Designation: X XXXX-XX

Work Item Number: 0

Date: 0

Include Ballot Rationale Here (Required for all Ballots)

Standard Test Method for
Asphalt Mixture Workability Index[1]

This standard is issued under the fixed designation X XXXX; 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 test method covers the testing of asphalt pavement mixtures such as Warm Mix Asphalt (WMA), Hot-Mix Asphalt (HMA), and Polymer Modified Hot-Mix Asphalt to establish the relative workability (compactability) at paving temperatures. This test can be performed on a modified Superpave Gyratory Compactor (SGC) or other suitable loading frame meeting the requirements outlined in the apparatus section.

1.2 The values stated in SI units are to be regarded as the 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:*

[1] This test method is under the jurisdiction of ASTM Committee *D04* and is the direct responsibility of Subcommittee *20*.

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D 979/D 979M-12 Standard Practice for Sampling Bituminous Paving Mixtures

D 3665 Standard Practice for Random Sampling of Construction Materials.

D 3666 Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials

D 4402 Test Method for Viscosity Determination of Asphalt at Elevated Temperatures Using a Rotational Viscometer

D 4753 Guide for Evaluating, Selecting, and Specifying Balances and Standard Masses for Use in Soil, Rock, and Construction Materials Testing ANSI B46.1

D 6925 Test Method for Preparation and Determination of the Relative Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor

2.2 *AASHTO Standards:*

AASHTO PP2 Practice for Short and Long Term Aging of Hot Mix Asphalt (HMA)

3. Terminology

3.1 *Definitions:*

3.1.1 Workability, n— a rheological property that quantifies the effort required to manipulate an un-compacted asphalt mixture with minimum loss of homogeneity (without segregation).

DISCUSSION— The term manipulate refers to operations such as mixing, handling, and placement at the construction site. A mixture that requires less effort (lower force) has a higher workability than a material which requires more effort (higher force) to be directed into the desired shape. Workability is a temperature dependent characteristic for asphalt concrete mixtures.

NOTE—This definition differs from that offered by ASTM D6704.

3.1.2 Compactability, n— a rheological characteristic of an un-compacted asphalt mixture describing how much effort is required to achieve consolidation in an unconfined condition.

DISCUSSION— The effort required to achieve consolidation influences when the material can be properly consolidated without flowing and thus impacts construction rolling techniques. Compactability is a temperature dependent characteristic for asphalt mixtures.

NOTE—Workability and compactability are interrelated temperature dependent characteristics for asphalt mixtures; however, two mixtures with the same laboratory workability may not have the same field compactability.

4. Summary of Test Method

4.1 An un-compacted (loose) asphalt mixture material specimen, conditioned at a pre-described temperature, is confined to a cylindrical steel mold while a consolidation pressure is applied at controlled travel rates (rate of strain). The resulting stress versus strain response of the material is used to determine an index value representing the relative workability and compactability of the material at the test temperature. Materials are typically tested at more than one temperature.

4.2 The test result represents the relative ease at which at which a loose material develops into an organized structure that can withstand a stress at a given temperature. A high workability result is indicative of a material easily manipulated to a point in which it can withstand stress at the test temperature. A low workability result indicates a material which is more difficult to manipulate at the test temperature to a point it can withstand stress.

5. Significance and Use

5.1 The value obtained in this test provides a relative index which ranks the behavior of the loose material related to the effort required to place and compact the material during construction. The index can indicate the relative temperature performance of materials and may be applicable for predicting appropriate production and construction temperatures. Lower production and construction temperatures may result in energy savings, lower emissions which reduce workers exposure to harmful vapors, and also contribute to the reduction in the release of pollutants to the environment.

5.2 Results of materials tested at multiple temperatures used to predict lower paving temperatures can be applied to extend haul distances, expand ambient temperature limitations during placement (extend paving season), and determine construction requirements for proper placement without test strips to determine rolling requirements. The results may also be applicable for evaluating the warm mix additive levels and the effectiveness of such additives.

