
Standard Specification for Balanced Mix Design

AASHTO Designation: MP 46-24¹

Technically Revised: 2024

**Technical Subcommittee: 2d, Proportioning
of Asphalt–Aggregate Mixtures**



**American Association of State Highway and Transportation Officials
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1. SCOPE

- 1.1. This specification for balanced mix design uses volumetric and/or performance-based/related test results to produce job-mix formulas for asphalt mixtures.
- 1.2. This standard specifies minimum performance testing requirements for balanced design of asphalt mixtures.
- 1.3. *This standard 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 determine the applicability of regulatory limitations prior to use.*

2. REFERENCED DOCUMENTS

- 2.1. *AASHTO Standards:*
 - PP 105, Balanced Design of Asphalt Mixtures
 - T 246, Resistance to Deformation and Cohesion of Hot Mix Asphalt by Means of Hveem Apparatus
 - T 283, Resistance of Compacted Asphalt Mixtures to Moisture-Induced Damage
 - T 320, Determining the Permanent Shear Strain and Stiffness of Asphalt Mixtures Using the Superpave Shear Tester
 - T 321, Determining the Fatigue Life of Compacted Asphalt Mixtures Subjected to Repeated Flexural Bending
 - T 322, Determining the Creep Compliance and Strength of Hot Mix Asphalt (HMA) Using the Indirect Tensile Test Device
 - T 324, Hamburg Wheel-Tracking Testing of Compacted Asphalt Mixtures
 - T 340, Determining Rutting Susceptibility of Hot Mix Asphalt (HMA) Using the Asphalt Pavement Analyzer (APA)
 - T 378, Determining the Dynamic Modulus and Flow Number for Asphalt Mixtures Using the Asphalt Mixture Performance Tester (AMPT)
 - T 393, Determining the Fracture Potential of Asphalt Mixtures Using the Illinois Flexibility Index Test (I-FIT)
 - T 394, Determining the Fracture Energy of Asphalt Mixtures Using the Semicircular Bend Geometry (SCB)
 - T 400, Determining the Damage Characteristic Curve and Failure Criterion Using the Asphalt Mixture Performance Tester (AMPT) Cyclic Fatigue Test
 - T 401, Cantabro Abrasion Loss of Asphalt Mixture Specimens

- T 419, Determining the Flexural Creep Stiffness of Asphalt Mixtures Using the Bending Beam Rheometer (BBR)
- TP 116, Rutting Resistance of Asphalt Mixtures Using Incremental Repeated Load Permanent Deformation (iRLPD)
- TP 133, Determining the Damage Characteristic Curve and Failure Criterion Using Small Specimens in the Asphalt Mixtures Performance Tester (AMPT) Cyclic Fatigue Test
- TP 134, Stress Sweep Rutting (SSR) Test Using the Asphalt Mixture Performance Tester (AMPT)
- TP 141, Determining the Indirect Tensile N_{flex} Factor to Assess the Cracking Resistance of Asphalt Mixtures

2.2. *ASTM Standards:*

- D7313, Standard Test Method for Determining Fracture Energy of Asphalt-Aggregate Mixtures Using the Disk-Shaped Compact Tension Geometry
- D7870/D7870M, Standard Practice for Moisture Conditioning Compacted Asphalt Mixture Specimens by Using Hydrostatic Pore Pressure
- D8044, Standard Test Method for Evaluation of Asphalt Mixture Cracking Resistance Using the Semi-Circular Bend Test (SCB) at Intermediate Temperatures
- D8225, Standard Test Method for Determination of Cracking Tolerance Index of Asphalt Mixture Using the Indirect Tensile Cracking Test at Intermediate Temperature

2.3. *Federal Highway Administration:*

- FHWA. Cyclic Fatigue Index Parameter (S_{app}) for Asphalt Performance Engineered Mixture Design. FHWA-HIF-19-091. Federal Highway Administration, U.S. Department of Transportation, Washington, DC, 2019. Available from <https://www.fhwa.dot.gov/pavement/pubs/hif19091.pdf>

2.4. *National Cooperative Highway Research Program:*

- Advanced Asphalt Technologies, LLC. *NCHRP Report 673: A Manual for Design of Hot Mix Asphalt with Commentary*. Project 9-33. National Cooperative Highway Research Program, Transportation Research Board, Washington, DC, 2011, pp. 142 and 144.
- Bonaquist, R. *NCHRP Report 691: Mix Design Practices for Warm Mix Asphalt*. Project 9-43. National Cooperative Highway Research Program, Transportation Research Board, Washington, DC, 2011, p. 80.
- Washington State University, Pennsylvania State University-Altoona, and Louisiana Transportation Research Center. *NCHRP Research Report 843: Long-Term Field Performance of Warm Mix Asphalt Technologies*. Project 9-49A. National Cooperative Highway Research Program, Transportation Research Board, Washington, DC, 2017.

2.5. *State Standards:*

- ALDOT-458, High Temperature Indirect Tensile Test for HMA
- NJDOT B-10, Overlay Test
- Tex-248-F, Overlay Test
- VDOT

2.6. *Other Documents:*

- Christensen, D. Analysis of Creep Data from Indirect Tension Test on Asphalt Concrete. *Journal of the Association of Asphalt Paving Technologists*, Vol. 67, 1998, pp. 458–492.
- Ghanbari, A., B. S. Underwood, and Y. R. Kim. Development of a Rutting Index Parameter Based on the Stress Sweep Rutting Test and Permanent Deformation Shift Model.

