Standard Method of Test for

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

AASHTO Designation: TP 107-18 (2020)[1]

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

Release: Group 3 (July)

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1. SCOPE

1.1. This test method covers procedures for preparing and testing asphalt concrete mixtures to determine the damage characteristic curve and failure criterion via direct tension cyclic fatigue tests in the Asphalt Mixture Performance Tester (AMPT).

1.2. This standard is applicable to laboratory prepared specimens of mixtures with nominal maximum size aggregate less than or equal to 25.0 mm (0.98 in.). Mixtures with a nominal maximum aggregate size greater than or equal to 25.0 mm (0.98 in.) may experience lower success rates.

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.*

2. REFERENCED DOCUMENTS

2.1. *AASHTO Standards*:

- R 30, Mixture Conditioning of Hot Mix Asphalt (HMA)
- R 38, Preparation of Cylindrical Performance Test Specimens Using the Superpave Gyratory Compactor (SGC)
- R 62, Developing Dynamic Modulus Master Curves for Asphalt Mixtures
- R 84, Developing Dynamic Modulus Master Curves for Asphalt Mixtures Using the Asphalt Mixture Performance Tester (AMPT)
- T 342, Determining Dynamic Modulus of Hot Mix Asphalt (HMA)
- T 378, Determining the Dynamic Modulus and Flow Number for Asphalt Mixtures Using the Asphalt Mixture Performance Tester (AMPT)

2.2. *ASTM Standard*:

- E4, Standard Practices for Force Verification of Testing Machines

2.3. *Other Documents*:

- Kim, Y. R., et al. *Development of Asphalt Mixture Performance Related Specifications*, Final Report, FHWA Project DTFH61-08-H-00005, 2018.
- *National Cooperative Highway Research Report 629: Ruggedness Testing of the Dynamic Modulus and Flow Number Tests with the Simple Performance Tester*, Appendix E, Final Version of the SPT Equipment Specifications. NCHRP, Transportation Research Board, 2008.

3. TERMINOLOGY

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

3.2. *average rate of dissipated pseudo strain energy per cycle (G^R)*—parameter used in the failure criterion for fatigue performance which is generated from a pseudo strain energy density function relating pseudo strain and damage.

3.3. *complex modulus* (E^*)—a complex number that defines the relationship between stress and strain for a linear viscoelastic 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 concrete.

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 norm of the E^*, which is calculated by dividing the peak-to-peak stress by the peak-to-peak axial strain measured during the steady-state period.

3.8. *dynamic modulus ratio (DMR)*—the ratio between the dynamic modulus fingerprint 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. *failure cycle* (N_f)—the cycle in which the measured phase angle drops sharply after a stable increase during cyclic loading.

3.10. *fatigue analysis coefficients (K_1, K_2, K_3)*—fitting coefficients to describe the classical stress (or strain) versus cycles to failure relationship.

3.11. *phase angle* (φ)—the angle, expressed in degrees, between an applied sinusoidal stress and the resulting sinusoidal strain measured during the steady-state period.

3.12. *pseudo strain* (ε_R)—a quantity that is similar to strain but does not include time effects. Pseudo strain is calculated by solving the convolution integral of the strain and $E(t)$.

3.13. *pseudo secant modulus* (C)—the secant modulus in stress–pseudo strain space.

3.14. *relaxation modulus* ($E(t)$)—the quotient of the stress response of a material with time to a constant step amplitude of strain.