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Glossary of Terms

- Absolute pressure, Pa** Pressure referenced to an absolute or complete vacuum. Absolute pressure is zero for a complete or absolute vacuum and increases as the pressure is increased to atmospheric pressure. (9)
- Aging** Process whereby the properties of the asphalt binder change with time due to the effects of the construction process or the environment. (9)
- Angular rotation, radian** Rotation of one DSR plate with respect to the other, expressed in degrees or radians. During a DSR test the rotation may be only a few degrees, alternating from clockwise to counter clockwise. (11)
- Annealing** The process of heating an asphalt binder until it is sufficiently fluid to pour. The heating removes any reversible steric hardening caused by associations between the molecules. (11)
- Apparent viscosity, Pa-s⁻¹** The viscosity obtained by dividing shear stress by shear rate for a non-Newtonian fluid reported at the corresponding shear stress or shear rate. (10)
- Asphalt binder** Includes both modified and unmodified asphalt cements. Modifiers added to the asphalt cement are restricted to non-particulate organic modifiers with largest dimension no greater than 250 μm . (1, 5, 6, 9, 11, 12)
- Asphalt cement** Dark brown to black cementitious material in which the predominant constituents are components that occur in nature or are obtained in petroleum processing. Restricted to materials that have been produced or supplied without modification. (1, 5, 6, 9, 11, 12)
- Asphaltenes** A fraction of asphalt cement that is large in molecular size and highly polar. When separated, a dark brown solid. (1)
- Barometric pressure, Pa** Atmospheric pressure measured relative to an absolute vacuum. At sea level and 25°C, the barometric pressure for dry air is 29.92 inches of Hg, 760 mm of Hg, 101.3 kPa, or 14.7 psig. (9)
- Bituminous** Refers to a substance, natural or manufactured, composed principally of high molecular weight hydrocarbons of which asphalt cement, pitches, and tars are examples. (5)
- Blown asphalt** An asphalt cement that has been oxidized and consequently hardened by passing air through an asphalt cement at an elevated temperature. (1)
- Bottom-up cracking** Fatigue cracking that initiates at the bottom of the pavement structure, typically at the edge of the wheel path and parallel to the line of traffic. (5)
- Calculated stiffness, Pa** The stiffness (BBR) calculated by fitting a curve to the measured values of the logarithm of stiffness plotted versus the logarithm of time. (12)
- Calibration (AASHTO PP 57, Section 3.2)** Process whereby relation between the values indicated by a measuring instrument or device are related to a reference material or to some values as determined by a process in the respective standard. NIST traceability and measurement uncertainty (dispersion) are required. (4)
- Calibration certificate** A certificate issued by a certifying agency to include a statement of NIST traceability and uncertainty. (4)
- Certificate of Analysis (COA)** A document issued by the supplier of an asphalt binder

certifying that the asphalt binder meets the appropriate specification requirements. (1)

Classification The process of determining the grade of an asphalt binder that has not been previously graded. Same as grading an unknown. (6)

Complete immersion thermometer A liquid-in-glass thermometer designed to indicate temperatures correctly when the entire thermometer is exposed to the temperature being measured. (4)

Complex shear modulus, Pa (G^*) The ratio formed by dividing the peak-to-peak shear stress that occurs during a DSR loading cycle by the peak-to-peak shear strain that occurs during the same loading cycle, kPa. (11)

Compression Implies pushing, compressing, or shortening. Occurs when load is applied perpendicular to the direction of the resulting displacement. (2)

Conditioning Used to describe a laboratory method of practice, such as the RTFOT or PAV, during which aging that occurs in the field is simulated. Conditioning is used throughout AASHTO R 28 to differentiate the laboratory simulation of aging from aging as it occurs in the field. (9)

Consistency The resistance of a material to deformation (strain) caused by the application of force (stresses). (2, 5)

Contact load, N A load applied to the BBR test specimen immediately prior to the application of the test load. The contact load provides assurance that the loading head is in contact with the test specimen at the start of the test. (12)

Continuous grade Grade based on the temperature at which the grading criteria are met, for example PG 65.2-18.9, sometimes called true grade. (6)

Continuous temperature (T_{CONT}), °C Temperature at which the specification requirements are met, e.g., for a 64-XX binder T_{CONT} for the RFTOT residue may be 63.7°C. At this temperature, $G^*/\sin\delta$ is equal to 2.20 kPa. Same as critical temperature. (6)