5.3 The information extracted during the test may be applicable to quality control procedures used to monitor production materials meet design requirements and consistency specifications. The measurement data may reflect changes to aggregate structure as well as binder quality and additive levels.

6. Interferences

6.1 Temperature is known to significantly influence the workability of asphalt pavement mixtures.

7. Apparatus

7.1 *Loading Frame*— A system capable of applying a force at a programmed rate of travel (velocity or strain rate) to a material specimen confined in a cylindrical mold of known diameter while simultaneously measuring and recording the applied force (stress), height of the material specimen, and time index. The system including an electromechanical, electro-hydraulic, or electro-pneumatic instrument comprised of the following system components: (1) reaction frame, and drive motor, (2) loading system and loading head, (3) force indicating and recording system, (4) position measuring and recording system, (5) mold and mold end plates.

NOTE—Some models of SUPERPAVE Gyratory Compactor modified to operate to the specified protocol have proven to be acceptable loading systems.

7.1.1 The loading system and force indicator shall be capable of applying and measuring a vertical force of at least 18kN which corresponds to up to 1000kPa on a 150mm diameter specimen. The axis of the loading ram shall be perpendicular to the platen of the loading frame. The force measurement and recording system shall be capable of measuring and recording the force to the nearest 10 Newton (pressure to the nearest 0.5 kPa).

7.1.2 The loading system shall be capable of providing the required rate of travel.

7.1.3 The position measurement and recording system shall be capable of measuring and recording the height of the specimen during the test process to the nearest 0.1 mm.

7.1.4 *Specimen Molds*—Specimen molds shall conform to the requirements of ASTM D6925. Molds shall be secured to the reaction frame throughout the test sequence.

7.1.5 *Mold End Plates*—*M*old end plates shall conform to the requirements of ASTM D6925.

7.2 *Data Acquisition*—The data acquisition system shall record at a minimum rate of 10 data sets per second throughout the test. Each data set shall include at minimum a time index (second), applied pressure (kPa) (or force (N) with specimen diameter (mm)), and specimen height (mm).

7.3 *Thermometers*—Armored or dial type thermometers with metal stems for determining the temperature of aggregates, asphalt binders, and asphalt mixtures between 10°C and 232°C, with a minimum sensitivity of 3°C. A means for measuring, recording, or otherwise indicating the specimen temperature at the completion of the test.

NOTE—Some loading systems may be equipped with instrumentation to measure and record the specimen temperature throughout the test.

7.4 *Tamping Rod*—A round, smooth, straight, steel rod with a diameter of 5/8 ± 1/16 and approximately 20 in. [500 mm] in overall length. The rod shall have the tamping end or both ends rounded to a hemispherical tip of the same diameter as the rod.

7.5 *Tamping Mallet*—A mallet with a rubber or rawhide head weighing 1.25 ± 0.50 lb [0.6 ± 0.2 kg] shall be used.

7.6 *Balance*—The balance shall have a minimum capacity of 10,000 g with a sensitivity of 0.1 g. The balance shall conform to Specification D 4753 as a Class GP2 balance.

7.7 *Ovens*—Two ovens are recommended for laboratory produced specimens. One oven shall be a forced draft oven capable of maintaining the temperature required, nominally 135°C, for short term aging. At least one more oven shall be available for heating aggregates, asphalt binders, and equipment. This oven shall have a range to a minimum of 204°C, thermostatically controlled to ± 3°C.

7.8 *Miscellaneous*—Miscellaneous equipment may include: flat bottom metal pans for heating aggregates; scoops for batching aggregates; containers for heating asphalt binders; mixing spoons; trowels; spatulas; welders gloves for handling hot equipment; 150 mm paper disks; lubricants for moving parts; laboratory timers; and mechanical mixers.

