified, the default is Table 1.

4.2. Asphalt binder grades may be selected by following the procedures described in M 323 and R 35.

5. MATERIALS AND MANUFACTURE

5.1. Asphalt binder shall be prepared by the refining of crude petroleum by suitable methods, with or without the addition of modifiers.

5.2. Modifiers may be any organic material of suitable manufacture that is used in virgin or recycled condition and that is dissolved, dispersed, or reacted in asphalt binder to enhance its performance.

5.3. The asphalt binder shall be homogeneous, free from water and deleterious materials, and shall not foam when heated to 175°C.

5.4. The asphalt binder shall be at least 99.0 percent soluble as determined by T 44 or ASTM D5546.

5.5. This specification is not applicable for asphalt binders in which fibers or other discrete particles are larger than 250 µm in size.

5.6. The grades of asphalt binder shall conform to the requirements given in Table 1 or Table 2.

Note 4—Grades outside of Table 1 or Table 2 are sometimes specified. If grades are specified beyond those listed in Table 1 or Table 2, a high, low, and intermediate temperature shall be specified. The high and low temperature grade should be specified in 6°C increments for consistency with the PG grading system.

6. SAMPLING

6.1. The material shall be sampled in accordance with R 66.

7. TEST METHODS

7.1. The properties outlined in Sections 5.3, 5.4, and 5.6 shall be determined in accordance with R 28, T 44 or ASTM D5546, T 48, ASTM D95, T 240, T 313, T 314, T 315, and T 316.

8. INSPECTION AND CERTIFICATION

8.1. Inspection and certification of the material shall be agreed on between the purchaser and the seller. Specific requirements shall be made part of the purchase contract. The seller shall provide material handling and storage procedures to the purchaser for each asphalt binder grade certified.

9. REJECTION AND RETESTING

9.1. If the results of any test do not conform to the requirements of this specification, retesting to determine conformity is performed as indicated in the purchase order or as otherwise agreed on between the purchaser and the seller.

10. KEYWORDS

10.1. Asphalt binder; asphalt cement; direct tension; flash point; modifier; performance specifications; pressure aging; rheology.

Table 1—Performance-Graded Asphalt Binder Specification

Performance Grade	PG 46			PG 52							PG 58					PG 64					
	34	40	46	10	16	22	28	34	40	46	16	22	28	34	40	10	16	22	28	34	40
Average 7-day max pavement design temp, °C[a]	<46			<52							<58					<64					
Min pavement design temperature, °C[a]	>–34	>–40	>–46	>–10	>–16	>–22	>–28	>–34	>–40	>–46	>–16	>–22	>–28	>–34	>–40	>–10	>–16	>–22	>–28	>–34	>–40
Original Binder																					
Flash point temp, T 48, min °C	230																				
Viscosity, T 316:[b] max 3 Pa•s, test temp, °C	135																				
Dynamic shear, T 315:[c] G*/sinδ,[d] min 1.00 kPa test temp @ 10 rad/s, °C	46			52							58					64					
Rolling Thin-Film Oven Residue (T 240)																					
Mass change,[e] max, percent	1.00																				
Dynamic shear, T 315: G*/sinδ,[d] min 2.20 kPa test temp @ 10 rad/s, °C	46			52							58					64					
Pressurized Aging Vessel Residue (R 28)																					
PAV aging temperature, °C[f]	90 (100, 110)			90 (100, 110)							100 (110)					100 (110)					
Dynamic shear, T 315: G* sinδ,[d] max 5000 kPa test temp @ 10 rad/s, °C	10	7	4	25	22	19	16	13	10	7	25	22	19	16	13	31	28	25	22	19	16
Creep stiffness, T 313:[g] S, max 300 MPa *m*-value, min 0.300 test temp @ 60 s, °C	–24	–30	–36	0	–6	–12	–18	–24	–30	–36	–6	–12	–18	–24	–30	0	–6	–12	–18	–24	–30
Direct tension, T 314:[g] Failure strain, min 1.0% test temp @ 1.0 mm/min, °C	–24	–30	–36	0	–6	–12	–18	–24	–30	–36	–6	–12	–18	–24	–30	0	–6	–12	–18	–24	–30

[a] Pavement temperatures are estimated from air temperatures using an algorithm contained in the LTPP Bind program, may be provided by the specifying agency, or by following the procedures as outlined in M 323 and R 35.

[b] This requirement may be waived at the discretion of the specifying agency if the supplier warrants that the asphalt binder can be adequately pumped and mixed at temperatures that meet all applicable safety standards.

[c] For quality control of unmodified asphalt binder production, measurement of the viscosity of the original asphalt binder may be used to supplement dynamic shear measurements of G*/sinδ at test temperatures where the asphalt is a Newtonian fluid.