Creep compliance, Pa⁻¹ Ratio formed by dividing strain at a specified time by the corresponding stress. Inverse of stiffness. (2)

Critical cracking temperature (T_{CR}), °C Temperature at which the tensile strength of the asphalt concrete mixture is equal to the thermal shrinkage stresses caused by lowering the pavement temperature. AASHTO PP 42 and ASTM D6816 give the procedures needed for calculating T_{CR} . (6)

Critical temperature (T_{C}), °C Temperature at which the specification requirements are met, e.g., for a 64-XX binder T_{C} for the RFTOT residue may be 67.3°C. At this temperature $G^*/\sin\delta$ is equal to 2.20 kPa. Same as continuous temperature. (5, 6)

Cross-link Process whereby many small molecules combine to form a single large molecule. (1)

Cumulative damage Refers to pavement damage that accumulates as a result of repetitive loading. (5)

Determining unknown grade Process whereby the grade of asphalt binder that has not been graded previously is determined. Also referred to as classification. (6)

Display temperature Refers to the temperature measured by a thermometric device internal to the test instrument. (10, 11)

Dummy test specimen An asphalt binder or other polymer placed between the DSR test plates and into which a thermal probe is inserted. (11)

Elastomer Natural or synthetic polymer having rubber-like properties and substantially recovering its size and shape after removal of a deforming force. (1)

Electronic thermometer A thermometer that is based upon the measurement of the electricity generated by its sensor (thermocouple). (4, 11)

emf An abbreviation for electro-motive force. As applied to thermocouples or electronic thermometers, the voltage produced when two dissimilar metals are joined. (4)

Empirical Based on observation and experiment rather than on fundamental properties. Empirical properties typically depend on size of test specimen and test equipment, e.g., penetration test. (5)

Equiviscous temperature, °C An asphalt binder-specific temperature at which

an asphalt binder exhibits a specified viscosity. (10)

Estimated stiffness, MPa Value of stiffness (BBR) calculated from an equation that describes the logarithm of stiffness versus the logarithm of time. (12)

External thermometer A thermometer that is external to a test device and that may be used to verify the standardization or calibration of an internal thermometric device. The thermometric device includes a thermal sensor, wiring, and associated electronics. (4)

Fatigue cracking Cracking caused by repeated loading at stress levels lower than those that cause cracking under a single load application. (5)

Flexural creep A method of test in which a constant load (stress) is applied to a test specimen and the resulting deflection (strain) is measured with time. (12)

Fractional distillation Process of separating a volatile liquid into fractions based on its boiling point. (1)

Fundamental mechanical property Property that is defined in terms of fundamental units (see SI) and is independent of the dimensions of the test device or tested specimen. (2, 5)

Gauge pressure, Pa Pressure relative to atmospheric pressure. Gauge pressure reads zero at atmospheric pressure regardless of altitude. (9)

Hertz (Hz), s⁻¹ Unit of cyclic frequency, one Hertz is one complete loading cycle per second, e.g., 20 Hz is equal to 20 loading cycles per second. One Hz is equal to 2π rad/s (6.2832 rad/s). (11)

HMAC Hot-mix asphalt concrete (1)

Ice point The freezing point of water at sea level, 0.00°C. See ASTM 563. (4)

In-service aging Aging that occurs in the binder in the field during the service life of a pavement. (9)

Internal thermometer A thermometer (thermometric device) that is internal to a device and that cannot be routinely or conveniently removed from the device for the purposes of standardization or calibration. The thermometer includes its

thermal sensor, wiring, and associated electronics. (4)

Laboratory reference thermometer A calibrated NIST traceable thermometer (thermometric device) that is typically reserved for the purpose of verification or standardization and not used for day-to-day measurements or as a “working thermometer.” Typically stored in a protected location and not used for everyday measurements. (4, 8, 9, 10, 11, 12)

Linear viscoelastic Material exhibits both viscous and elastic behavior and the modulus is independent of the test load. (11)

Linear Refers to a modulus or mechanical property when the mechanical property is independent of load, i.e., a constant ratio between stress and strain. (2)

Link The metal wire that connects the spindle to the viscometer (RV) shaft. (10)

Loading cycle As applied to the DSR, the rotation of the upper plate with respect to the fixed lower plate. A cycle starts at the zero position, rotates to its maximum position in one direction, back through zero to the other maximum position, and returns to the zero position. (11)

