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Standard Specification for Performance Graded Asphalt Binder[1]

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1. Scope

1.1 This specification[2] covers asphalt binders graded by performance. Grading designations are related to the average seven-day maximum pavement design temperature, and minimum pavement design temperature. This specification contains Table 1 and Table 2. Table 2 incorporates Practice D6816 for determining the critical low cracking temperature using a combination of Test Method D6648 and Test Method D6723 test procedures. If no table is specified, the default is Table 1.

NOTE 1—For asphalt cements graded by penetration at 25°C, see Specification D946. For asphalt cements graded by viscosity at 60°C see Specification D3381.

NOTE 2—AASHTO R 29 provides non-mandatory information for determining the performance grade of an asphalt binder.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

2. Referenced Documents

2.1 *ASTM Standards:*[3]

D8 Terminology Relating to Materials for Roads and Pavements
D92 Test Method for Flash and Fire Points by Cleveland Open Cup Tester
D95 Test Method for Water in Petroleum Products and Bituminous Materials by Distillation
D140 Practice for Sampling Bituminous Materials
D946 Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction
D2042 Test Method for Solubility of Asphalt Materials in Trichloroethylene
D2170 Test Method for Kinematic Viscosity of Asphalts (Bitumens)
D2171 Test Method for Viscosity of Asphalts by Vacuum Capillary 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
D4402 Test Method for Viscosity Determination of Asphalt at Elevated Temperatures Using a Rotational Viscometer
D5546 Test Method for Solubility of Asphalt Binders in Toluene by Centrifuge
D6521 Practice for Accelerated Aging of Asphalt Binder Using a Pressurized Aging Vessel (PAV)
D6648 Test Method for Determining the Flexural Creep Stiffness of Asphalt Binder Using the Bending Beam Rheometer (BBR)
D6723 Test Method for Determining the Fracture Properties of Asphalt Binder in Direct Tension (DT)
D6816 Practice for Determining Low-Temperature Performance Grade (PG) of Asphalt Binders
D7175 Test Method for Determining the Rheological Properties of Asphalt Binder Using a Dynamic Shear Rheometer
D7553 Test Method for Solubility of Asphalt Materials in N-Propyl Bromide

2.2 *AASHTO Standards:*[4]

AASHTO R 29 Grading or Verifying the Performance Grade of an Asphalt Binder
AASHTO M 320 Standard Specification for Performance-Graded Asphalt Binder

3. Terminology

3.1 *Definitions:*

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

[1] 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.

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[2] This specification is based on SHRP Product 1001 and AASHTO MP1.

[3] 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.

[4] Available from American Association of State Highway and Transportation Officials (AASHTO), 444 N. Capitol St., NW, Suite 249, Washington, DC 20001, http://www.transportation.org.

TABLE 1 Performance Graded Asphalt Binder Specification

Performance Grade	PG 46	PG 52	PG 58	PG 64	PG 70	PG 76	PG 82
	–34 –40 –46	–10 –16 – 22 –28 –34 –40 –46	–16 –22 –28 –34 –40	–10 –16 –22 –28 –34– 40	–10 –16 –22– 28 –34 –40	–10 –16 –22 –28 –34	–10 –16 –22 –28 –34
Average 7-day maximum Pavement Design Temperature, °C	<46	<52	<58	<64	<70	<76	<82
Minimum 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	> –10 > –16 > –22 > –28 > –34 > –40	> –10 > –16 > –22 > –28 > –28 > –34	> –10 > –16 > –22 > –28 > –28 > –34
Original Binder							
Flash Point Temp., D92; min °C	230						
Viscosity, D4402:[B] max. 3 Pa·s, Test Temp., °C	135						
Dynamic Shear, D7175:[C] G*/sinδ, min. 1.00 kPa 25 mm Plate, 1 mm Gap Test Temp. at 10 rad/s, °C	46	52	58	64	70	76	82
Rolling Thin Film Oven (Test Method D2872)							
Mass Change, max. percent	1.00						
Dynamic Shear, D7175: G*/sinδ, min. 2.20 kPa 25 mm Plate, 1 mm Gap Test Temp. at 10 rad/s,°C	46	52	58	64	70	76	82
Pressure Aging Vessel Residue (Practice D6521)							
PAV Aging Temperature, °C[D]	90	90	100	100	100 (110)	100 (110)	100 (110)
Dynamic Shear, D7175: G*·sinδ, max 5000 kPa 8 mm Plate, 2 mm Gap Test Temp. at 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	34 31 28 25 22 19	37 34 31 28 25	40 37 34 31 28
Creep Stiffness, D6648:[E] S, max 300 MPa, m-value; min. 0.300 Test Temp at 60 s, °C	–24 –30 –36	0 – 6 –12 –18 –24 –30 –36	– 6 –12 –18 –24 –30	0 – 6 –12 –18 –24 –30	0 – 6 –12 –18 –24 –30	0 –6 –12 –18 –24	0 – 6 –12 –18 –24
Direct Tension, D6723:[E] Failure Strain, min. 1.0 % Test Temp. at 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	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 software program, or are provided by the specifying agency.