[d] G*/sinδ = high temperature stiffness and G* sinδ = intermediate temperature stiffness.

[e] The mass change shall be less than 1.00 percent for either a positive (mass gain) or a negative (mass loss) change.

[f] The PAV aging temperature is based on anticipated climatic conditions and is one of three temperatures, 90°C for climates requiring PG 52-xx and below, 100°C for climates requiring PG 58-xx to PG 70-xx, or 110°C for climates requiring PG 76-xx and above. Normally the PAV aging temperature is specified based on the PG grade. However, when the binder is being used in a different climate due to grade bumping or need for softer binder due to blending, the PAV aging temperature may be specified as 100°C when used in climates requiring PG 58-xx to PG 70-xx, or 110°C when used in climates requiring PG 76-xx and above.

[g] If the creep stiffness is below 300 MPa, the direct tension test is not required. If the creep stiffness is between 300 and 600 MPa, the direct tension failure strain requirement can be used in lieu of the creep stiffness requirement. The m-value requirement must be satisfied in both cases.

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Table 1—Performance-Graded Asphalt Binder Specification *(Continued)*

Performance Grade	PG 70						PG 76					PG 82				
	10	16	22	28	34	40	10	16	22	28	34	10	16	22	28	34
Average 7-day max pavement design temperature, °C[a]	<70						<76					<82				
Min pavement design temperature, °C[a]	>–10	>–16	>–22	>–28	>–34	>–40	>–10	>–16	>–22	>–28	>–34	>–10	>–16	>–22	>–28	>–34
Original Binder																
Flash point temp, T 48, min °C	230															
Viscosity, T 316:[b] max 3 Pa•s, test temp, °C	135															
Dynamic shear, T 315:[c] G*/sin δ,[d] min 1.00 kPa test temp @ 10 rad/s, °C	70						76					82				
Rolling Thin-Film Oven Residue (T 240)																
Mass change,[e] max, percent	1.00															
Dynamic shear, T 315: G*/sin δ,[d] min 2.20 kPa test temp @ 10 rad/s, °C	70						76					82				
Pressurized Aging Vessel Residue (R 28)																
PAV aging temperature, °C[f]	100 (110)						110 (100)					110 (100)				
Dynamic shear, T 315: G* sin δ,[d] max 5000 kPa test temp @ 10 rad/s, °C	34	31	28	25	22	19	37	34	31	28	25	40	37	34	31	28
Creep stiffness, T 313:[g] S, max 300 MPa *m*-value, min 0.300 test temp @ 60 s, °C	0	–6	–12	–18	–24	–30	0	–6	–12	–18	–24	0	–6	–12	–18	–24
Direct tension, T 314:[g] Failure strain, min 1.0% test temp @ 1.0 mm/min, °C	0	–6	–12	–18	–24	–30	0	–6	–12	–18	–24	0	–6	–12	–18	–24

[a] Pavement temperatures are estimated from air temperatures using an algorithm contained in the LTPP Bind program, may be provided by the specifying agency, or by following the procedures as outlined in M 323 and R 35.

[b] This requirement may be waived at the discretion of the specifying agency if the supplier warrants that the asphalt binder can be adequately pumped and mixed at temperatures that meet all applicable safety standards.

[c] For quality control of unmodified asphalt binder production, measurement of the viscosity of the original asphalt binder may be used to supplement dynamic shear measurements of G*/sinδ at test temperatures where the asphalt is a Newtonian fluid.

[d] G*/sinδ = high temperature stiffness and G* sinδ = intermediate temperature stiffness.

[e] The mass change shall be less than 1.00 percent for either a positive (mass gain) or a negative (mass loss) change.

[f] The PAV aging temperature is based on anticipated climatic conditions and is one of three temperatures, 90°C for climates requiring PG 52-xx and below, 100°C for climates requiring PG 58-xx to PG 70-xx, or 110°C for climates requiring PG 76-xx and above. Normally the PAV aging temperature is specified based on the PG grade. However, when the binder is being used in a different climate due to grade bumping or need for softer binder due to blending, the PAV aging temperature may be specified as 100°C when used in climates requiring PG 58-xx to PG 70-xx, or 110°C when used in climates requiring PG 76-xx and above.

[g] If the creep stiffness is below 300 MPa, the direct tension test is not required. If the creep stiffness is between 300 and 600 MPa, the direct tension failure strain requirement can be used in lieu of the creep stiffness requirement. The *m*-value requirement must be satisfied in both cases.