Loading time The time that a load is applied; the total amount of time that a load is applied to a test specimen. (12)

Long crude Residue from atmospheric distillation. (1)

Long-term aging Refers to the aging of asphalt binders that occurs in the field during service over five or more years. (5, 9)

Mass change The change in mass that occurs during the RTFOT test. A negative sign indicates a decrease in mass and a positive sign indicates a mass gain. (8)

Mass loss A term used in previous editions of the AASHTO and ASTM versions of the RTFOT. This term was often confusing because the meaning of a negative loss was not clear. The term mass loss has been replaced by mass change. (8)

Measured stiffness, MPa The ratio (BBR) obtained by dividing the measured stress by the measured strain at preselected loading times. (12)

Mechanical property A material property that provides the relationship between load (stress) and displacement (strain). (2)

Meniscus The curved surface where a liquid intersects the walls of a container as in a mercury thermometer. (4)

Modulus, Pa Ratio formed by dividing stress by corresponding strain. (2)

Morphology Implying the molecular structure of an asphalt binder. (1)

m-value The slope of the stiffness curve plotted versus the logarithm of time in seconds. The slope is always taken as positive value. (12)

NIST National Institute for Science and Technology, formerly the Bureau of Standards. The national reference laboratory for standards, it provides high-level calibration services to calibration agencies and manufacturers. (4)

Normal force, N A force applied perpendicular to the area upon which the force is applied. For example (DSR), the vertical force created when the gap is closed on the DSR. (11)

Oils A very fluid (low viscosity), sometimes colorless fraction of asphalt cement that is non-polar. (1)

Oxidation Process of reacting with oxygen. When oxidation occurs in asphalt cement the molecules increase in size and polarity resulting in nonreversible stiffening. (3)

Oxidation Process whereby an oxygen molecule reacts with one or more asphalt cement molecules. Oxidation can occur during handling, during accelerated laboratory aging, during construction, or during service. (9)

Parallax A liquid-in-glass thermometer reading error created when the line of sight is not perpendicular to the thermometer stem. (4)

Parallel plate geometry Refers to the testing configuration used in the DSR test method where the asphalt binder is sandwiched between two rigid parallel plates. (11)

Partial immersion thermometer A liquid-in-glass thermometer designed to indicate temperatures correctly when the bulb and

a specified part of the stem are exposed to the temperature being measured. (4)

Pavement design temperature (T_{DES}), °C

A temperature based on weather records or engineering judgment that is used for pavement design purposes. An upper and lower temperature are used for design purposes. (5, 6)

Pavement performance Refers to the serviceability of the pavement from the perspective of the user. (2)

Phase angle, radians or degrees Used to quantify the lag that occurs between an applied stress (or strain) and the resulting strain (or stress), degrees. (11)

Physical hardening Reversible stiffening of an asphalt binder that occurs below room temperature; reversed by heating to room temperature. (3, 12)

Plastomers Refers to asphalt cement modifiers that are plastic-like. Materials that are typically solid at room temperature but melt when added to an asphalt cement at mixing temperatures, e.g., polyethylene. (1)

Portable (working) thermometer Used in several test methods to describe a thermometric device that is used for everyday measurements, can be moved about the laboratory, and is used to transfer measurements from a laboratory reference standard to a thermoelectric device that is integral with a testing device. (4, 9, 10, 11, 12)

PRT An abbreviation for platinum resistance thermometer, a resistance thermometer (thermometric device) that uses a platinum element as the temperature sensor. (4)

Radian Used to describe the test frequency. One complete loading cycle is 2π radians ($\pi = \text{pi} = 3.1416$). Multiply test frequency in Hertz (cycles per second) by 6.28 to obtain frequency in radians per second (rad/s). (2, 11)

Random sample A sample that is taken using a procedure whereby each sample obtained from the lot has an equal probability of being selected. (3)

Reference fluid A fluid with a known property (viscosity, DSR) and traceable to a NIST standard. (11)

Representative sample Selected by some process, which may or may not be random, that gives all samples an equal chance of appearing to represent the population. (3)

Resins The largest fraction of an asphalt cement, when separated dark in color, highly viscous and polar in nature. (1)

Resistance thermometer A thermometric device for determining temperature by measuring the electrical resistance of a standardized material exposed to that temperature. The resistive element may be a platinum element or a thermistor. The element is typically protected by a metallic or other covering (sheath). (4)

