Standard Method of Test for

Determining the Fracture Energy of Asphalt Mixtures Using the Semicircular Bend Geometry (SCB)

AASHTO Designation: T 394-21[1]

Adopted without Revisions: 2021

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

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1. SCOPE

1.1. This test method covers the determination of the fracture energy (G_f) of asphalt mixtures by means of the semicircular bend geometry (SCB). The method also includes procedures for calculating fracture toughness (K_{IC}) and stiffness (S). The SCB specimen is a half disc with a notch (its length expressed in meters) that makes an angle α with the vertical axis of the disc. The SCB test can be used to determine mode I and mixed mode I and II stress intensity factors (Lim et al., 1993). In this standard, only mode I fracture toughness is addressed (α is equal to zero).

1.2. The procedures in this standard provide parameters that describe the fracture resistance of asphalt mixtures at low temperatures. These parameters are used in the new low-temperature module of the *Mechanistic Empirical Pavement Design Guide*.

1.3. These procedures apply to test specimens having a maximum aggregate size of 19 mm or less. Specimens shall be 150 ± 9 mm in diameter and 24.7 mm ± 2 mm thick. These procedures are valid at temperatures below the performance grade (PG) lower limit of the asphalt binder used to prepare the asphalt mixture plus 22°C.

1.4. *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 to determine the applicability of regulatory limitations prior to use.*

1.5. *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 DOCUMENTS

2.1. *AASHTO Standards*:

- M 320, Performance-Graded Asphalt Binder

- R 18, Establishing and Implementing a Quality Management System for Construction Materials Testing Laboratories
- T 166, Bulk Specific Gravity (G_{mb}) of Compacted Asphalt Mixtures Using Saturated Surface-Dry Specimens
- T 269, Percent Air Voids in Compacted Dense and Open Asphalt Mixtures
- T 312, Preparing and Determining the Density of Asphalt Mixture Specimens by Means of the Superpave Gyratory Compactor
- T 322, Determining the Creep Compliance and Strength of Hot Mix Asphalt (HMA) Using the Indirect Tensile Test Device

2.2. *ASTM Standards*:

- D3549/D3549M, Standard Test Method for Thickness or Height of Compacted Bituminous Paving Mixture Specimens
- D5045, Standard Test Methods for Plane-Strain Fracture Toughness and Strain Energy Release Rate of Plastic Materials
- D5361/D5361M, Standard Practice for Sampling Compacted Asphalt Mixtures for Laboratory Testing
- E399, Standard Test Method for Linear-Elastic Plane-Strain Fracture Toughness of Metallic Materials

3. TERMINOLOGY

3.1. *Definitions:*

3.1.1. *crack mouth*—portion of the notch that is on the flat bottom surface of the specimen, that is, opposite the notch tip.

3.1.2. *crack mouth opening displacement (CMOD)*—relative displacement of the crack mouth.

3.1.3. *load line displacement (LLD)*—the displacement measured in the direction of the load application.

3.1.4. *linear variable differential transformer (LVDT)*—sensor device for measuring linear displacement.

3.1.5. *semicircular bend (SCB) geometry*—a geometry that utilizes a semicircular specimen.

3.1.6. *fracture energy, G_f*—the energy required to create a unit surface area of a crack.

3.1.7. *stiffness, S*—the slope of the linear part of the ascending load-load line displacement curve.

3.1.8. *linear elastic fracture mechanics (LEFM)*—a method of fracture analysis for determining the stress required to induce fracture instability in a structure containing a crack-like flaw of known size and shape.

3.1.9. *mode I stress intensity factor, K_I*—the parameter used to characterize the mode I stress field in the vicinity of the crack tip in the LEFM analysis.

3.1.10. *mode I critical stress intensity factor, K_{IC}*—stress intensity factor corresponding to the initiation of the crack, also referred to as fracture toughness.