Table 2—Performance-Graded Asphalt Binder Specification Using Critical Cracking Temperature

Performance Grade	PG 46			PG 52							PG 58					PG 64					
	34	40	46	10	16	22	28	34	40	46	16	22	28	34	40	10	16	22	28	34	40
Average 7-day max pavement design temperature, °C[a]	<46			<52							<58					<64					
Min pavement design temperature, °C[a]	>–34	>–40	>–46	>–10	>–16	>–22	>–28	>–34	>–40	>–46	>–16	>–22	>–28	>–34	>–40	>–10	>–16	>–22	>–28	>–34	>–40
Original Binder																					
Flash point temp, T 48, min °C	230																				
Viscosity, T 316:[b] max 3 Pa•s, test temp, °C	135																				
Dynamic shear, T 315:[c] G*/sinδ[d], min 1.00 kPa test temp @ 10 rad/s, °C	46			52							58					64					
Rolling Thin-Film Oven Residue (T 240)																					
Mass change,[e] max, percent	1.00																				
Dynamic shear, T 315: G*/sinδ[d], min 2.20 kPa test temp @ 10 rad/s, °C	46			52							58					64					
Pressurized Aging Vessel Residue (R 28)																					
PAV aging temperature, °C[f]	90 (100, 110)			90 (100, 110)							100 (110)					100 (110)					
Dynamic shear, T 315: G* sinδ[d], max 5000 kPa test temp @ 10 rad/s, °C	10	7	4	25	22	19	16	13	10	7	25	22	19	16	13	31	28	25	22	19	16
Critical low cracking temp, R 49:[g] Critical cracking temp determined by R 49, test temp, °C	–24	–30	–36	0	–6	–12	–18	–24	–30	–36	–6	–12	–18	–24	–30	0	–6	–12	–18	–24	–30

[a] Pavement temperatures are estimated from air temperatures using an algorithm contained in the LTPP Bind program, may be provided by the specifying agency, or by following the procedures as outlined in M 323 and R 35.

[b] This requirement may be waived at the discretion of the specifying agency if the supplier warrants that the asphalt binder can be adequately pumped and mixed at temperatures that meet all applicable safety standards.

[c] For quality control of unmodified asphalt binder production, measurement of the viscosity of the original asphalt binder may be used to supplement dynamic shear measurements of G*/sinδ at test temperatures where the asphalt is a Newtonian fluid.

[d] G*/sinδ = high temperature stiffness and G* sinδ = intermediate temperature stiffness.

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[g] For verification of grade, at a minimum perform T 313 at the test temperature and at the test temperature minus 6°C and T 314 at the test temperature. Testing at additional temperatures for T 313 may be necessary if 300 MPa is not bracketed at the initial two test temperatures. Compare the failure stress from T 314 to the calculated induced thermal stress as per R 49. If the failure stress exceeds the induced thermal stress, the asphalt binder is deemed a "PASS" at the specification temperature.

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Table 2—Performance-Graded Asphalt Binder Specification Using Critical Cracking Temperature *(Continued)*

Performance Grade	PG 70						PG 76					PG 82				
	10	16	22	28	34	40	10	16	22	28	34	10	16	22	28	34
Average 7-day max pavement design temperature, °C[a]	<70						<76					<82				
Min pavement design temperature, °C[a]	>–10	>–16	>–22	>–28	>–34	>–40	>–10	>–16	>–22	>–28	>–34	>–10	>–16	>–22	>–28	>–34
Original Binder																
Flash point temp, T 48, min °C	230															
Viscosity, T 316:[b] max 3 Pa•s, test temp, °C	135															
Dynamic shear, T 315:[c] G*/sinδ[d], min 1.00 kPa test temp @ 10 rad/s, °C	70						76					82				
Rolling Thin-Film Oven Residue (T 240)																
Mass change,[e] max, percent	1.00															
Dynamic shear, T 315: G*/sinδ[d], min 2.20 kPa test temp @ 10 rad/s, °C	70						76					82				
Pressurized Aging Vessel Residue (R 28)																
PAV aging temperature, °C[f]	100 (110)						110 (100)					110 (100)				
Dynamic shear, T 315: G* sinδ[d], max 5000 kPa test temp @ 10 rad/s, °C	34	31	28	25	22	19	37	34	31	28	25	40	37	34	31	28
Critical low cracking temp, R 49:[g] Critical cracking temp determined by R 49, test temp, °C	0	–6	–12	–18	–24	–30	0	–6	–12	–18	–24	0	–6	–12	–18	–24

[a] Pavement temperatures are estimated from air temperatures using an algorithm contained in the LTPP Bind program, may be provided by the specifying agency, or by following the procedures as outlined in M 323 and R 35.

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[g] For verification of grade, at a minimum perform T 313 at the test temperature and at the test temperature minus 6°C and T 314 at the test temperature. Testing at additional temperatures for T 313 may be necessary if 300 MPa is not bracketed at the initial two test temperatures. Compare the failure stress from T 314 to the calculated induced thermal stress as per R 49. If the failure stress exceeds the induced thermal stress, the asphalt binder is deemed a "PASS" at the specification temperature.