Response time, s Also see rise time. The time required for a sensor to change a specified percentage of the total difference between its initial and final temperatures when subjected to a specified and sudden change in temperature. (4)

Rheometer A device that measures flow (rheo as in flow plus meter as in to measure). Used to characterize materials with mechanical properties that are loading time dependent. (5)

Rise time, s Rise time is used to specify the transient response of a thermometer, and is similar to its time constant, or response time. Amount of time required for a thermometer to reach a specified percent of its equilibrium reading given a specified increase in temperature. Refer to the appropriate thermometer standard or manufacturer's product sheet for thermometer-specific specifications. (4)

RTD Abbreviation for resistance thermal detector including those based on platinum or other resistive metals. By itself it is not a thermometer.

Rutting Permanent deformation in a pavement caused by repeated traffic loads and an HMAC mixture with inadequate shearing resistance. Evidenced by the formation of ruts in the wheel path. (5)

Sample chamber The aluminum (disposable) or steel (non-disposable) cylindrical tube into which the binder is poured (RV). (10)

Seating load A one second load (BBR) applied immediately after the contact load

and used to ensure that the test specimen is properly seated on the supports. (12)

Self-heating Occurs when the temperature of a resistive thermal element (thermistor or platinum element) increases as a result of an externally measurement current. (4)

Shear Implies a sliding action within a material. Process whereby a load is applied parallel to the direction of the resulting displacement. (2)

Short crude Residue from vacuum distillation. (1)

Short-term aging Aging that occurs in an asphalt binder at above ambient temperatures as a result of mixing, transport and storage, laydown, and compaction. (5)

Shoving Permanent deformation in a pavement caused by repeated traffic loads and an HMAC mixture with inadequate shearing resistance. Typified by a washboard effect with ripples transverse to the pavement. (5)

SHRP Plus Refers to specification requirements in addition to the SuperPave requirements of AASHTO M 320 or ASTM D6373. (6)

Single event thermal cracking Occurs when the pavement temperature reaches the critical cracking temperature as a result of a single thermal cycle. (5)

Specification temperature (T_{SPEC}), °C The temperatures that are used to generate different PG grades are referred to as specification temperatures. For example, the upper, intermediate, and lower specification temperatures for a PG 70-28 are 70°C, 25°C, and -28°C, respectively. (6)

Spindle The cylinder-shaped component that is submerged in the hot asphalt binder during a test. In ASTM this is referred to as the apparatus-measuring geometry—a cumbersome term! (10)

Standardization (AASHTO PP 57, Section 3.7) Process that determines the correction to a measuring system or instrument or the adjustment that must be made when compared to a standard reference material. No adjustment is made to the device and a measure of uncertainty (measurement dispersion) is not made. (4)

Steric hardening Reversible stiffening of an asphalt binder that occurs at room temperature; reversed by heating the binder until it is sufficiently fluid to pour. (3, 11)

Stiffness, Pa Ratio (BBR) formed by dividing stress at a specified time by the corresponding strain. Inverse of stiffness. (2)

Strain sweep A series of measurements taken at different strain levels but at single values of frequency and temperature. In the DSR test method measurements are taken from two to twelve percent strain in increments of two percent. (11)

Strain Ratio formed by dividing displacement caused by applied load by the distance over which the displacement occurs. Considered unitless. (2)

Stress, Pa Force (load) divided by area; tension, compression or shear. (2)

Stretch grades This term relates to the “stretching” of the temperature difference between the upper and lower specification temperature. For example, this difference is 104°C for a PG 76-28 and 86°C for a PG 64-22. Grades with a temperature difference (UTI) of 92°C or more are referred to as stretch grades. Binders with a UTI of 92 may be modified while binders with a UTI of 98 or more will most definitely be modified. (6)

Système International d’Unités (SI)
International system of units based on the following units: meter, kilogram, second, Newton, Pascal and °C. (2, 9, 11)

Temperature controller An electronic device that is used to control temperature. Consists of a thermal probe and associated electronics. (10)

Temperature correction, °C The difference between the temperature of the test specimen (DSR) and the temperature indicated by the internal thermometric device. (11)

Temperature offset Same as temperature correction. (11)

Temperature spread, °C See UTI. (6)

Tension Implies pulling, stretching or elongation. Occurs when load is applied

perpendicular to the direction of the resulting displacement. (2)

Test load, N Load applied during the duration of the test (DSR) and that is used to calculate the stress which is subsequently used to calculate the stiffness. (12)

