Designation: D7643 – 10

Standard Practice for Determining the Continuous Grading Temperatures and Continuous Grades for PG Graded Asphalt Binders[1]

This standard is issued under the fixed designation D7643; 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 (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice is used to determine the continuous grading temperatures and continuous grade for an asphalt binder graded in accordance with the specification criteria specified in D6373, Standard Specification for Performance Graded Asphalt Binders.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this 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:*[2]

D8 Terminology Relating to Materials for Roads and Pavements

D2872 Test Method for Effect of Heat and Air on a Moving Film of Asphalt (Rolling Thin-Film Oven Test)

D6373 Specification for Performance Graded Asphalt Binder

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

3. Terminology

3.1 *Definitions:* Definitions for many terms common to asphalt cement and asphalt binder are found in Terminology D8.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *continuous grading temperatures, T_c, n*—the high, intermediate, and low temperatures at which the specification requirements given in Tables 1 or 2 of Specification D6373 are met.

3.2.2 *continuous grade, n*—a grade defined by upper and lower continuous grading temperatures.

3.2.3 *PG grading temperatures, T_{PG}, n*—the temperatures listed in Specification D6373 used to designate the grade of a PG binder, for example, 64ºC, 22ºC and -28ºC for a PG 64-28.

3.2.4 *test temperatures, T_1 and T_2, n*—two PG grading temperatures, one grade apart and with $T_2 > T_1$ such that the test properties at the two temperatures bracket the specification requirement for the property in question.

3.2.5 *specification requirements, n*—the limiting values given in Specification D6373 that are used to grade an asphalt binder, for example, 1.00 kPa for G*/sinδ, 300 MPa for S(60), etc.

4. Summary of Practice

4.1 The temperatures required to determine the continuous grading temperatures and grade are obtained from test results obtained at the specification grading temperatures as listed in Specification D6373 and, for each specification requirement, at a second temperature above or below the specification grading temperature. The continuous grading temperature is determined by interpolating between the two test temperatures to calculate the test temperature at which the specification requirement is met. The continuous grading temperatures are then used to determine the continuous grade of the asphalt binder.

[1] This practice is under the jurisdiction of ASTM Committee D04 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.44 on Rheological Tests.

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[2] 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.

5. Significance and Use

5.1 The continuous grading temperatures and continuous grade are used for informational purposes only and are not used for the sale or purchase of asphalt binders. The continuous grading temperatures and continuous grade may be used for forensic or research studies and when producing, blending, modifying, or otherwise evaluating asphalt binders. This guide is applicable to Specification D6373, Tables 1 and 2.

6. Procedure

6.1 *Conduct tests*—For each of the specification properties (for example, G*/sinδ, S(60), etc.) for which a T_C is to be calculated determine the test results at two temperatures, T_1 and T_2 such that T_2 is greater than T_1. The difference between T_1 and T_2 shall be 6ºC for the upper and lower test temperatures and 3ºC for the intermediate temperature. The two temperatures shall provide test results that bracket the specification requirements.

NOTE 1—For example, a PG 64-XX tested for G*/sinδ at 64ºC and 70ºC may give test results of 1.86 and 0.89 kPa respectively. These results bracket the specification requirement, 1.00 kPa.

6.1.1 If the results of the applicable specification provides a temperature rather than a limiting property value (for example, T_{CR} in Specification D6373, Table 2) then the temperature shall be used as the continuous grading temperature.

6.2 *Perform Interpolation to Determine Continuous Grading Temperatures*—For each pair of test results obtained as per 6.1 determine the continuous grading temperature by interpolating between T_1 and T_2 to determine the temperature at which the test results equal the specification requirement. The interpolated temperature shall be reported as the continuous grading temperature.

6.2.1 The interpolation for each of the properties, except the m-value, shall be done using a linear relationship between the test results (log_{10} scale) and the test temperature (arithmetic scale). The interpolation takes the following form:

$$T_C = T_1 + \left(\frac{log_{10}(P_S) - log_{10}(P_1)}{log_{10}(P_2) - log_{10}(P_1)} \right)(T_2 - T_1) \quad (1)$$

where:

T_C = Continuous grading temperature, ºC,
T_1 = Lower of the two test temperatures, ºC,
P_S = Specification requirement for property in question; determined at the respective PG grading temperature for the respective property,
P_1 = Test result for the specification property in question at T_1,
P_2 = Test result for the specification property in question at T_2, and
T_2 = Higher of two test temperatures, ºC.

6.2.2 The interpolation for the m-value shall be done using an arithmetic scale. The interpolation takes the following form:

$$T_C = T_1 + \left(\frac{P_S - P_1}{P_2 - P_1} \right)(T_2 - T_1) \quad (2)$$

NOTE 2—Equations and are valid whether the test results increase with temperature or decrease with temperature. When using these equations retain the negative signs for temperatures below 0ºC.

NOTE 3—Because the properties are a non-linear function of temperature linear interpolation results in a slight error in the estimated values of T_C.

6.3 *Determine Continuous Grade*—Determine the continuous grade based on the upper and lower continuous grading temperature using the same rationale as presented in Specification D6373. The lower of the two upper continuous grading temperatures (for G*/sinδ, Original and RTFO) shall determine the upper continuous grade. The upper of the two continuous grading temperatures (for S and m, PAV) shall determine the lower continuous grade. The intermediate temperature criterion as given in Specification D6373 is not considered when determining the continuous grade but may be reported in parenthesis as a suffix to the continuous grade. Sample problems are given in Appendix X1.

7. Report

7.1 *Continuous Grading Temperatures*—Report the upper, intermediate, and lower continuous grading temperatures to the nearest 0.1ºC using the procedure as described in 6.2.

7.2 *Intermediate Continuous Grading Temperature (Optional)*—Although the intermediate criteria is not considered when determining the continuous grade, the intermediate continuous grading temperature may be included for informational purposes as part of the continuous grade.

7.3 *Continuous Grade*—Report the continuous grade to the nearest 0.1ºC using the procedure as described in 6.2. If required, the continuous intermediate temperature may be reported in parentheses as a suffix to the continuous grade, for example, PG 61.9-22.6 (19.3).

7.4 Depending upon the use of the results, all of the information requested in Section 8. may not be required. If this is the case, it is only necessary to report the required information.

8. Keywords

8.1 continuous grading temperature; continuous grade; performance graded binders (PG Grade)