Standard Practice for

Determination of Low-Temperature Performance Grade (PG) of Asphalt Binders

AASHTO Designation: R 49-09 (2018)[1]

Technical Subcommittee: 2b, Liquid Asphalt

Release: Group 3 (July)

American Association of State Highway and Transportation Officials
444 North Capitol Street N.W., Suite 249
Washington, D.C. 20001

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1. SCOPE

1.1. This standard practice covers the determination of low-temperature properties of asphalt binders using data from the bending beam rheometer (T 313) and the direct tension tester (T 314). This standard practice can be used on data from unaged material or from material aged using T 240 (RTFOT), R 28 (PAV), or T 240 (RTFOT) and R 28 (PAV). This standard practice can be used on data generated within the temperature range from +6 to –36°C.

1.2. This standard practice is only valid for data on materials that fall within the scope of suitability for both test methods T 313 and T 314.

1.3. *This standard practice can be used to determine the following*:

1.3.1. *PG Grade Determination of an Asphalt Binder*—The determination of a low-temperature grade or grades that are satisfied by an asphalt binder. The determination of the temperature corresponds to the specification parameter, T_{cr}, the critical cracking temperature.

1.3.2. *Prequalification of an Asphalt Binder*—The procedure required to qualify an asphalt binder for supply.

1.3.3. *Verification of an Asphalt Binder Grade*—The testing required to certify that a binder complies with an existing prequalified binder.

1.4. While this standard practice determines the critical cracking temperature for typical hot mix asphalt (HMA), the intent of this standard practice is grading of asphalt binder according to M 320, not performance prediction for asphalt pavement. This standard practice should not be used in lieu of T 322.

1.5. *This standard practice may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety concerns associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.*

Note 1—The algorithms contained in this standard require implementation by a person trained in the subject of numerical methods and viscoelasticity. However, due to the complexity of the calculations they must, of necessity, be performed on a computer. Software to perform the calculations may be written or purchased as a spreadsheet or as a stand-alone program.[2]

2. REFERENCED DOCUMENTS

2.1. *AASHTO Standards*:

- M 320, Performance-Graded Asphalt Binder
- R 28, Accelerated Aging of Asphalt Binder Using a Pressurized Aging Vessel (PAV)
- 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 322, Determining the Creep Compliance and Strength of Hot Mix Asphalt (HMA) Using the Indirect Tensile Test Device

3. TERMINOLOGY

3.1. *Definitions of Terms Specific to This Standard*:

3.1.1. *Arrhenius parameter* (a_1)—the constant coefficient in the Arrhenius model for shift factors, $\ln(a_T) = a_1(1/T - 1/T_{\mathrm{ref}})$.

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

3.1.3. *coefficient of linear thermal expansion* (α)—the fractional change in size in one dimension associated with a temperature increase of 1°C.

3.1.4. *conventional unmodified asphalt binders*—asphalt binders for which the following two conditions are satisfied: (1) The difference between the temperature at which $S(60) = 300$ MPa and m-value $(60) = 0.300$ is less than or equal to ±2.0°C. The $S(60)$ and the m-value are determined using the T 313 BBR test; (2) The failure strength determined using T 314 must be within 3.77 ± 0.77 MPa.

3.1.5. *creep compliance* [$D(T,t)$]—the reciprocal of the stiffness of a material, $1/S(T,t)$, at temperature, T, and time, t. Creep compliance may also be expressed using reduced time, ξ, as $D(T_{\mathrm{ref}}, \xi)$.

3.1.6. *critical cracking temperature* (T_{cr})—the temperature, estimated using this standard practice, at which the induced thermal stress in a material exceeds its fracture stress. The critical cracking temperature is a "single event cracking" limit prediction that does not include the effect of low-temperature thermal fatigue.

3.1.7. *failure stress* (σ_f)—the tensile stress value at the point of failure obtained from T 314.

3.1.8. *glassy modulus*—the modulus at which the binder exhibits glass-like behavior, assumed to be 3×10^9 Pa for this procedure.

3.1.9. *induced thermal stress* (σ_{th})—the stress induced in a material by cooling it while it is restrained so that it cannot contract.

3.1.10. *master curve*—a composite curve at a single reference temperature, T_{ref}, which can be constructed by shifting, along the log time or log frequency axis, a series of overlapping modulus data curves at various test temperatures. The modulus data curve at the reference temperature is not shifted. The shifted smooth curve is called the master curve at the reference temperature.