8. Reagents and Materials

8.1

9. Hazards

9.1 Use standard safety precautions and protective equipment when handling hot materials, hazardous materials, and testing material specimens.

10. Sampling, Test Specimens, and Test Units

10.1 Materials for laboratory produced specimens shall be sampled following procedure ASTM D 3665 Standard Practice for Random Sampling of Construction Materials.

10.2 Plant produced asphalt mixtures shall be sampled following procedure ASTM D 979/D 979M-12 Standard Practice for Sampling Bituminous Paving Mixtures.

10.3 Sample adequate materials to prepare specimens of approximately 4600 g. Mixture weights for specimens prepared in the laboratory vary with different aggregate sources and with different mix types.

11. Preparation of Apparatus

11.1 Molds and mold end plates shall be clean and free of damage prior to the start of each test.

12. Calibration and Standardization

12.1 Calibration of the following items shall be verified following the manufacturer's recommendations annually: applied force, measured height, time recorder, mold and mold end plate dimensions, oven temperature, and thermometer.

12.1.1 Verification of calibration shall be performed by the equipment manufacturer, agencies providing standardization services, or in-house personnel.

13. Preparation and Conditioning of Laboratory Prepared Material Specimens

13.1 Material samples are often tested at multiple temperatures to determine the workability index at each test temperature; therefore, multiple material specimens are typically used but are not required.

NOTE—Two material specimens are typically tested at each testing temperature with the results averaged.

13.2 Preparation of Aggregates—Weigh and combine the appropriate aggregate fractions to the desired specimen mass. Generally, 4600 g of aggregate are required for aggregates with combined bulk specific gravities in the range of 2.55 to 2.70. The final height of specimens of this mass will be approximately 130mm. If the test utilizes molds other than 150mm diameter, the mass shall be adjusted to achieve the desired specimen final height.

NOTE—Details of aggregate preparation may be found in any suitable mix design manual, such as the Asphalt Institute's MS-2.

NOTE—SUPERPAVE™ volumetric design specimens have been shown to be of appropriate mass.

13.3 Place the blended aggregate specimens and asphalt binder in an oven and bring to the required mixing temperature. Heat the mixing container and all necessary mixing implements to the required temperature.

13.4 The laboratory mixing temperature range is typically defined as the range of temperatures where the un-aged asphalt binder has a kinematic viscosity of 170 ± 20 mm2/s (approximately 0.17 ± 0.02 Pa-s for an asphalt binder density of 1.000 g/cm3) measured in accordance with Test Method D 4402.

NOTE—Modified asphalt binders, especially those produced with polymer additives, generally do not adhere to the viscosity ranges noted. The user should refer to the asphalt binder manufacturer to establish appropriate mixing and compaction temperature ranges. In no case should the mixing temperature exceed 175°C.

13.5 Charge the heated mixing bowl with the dry, heated aggregate and dry mix. Form a crater in the heated aggregate blend and weigh the required amount of asphalt binder into the aggregate blend. Immediately initiate mixing.

13.6 Mix the asphalt binder and aggregate as quickly and thoroughly as possible to yield an asphalt mixture having a uniform distribution of asphalt binder. Because of the large batch weights, a mechanical mixer is preferable for the mixing process.

13.7 Laboratory prepared material specimens require short term aging prior to testing.

13.7.1 After completing the mixing process, subject the loose mix to short-term conditioning according to AASHTO PP2 for 2 h ± 5 min at the conditioning temperature ± 3°C. Stir the mix after 60 ± 5 min to maintain uniform conditioning.

14. Preparation of Field Plant Mix Material Specimens

14.1 For samples of HMA plant-produced mix, the user must specify one of the following short-term aging conditions.

14.1.1 No conditioning, test immediately as produced once the specimen is at test temperature for a period of 15 minutes.

14.1.2 Another conditioning that the user can demonstrate will replicate the design conditioning.

15. Testing of Material Specimens

15.1 Bring the material specimen to the selected test temperature and hold for 15 minutes.

NOTE—A temperature offset may be required to help compensate for temperature loss during placement of material into the mold.