International Journal of Pavement Engineering, 2020. Available from
<https://doi.org/10.1080/10298436.2020.1748190>

- Hiltunen, D. R., and Roque, R. A Mechanics-Based Prediction Model for Thermal Cracking of Asphaltic Concrete Pavements (with Discussion). *Journal of the Association of Asphalt Paving Technologists*, Vol. 63, 1994.

3. TERMINOLOGY

- 3.1. *Definitions:*
 - 3.1.1. *ADT*—average daily traffic.
 - 3.1.2. *design ESALs*—design equivalent (80-kN) single-axle loads.
 - 3.1.3. *HMA*—hot mix asphalt.
 - 3.1.4. *NMAS*—nominal maximum aggregate size.
 - 3.1.5. *WMA*—warm mix asphalt.

4. SIGNIFICANCE AND USE

- 4.1. In conjunction with PP 105, this standard may be used to select and evaluate materials for balanced design of asphalt paving mixtures. This approach is only applicable to pavements with design traffic greater than 3 million ESALs or high stress non-highway applications.

5. RUTTING TESTS

- 5.1. Highway agencies should select one of the tests in this section.
- 5.2. *Asphalt Pavement Analyzer (APA) (T 340):*
 - 5.2.1. *Test Criteria*—Compare the test results with the criteria given in Table 1 (Note 1), or criteria specified by the state highway agency.

Table 1—Asphalt Pavement Analyzer Criteria

Traffic Level, million ESALs	Criteria
3 to <10	TBD
10 to <30	TBD
≥30	TBD

Note 1—Table X1.1 summarizes the APA criteria used by different state DOTs.

- 5.3. *Flow Number Test (T 378):*
 - 5.3.1. *Test Criteria*—Compare the test results with the criteria given in Table 2, or criteria specified by the state highway agency.

Table 2—Flow Number Test Criteria

Traffic Level, million ESALs	HMA Minimum Average Flow Number ^a	WMA Minimum Average Flow Number ^b
3 to <10	50	30
10 to <30	190	105
≥30	740	415

^a Recommended criteria from NCHRP Report 673.

^b Recommended criteria from NCHRP Report 691, p. 80.

5.4. *Hamburg Wheel-Tracking Test (HWTT) (T 324):*

- 5.4.1. *Test Criteria*—Compare the test results with the criteria given in Table 3, or criteria specified by the state highway agency (Note 2).

Table 3—Hamburg Wheel-Tracking Test Criteria

Traffic Level, million ESALs	Criteria
3 to <10	TBD
10 to <30	TBD
≥30	TBD

Note 2—Table X1.3 summarizes the HWTT criteria used by different state DOTs. Many agencies require a maximum rut depth at a certain number of passes or a minimum number of passes at a certain rut depth. In addition, several agencies have a minimum requirement for the moisture susceptibility parameter of stripping inflection point (SIP). It is also important to note that different test temperatures (ranging from 40 to 56°C) are currently being used by state DOTs. Future research should consider setting the test temperature based on the predicted design pavement temperature from the LTPP Bind software and establishing nationally accepted criteria that account for different design traffic levels.

5.5. *High Temperature Indirect Tensile Test (HT-IDT) (ALDOT-458):*

- 5.5.1. *Test Criteria*—Compare the test results with the criteria given in Table 4 or criteria specified by the state highway agency (Note 3).

Table 4—High Temperature Indirect Tensile Test Criteria

Traffic Level, million ESALs	Criteria
3 to <10	TBD
10 to <30	TBD
≥30	TBD

Note 3—The Alabama Department of Transportation requires a minimum HT-IDT strength of 20 psi at 50°C in a provisional specification, ALDOT-22-PS0165(2).

5.6. *Hveem Stability Test (T 246):*

- 5.6.1. *Test Criteria*—Compare the test results with the criteria given in Table 5, or criteria specified by the state highway agency (Note 4).

Table 5—Hveem Stability Test Criteria

Traffic Level, million ESALs	Criteria
3 to <10	TBD
10 to <30	TBD
≥30	TBD

Note 4—Table X1.4 summarizes the Hveem stability test criteria used by different state DOTs.

5.7. *Superpave Shear Tester (SST) (T 320):*

5.7.1. *Test Criteria*—Compare the test results with the criteria given in Table 6, or criteria specified by the state highway agency.

Table 6—Superpave Shear Test Criteria

Traffic Level, million ESALs	Max Permanent Shear Strain (%) ^a
3 to <10	3.4
10 to <30	2.1
≥30	0.8

^a Recommended criteria for the repeated shear at constant height test from NCHRP Report 673.

5.8. *Incremental Repeated-Load Permanent Deformation (iRLPD) (TP 116):*

5.8.1. *Test Criteria*—Compare the test results with the criteria given in TP 116, or criteria specified by the state highway agency.

5.9. *Stress Sweep Rutting (SSR) Test Using the AMPT (TP 134):*

5.9.1. *Analysis*—The test results from TP 134 can be imported to and processed by the FlexMAT™ program (available from FHWA) to calculate the Rutting Strain Index (RSI) parameter.

5.9.2. *Test Criteria*—Compare the test results with the criteria given in Table 7, or criteria specified by the state highway agency.

Table 7—Stress Sweep Rutting Test Criteria

Traffic Level, million ESALs	Max Rutting Strain Index (RSI) ^a
3 to <10	12
10 to <30	4
≥30	2
≥ 30 and slow traffic	1

^a Recommended criteria for the stress sweep rutting test from Ghanbari et al. (2020).

6. CRACKING TESTS

6.1. Highway agencies should select at least one of the tests in this section.

6.2. *BBR Mixture Bending Test (T 419):*

6.2.1. *Test Criteria*—Compare the test results with the criteria given in Table 8, or criteria specified by the state highway agency (Note 5).