Test thermometer Used to indicate the thermometer that is supplied as part of the device and typically internal to the device. Same as internal thermometer. More correctly test thermometric device or internal thermometric device. (8, 9)

Thermal chamber A temperature-controlled chamber into which a sample and its container or fixtures are inserted. (10, 11)

Thermal equilibrium Occurs when the temperature, including any thermal gradients present, remains constant with time. (4, 11)

Thermal fatigue cracking Occurs when the pavement temperature repeatedly cycles to temperatures that are above the critical cracking (single event) temperature. (5)

Thermal gradients Present when the temperature within a body is not uniform, not to be confused with thermal equilibrium. (4)

Thermal lag An effect that occurs in a body or device during temperature fluctuations in which the temperature at one point lags behind the temperature at some other point in the body or device. (11)

Thermal probe A thermal sensor (thermocouple, platinum element, or thermistor) housed in a protective sheath. (4)

Thermal sensor A thermocouple or a metallic or ceramic element that changes resistance with temperature. (4)

Thermal shrinkage cracking Caused by a single thermal event or repeated thermal cycling. See also thermal fatigue cracking and single event thermal cracking. (5)

Thermal well A mass that is a good conductor of heat into which one or more thermal probes can be inserted. (9)

Thermistor A ceramic element (semiconductor) that changes resistance with temperature. (4)

Thermoelectric thermometer Thermometer that uses a measure of electricity to measure

temperature; a device with a thermocouple temperature sensor. (4, 10, 12)

Thermometer Any device used for measuring temperature. Usage is increasingly being reserved only for liquid-in-glass devices. (4)

Thermometric device (TMD) Any device used to measure temperature, same meaning as thermometer (thermo for temperature and metric for measurement). (4, 9, 10, 11, 12)

Thin film A relative term used to define the thickness of an asphalt binder film. The film created in the rotating RTFO bottles is considered to be a thin film. A several millimeter thick residue in the bottom of a container would be considered a thin film. For the purposes of handling procedures, thin describes an asphalt binder layer that is sufficiently thin so that oxygen can readily diffuse into and saturate the asphalt binder and thereby contribute to oxidation. (3, 8)

Top-down cracking Fatigue cracking that initiates at the top of the pavement, parallel and to the side of the wheel tracks. (5)

Torque, $N \times m$ Force multiplied by a lever arm used to apply the force. Consider the application of the force when tightening a nut with a wrench. The force applied to the end of the wrench multiplied by the length of the wrench is the torque. The longer the wrench the greater the torque. (2)

Total immersion thermometer A liquid-in-glass thermometer designed to indicate temperatures correctly when just that portion of the thermometer containing the liquid is exposed to the temperature being measured. (4)

Transverse cracks Cracks that occur across the pavement. Associated with thermal cracking. (5)

True grade PG grade based on the temperature at which the grading criteria are met, e.g., PG 65.2-18.9. See continuous grade. (6)

Uncertainty Similar to standard deviation. Describes the dispersion of measurements and is used to judge the suitability of a device for its intended purpose. (4)

Useful temperature interval (UTI), °C The difference between the upper grading temperature and lower grading temperature.

The UTI for a PG 64-28 is 92°C. The UTI for a PG 65.2-18.9 is 84.1°C. (6)

Verification of calibration (AASHTO PP 57, Section 3.10) Process that determines if a previously calibrated instrument is in control (i.e., still properly calibrated). Used to maintain traceability, verification data should be maintained in a control chart. (4)

Verification of grade Process whereby the grade of an asphalt binder that has been graded previously is verified. See classification. (6)

Verification of standardization (AASHTO PP 57, Section 3.11) Process that determines if a previously standardized instrument is in control (i.e., still properly calibrated). Used to maintain traceability, verification data should be maintained in a control chart. (4)

Viscoelastic A type of material behavior that includes both viscous and elastic behavior. The moduli for viscoelastic materials are time dependent. (2)

Viscometer A device that measures viscosity. (5, 10)

Volatilization Process whereby lighter weight (more volatile) molecules evaporate from the asphalt binder. Accelerated by heating and results in nonreversible stiffening of asphalt binders. (3)

Working thermometer Used in this manual to describe a thermometric device that is used for everyday measurements, can be moved about the laboratory, and is used to transfer measurements from a laboratory standard to a thermometric device that is integral with a testing device. Called portable thermometer in some test methods. (4, 8, 9, 10, 11, 12)