NOTE—For construction temperature prediction models, test temperatures are typically selected to achieve workability index values less than 150kPa or greater than 170 kPa. Depending on material type, the temperature for a DWT value less than or equal to 150kPa may range from 60°C (140°F) for Warm Mix Asphalt, 71°C (160°F) Hot Mix Asphalt, to 80°C (176°F) for Polymer Modified materials. The temperature to achieve a workability value greater than or equal to 170kPa may range from 104°C (220°F) for Warm Mix Asphalt, 120°C (248°F) Hot Mix Asphalt, to 150°C (302°F) for Polymer Modified materials. temper

15.2 Place the mold, mold end plates, and tamping rod into an oven at a temperature 3°C higher than the test temperature for a minimum of 45 min prior to the testing of the first specimen (during the time the mixture is in the conditioning process).

15.3 At the end of the conditioning period, bring the specimen to the desired test temperature.

15.4 Remove the loose mix specimen, mold, and mold end plates from the oven. Place a paper disk on the bottom end plate inside the mold to aid separation of the specimen after testing.

15.5 Quickly place the specimen into the mold in a single lift using a transfer bowl or other suitable device. Take care to minimize segregation of the mixture in the mold.

15.6 Rod the specimen with the heated tamping rod 15 strokes distributed around the perimeter and 10 strokes over the interior for a total of 25 strokes. The rodding should be to the full depth of the specimen.

15.7 After the sample is rodded, tap the outside of the mold in the area occupied by the specimen lightly 10 to 15 times with the mallet to close any holes left by rodding and to release any large air bubbles that may have been trapped.

15.8 Level the top of the specimen then place a second paper disk onto the material specimen to avoid material adhering to the top end plate.

15.9 Insert the top end plate into the mold if required.

15.10 Place the prepared specimen and mold into the loading frame and initiate the test sequence. The loading frame shall apply a force to the specimen at the specified rate until the desired final stress is achieved. Unless noted otherwise, loading rate shall be 0.05mm/s over the stress range of 40 kPa through 950 kPa.

15.11 Record the time, applied force, and specimen height every 0.1 seconds.

15.12 At the completion of the test profile, measure and record the temperature of the specimen. On systems equipped with temperature measurement instrumentation, record the specimen temperature throughout the test.

15.13 Remove the mold specimen assembly from the loading frame and remove the specimen from the mold.

NOTE—The material specimen may not be sufficiently compacted to remain intact when removed from the mold.

15.14 If the loading frame is a gyratory compactor, at the completion of the workability test profile, the material specimen may be compacted using gyratory compaction. Specimens compacted in this manner have the advantage of further evaluation.

16. Calculation or Interpretation of Results

16.1 Calculate the Normal Stress at each index point *n* for the test sequence:

$$\sigma_n = \frac{F_n}{A} \qquad Equation\ 1$$

Where,

σ_n = Stress at *n*, kPa
P_n = Force at *n*, kN
A = Area of cross-section, m^2
n = Time Index

16.2 Calculate the % Volumetric Strain at each index point *n* for the test sequence:

$$\varepsilon_n = \frac{h_0 - h_n}{h_0} * 100 \qquad Equation\ 2$$

Where,

ε_n = Volumetric Strain at *n*, %
h_n = Specimen Height at *n*, mm
h_0 = Specimen Height at stress level of 90kPa, mm
n = Time Index

16.3 Calculate the Dongre Workability Test Value (slope of stress vs. volumetric strain curve near 600 kPa):

$$DWT_T = \frac{\sigma_{650} - \sigma_{550}}{\varepsilon_{650} - \varepsilon_{550}} \qquad Equation\ 3$$