[B]The referee method shall be D4402 using a #21 spindle at 20RPM, however alternate methods may be used for routine testing and quality assurance. If the binder is too stiff to test with the No. 21 Spindle, the No. 27 spindle shall be used. The spindle size and shear rate shall be reported. 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 cement production, measurement of the viscosity of the original asphalt cement may be substituted for dynamic shear measurements of G*/sinδ at test temperatures where the asphalt is a Newtonian fluid. Any suitable standard means of viscosity measurement may be used, including capillary viscometry (Test Methods D2170 or D2171) or rotational viscometry.

[D]The PAV aging temperature is based on simulated climatic conditions and is one of three temperatures 90°C, 100°C or 110°C. Normally the PAV aging temperature is 100°C for PG 58–xx and above. However, in desert climates, the PAV aging temperature for PG 70–xx and above may be specified as 110°C

[E]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. If the creep stiffness and m-value data are unobtainable because the binder is too soft at the test temperature, the asphalt binder will be deemed to pass at that grade temperature if it meets the creep stiffness and m-value requirements at the test temperature minus 6°C.

TABLE 2 Performance Graded Asphalt Binder Specification

Performance Grade	PG 46	PG 52	PG 58	PG 64	PG 70	PG 76	PG 82
	–34 –40 –46	–10 –16 – 22 –28 –34 –40 –46	–16 –22 –28 –34 –40	–10 –16 –22 –28 –34– 40	–10 –16 –22– 28 –34 –40	–10 –16 –22 –28 –34	–10 –16 –22 –28 –34
Average 7-day maximum Pavement Design Temperature, °C	<46	<52	<58	<64	<70	<76	<82
Minimum 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	> –10 > –16 > –22 > –28 > –34 > –40	> –10 > –16 > –22 > –28 > –34	> –10 > –16 > –22 > –28 > –34
Original Binder							
Flash Point Temp., D92; min °C	230						
Viscosity, D4402:[B] max. 3 Pa·s, Test Temp., °C	135						
Dynamic Shear, D7175:[C] G*/sinδ, min. 1.00 kPa 25 mm Plate, 1 mm Gap Test Temp. at 10 rad/s, °C	46	52	58	64	70	76	82
Rolling Thin Film Oven (Test Method D2872)							
Mass Change, max. percent	1.00						
Dynamic Shear, D7175: G*/sinδ, min. 2.20 kPa 25 mm Plate, 1 mm Gap Test Temp. at 10 rad/s,°C	46	52	58	64	70	76	82
Pressure Aging Vessel Residue (Practice D6521)							
PAV Aging Temperature, °C[D]	90	90	100	100	100 (110)	100 (110)	100 (110)
Dynamic Shear, D7175: G*·sinδ, max 5000 kPa 8 mm Plate, 2 mm Gap Test Temp. at 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	34 31 28 25 22 19	37 34 31 28 25	40 37 34 31 28
Critical Low Cracking Temperature, D6816,:[E] PASS Test Temp °C	–24 –30 –36	0 – 6 –12 –18 –24 –30 –36	– 6 –12 –18 –24 –30	0 – 6 –12 –18 –24 –30	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 software program, or are provided by the specifying agency.

[B]The referee method shall be D4402 using a #21 spindle at 20RPM, however alternate methods may be used for routine testing and quality assurance. If the binder is too stiff to test with the No. 21 Spindle, the No. 27 spindle shall be used. The spindle size and shear rate shall be reported. 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 cement production, measurement of the viscosity of the original asphalt cement may be substituted for dynamic shear measurements of G*/sinδ at test temperatures where the asphalt is a Newtonian fluid. Any suitable standard means of viscosity measurement may be used, including capillary viscometry (Test Methods D2170 or D2171) or rotational viscometry.

[D]The PAV aging temperature is based on simulated climatic conditions and is one of three temperatures 90°C, 100°C or 110°C. Normally the PAV aging temperature is 100°C for PG 58–xx and above. However, in desert climates, the PAV aging temperature for PG 70–xx and above may be specified as 110°C

[E]For verification of grade, at a minimum perform D6648 at the test temperature and at the test temperature minus 6°C, and D6723 at the test temperature. Testing at additional temperatures for D6648 may be necessary if 300 MPa is not bracketed at the initial two test temperatures. Compare the failure stress from D6723 to the calculated induced thermal stress as per D6816. If the failure stress exceeds the induced thermal stress, the asphalt binder is deemed a “PASS” at the specification temperature. If the creep stiffness and m-value data are unobtainable because the binder is too soft at the test temperature, the asphalt binder will be deemed to pass at that grade temperature if it meets the critical low cracking temperature requirements at the test temperature minus 6°C.