Standard Method of Test for

Determining the Damage Characteristic Curve and Failure Criterion Using Small Specimens in the Asphalt Mixture Performance Tester (AMPT) Cyclic Fatigue Test

AASHTO Designation: TP 133-21[1]

Technically Revised: 2021 **Editorially Revised: 2021**

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 test method covers procedures for preparing and testing both laboratory-compacted and field-cored asphalt mixture specimens to determine the damage characteristic curve and fatigue analysis parameters via the direct tension cyclic fatigue test using the asphalt mixture performance tester (AMPT).

1.2. This standard is intended for dense-graded mixtures with nominal maximum aggregate size less than or equal to 19.0 mm (0.75 in.). Mixtures with a nominal maximum aggregate size greater than 19.0 mm (0.75 in.) should be tested following TP 107.

1.3. *This standard may involve hazardous material, operations, and equipment. This standard does not purport to address all safety problems 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.*

1.4. *The quality of the results produced by this standard are dependent on the competence of the personnel performing the procedure and the capability, calibration, and maintenance of the equipment used. Agencies that meet the criteria of R 18 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with R 18 alone does not completely assure reliable results. Reliable results depend on many factors; following the suggestions of R 18 or some similar acceptable guideline provides a means of evaluating and controlling some of those factors.*

2. REFERENCED STANDARDS

2.1. *AASHTO Standards*:

- M 320, Standard Specification for Performance-Graded Asphalt Binder
- M 332, Standard Specification for Performance-Graded Asphalt Binder Using Multiple Stress Creep Recovery (MSCR) Test
- PP 99, Preparation of Small Cylindrical Performance Test Specimens Using the Superpave Gyratory Compactor (SGC) and Field Cores
- R 18, Establishing and Implementing a Quality Management System for Construction Materials Testing Laboratories

- TP 107, Determining the Damage Characteristic Curve of Asphalt Mixtures from Direct Tension Cyclic Fatigue Tests
- TP 132, Determining the Dynamic Modulus for Asphalt Mixtures Using Small Specimens in the Asphalt Mixture Performance Tester (AMPT)

2.2. *Federal Highway Administration*:

- *Cyclic Fatigue Index Parameter* (S_{app}) *for Asphalt Performance Engineered Mixture Design*, FHWA-HIF-091, 2019.
- *Development of Asphalt Mixture Performance Related Specifications*, Final Report, FHWA Project No. DTFH61-08-H-00005, 2020.

2.3. *NCHRP Document*:

- *Equipment Specification for the Simple Performance Test System*, Version 3.0, Prepared for National Cooperative Highway Research Program, Transportation Research Board, National Research Council, Washington, DC, October 16, 2007.

2.4. *Other Documents*:

- Lee, K., S. Pape, C. Castorena, B. S. Underwood, and Y. R. Kim. Strain-Level Determination Procedure for Small-Specimen Cyclic Fatigue Testing in the Asphalt Mixture Performance Tester. In *Transportation Research Record 2673*. pp. 824–835, 2019.
- Li, X. and N. H. Gibson. Using Small Specimens for AMPT Dynamic Modulus and Fatigue Tests. *Asphalt Paving Technology*, Journal of the Association of Asphalt Paving Technologists, Vol. 82, pp. 579–615, 2013.

3. TERMINOLOGY

3.1. *alpha term* (α)—value corresponding to the slope of the relaxation modulus master curve which is used in the accumulation of damage with time.

3.2. *command load*—the load level that a user inputs to the control software of the AMPT equipment.

3.3. *cyclic fatigue index parameter* (S_{app})—the apparent damage capacity of the material.

3.4. *cyclic pseudo secant modulus* (C^*)—the secant modulus in stress–pseudo strain space for a single cycle. This pseudo modulus differs from C because it is computed using a steady-state assumption and is used only with cycle-based data.

3.5. *damage* (S)—the internal state variable that quantifies microstructural changes in asphalt mixtures.

3.6. *damage characteristic curve* (C versus S curve)—the curve formed when plotting the damage on the x-axis and the pseudo secant modulus on the y-axis. It defines the unique relationship between the structural integrity and amount of damage in a given mixture.

3.7. *dynamic modulus* ($|E^*|$)—the peak-to-peak stress divided by the peak-to-peak axial strain resulting from sinusoidal loading measured during the steady-state period.

3.8. *dynamic modulus ratio* (*DMR*)—the ratio between the fingerprint dynamic modulus and the dynamic modulus value from a master curve construction, both evaluated at the same temperature and frequency condition. This value is also used to characterize specimen-to-specimen variability.

3.9. *end failure*—specimen failure in which the macrocrack develops outside the range of one or more axial deformation sensors. Several example end failure locations are shown in Figure 1.