Where,

DWT_T = Workability at Temperature T, kPa
σ_{550} = Measured stress at index nearest 550 kPa, kPa
σ_{650} = Measured stress at index nearest 650 kPa, kPa
ε_{550} = Volumetric Strain at index nearest 550 kPa stress, %
ε_{650} = Volumetric Strain at index nearest 650 kPa stress, %

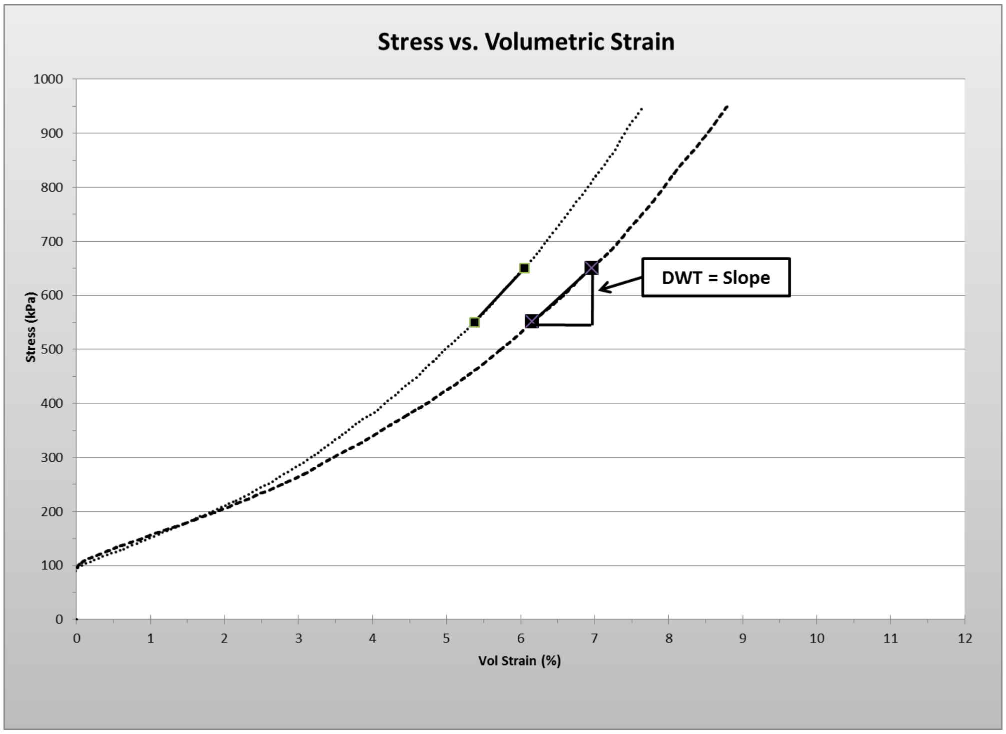

Figure 1: Stress vs. Volumetric Strain Chart

NOTE—Lower slope (less steep) reflects lower workability.

17. Report

17.1 For each specimen tested, the report shall contain the following information:

17.1.1 Date of test

17.1.2 Specimen Identification and Material information (mix type, etc.)

17.1.3 Specimen Temperature, °C

17.1.4 Specimen Workability (DWT) value, kPa

17.1.5 Name of the technician performing the test

18. Precision and Bias

18.1 *Precision*— The within-laboratory repeatability standard deviation has been determined to be ____, based on ____ labs, ____ test replicates, and ___ different samples. The between-laboratory reproducibility of this test method is being determined and will be available on or before (date). Therefore, this standard should not be used for acceptance or rejection of a material for purchasing purposes.

18.2 *Bias*— Bias has not been determined since there is no accepted reference material suitable for determining the bias for the procedure in this test method.

19. Keywords

19.1 **Bituminous paving mixtures, asphalt, compaction, workability, compactability, warm mix**

ANNEX

(Mandatory Information)

A1.

A1.1

A1.1.1

APPENDIX

(Nonmandatory Information)

X1.

X1.1

X1.1.1

REFERENCES

(1)