Designation: D 7313 – 07

Standard Test Method for Determining Fracture Energy of Asphalt-Aggregate Mixtures Using the Disk-Shaped Compact Tension Geometry[1]

This standard is issued under the fixed designation D 7313; 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 determination of fracture energy (G_f) of asphalt-aggregate mixtures using the disk-shaped compact tension geometry. The disk-shaped compact tension geometry is a circular specimen with a single edge notch loaded in tension. The fracture energy can be utilized as a parameter to describe the fracture resistance of asphalt concrete. The fracture energy parameter is particularly useful in the evaluation of mixtures with ductile binders, such as polymer-modified asphalt concrete, and has been shown to discriminate between these materials more broadly than the indirect tensile strength parameter (AASHTO T322, Wagoner[2]). The test is generally valid at temperatures of 10°C (50°F) and below, or for material and temperature combinations which produce valid material fracture, as outlined in 7.4.

1.2 The specimen geometry and terminology (disk-shaped compact tension, DC(T)) is modeled after Test Method E 399 for Plane-Strain Fracture Toughness of Metallic Materials, Appendix A6, with modifications to allow fracture testing of asphalt concrete.

1.3 The test method describes the testing apparatus, instrumentation, specimen fabrication, and analysis procedures required to determine fracture energy of asphalt concrete and similar quasi-brittle materials.

1.4 The standard unit of measurement for fracture energy is Joules/meter^2 (J/m^2) [inch-pound/inch^2 (in.-lbf/in.^{2})].

1.5 The text of this standard references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

1.6 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.7 *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:* [3]

D 8 Terminology Relating to Materials for Roads and Pavements

D 6373 Specification for Performance Graded Asphalt Binder

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

E 399 Test Method for Linear-Elastic Plane-Strain Fracture Toughness $\boldsymbol{K_{Ic}}$ of Metallic Materials

E 1823 Terminology Relating to Fatigue and Fracture Testing

2.2 *AASHTO Standard:*

AASHTO T322 Standard Method of Test for Determining the Creep Compliance and Strength of Hot Mix Asphalt (HMA) Using the Indirect Tensile Test Device[4]

3. Terminology

3.1 *Definitions*—Terminologies E 1823 and D 8 are applicable to this test method.

3.1.1 *crack mouth*—portion of the notch that is on the flat surface of the specimen, that is, opposite the notch tip (see Fig. 3).

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

3.1.3 *disk-shaped compact tension geometry*—a geometry that utilizes a disk-shaped specimen with a single edge notch as described in Test Method E 399.

3.1.4 *2 fracture energy, G_f*—the energy required to create a unit surface area of a crack.

[1] This test method is under the jurisdiction of ASTM Committee D04 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.26 on Fundamental/Mechanistic Tests.

Current edition approved March 15, 2007. Published April 2007.

[2] Wagoner, M. P., Buttlar, W. G., Paulino, G. H., and Blankenship, P., "Laboratory Testing Suite for Characterization of Asphalt Concrete Mixtures Obtained from Field Cores," *Journal of the Association of Asphalt Paving Technologists*, 2006.

[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[4] Available from American Association of State Highway and Transportation Officials (AASHTO), 444 N. Capitol St., NW, Suite 249, Washington, DC 20001, http://www.transportation.org.

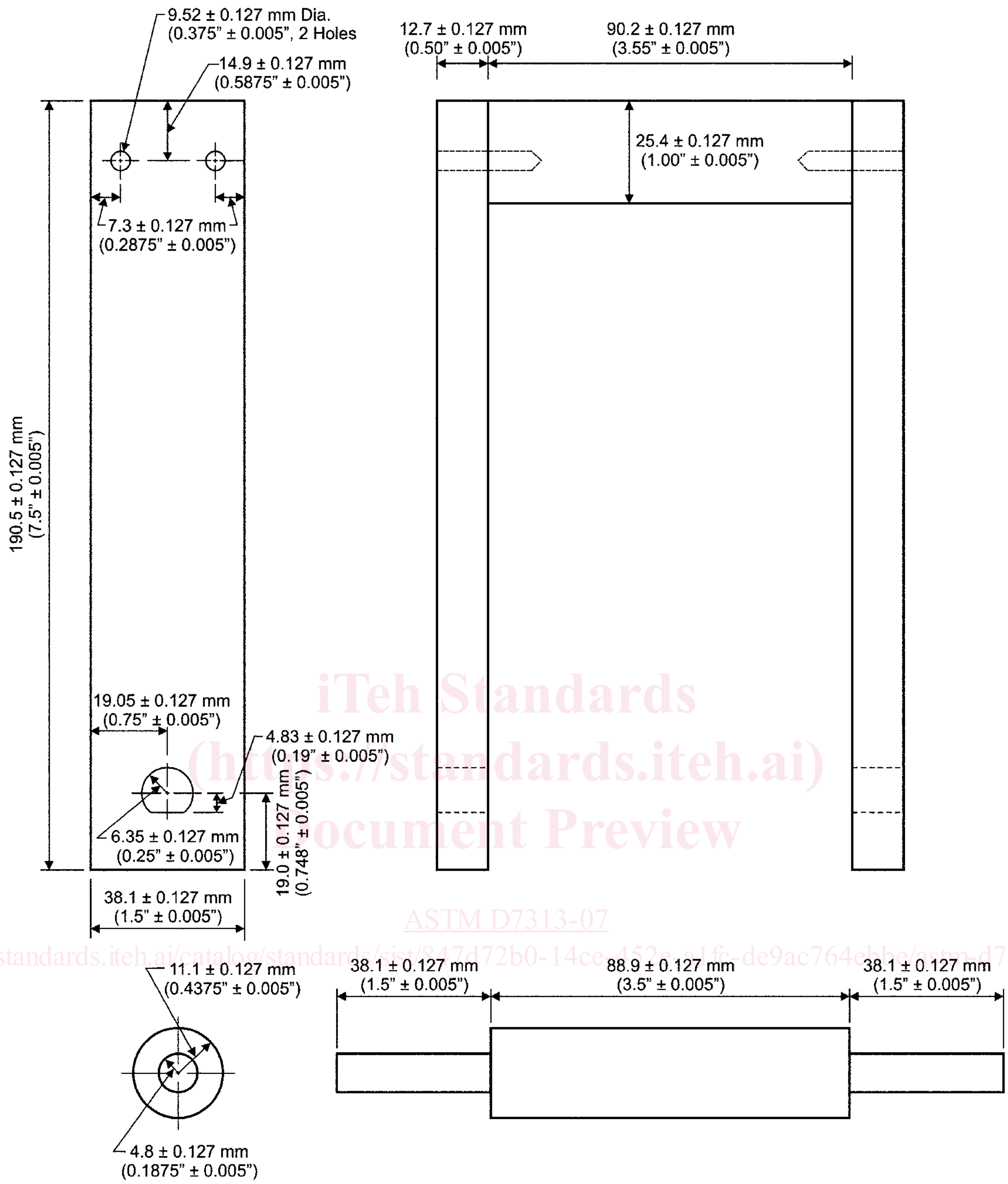


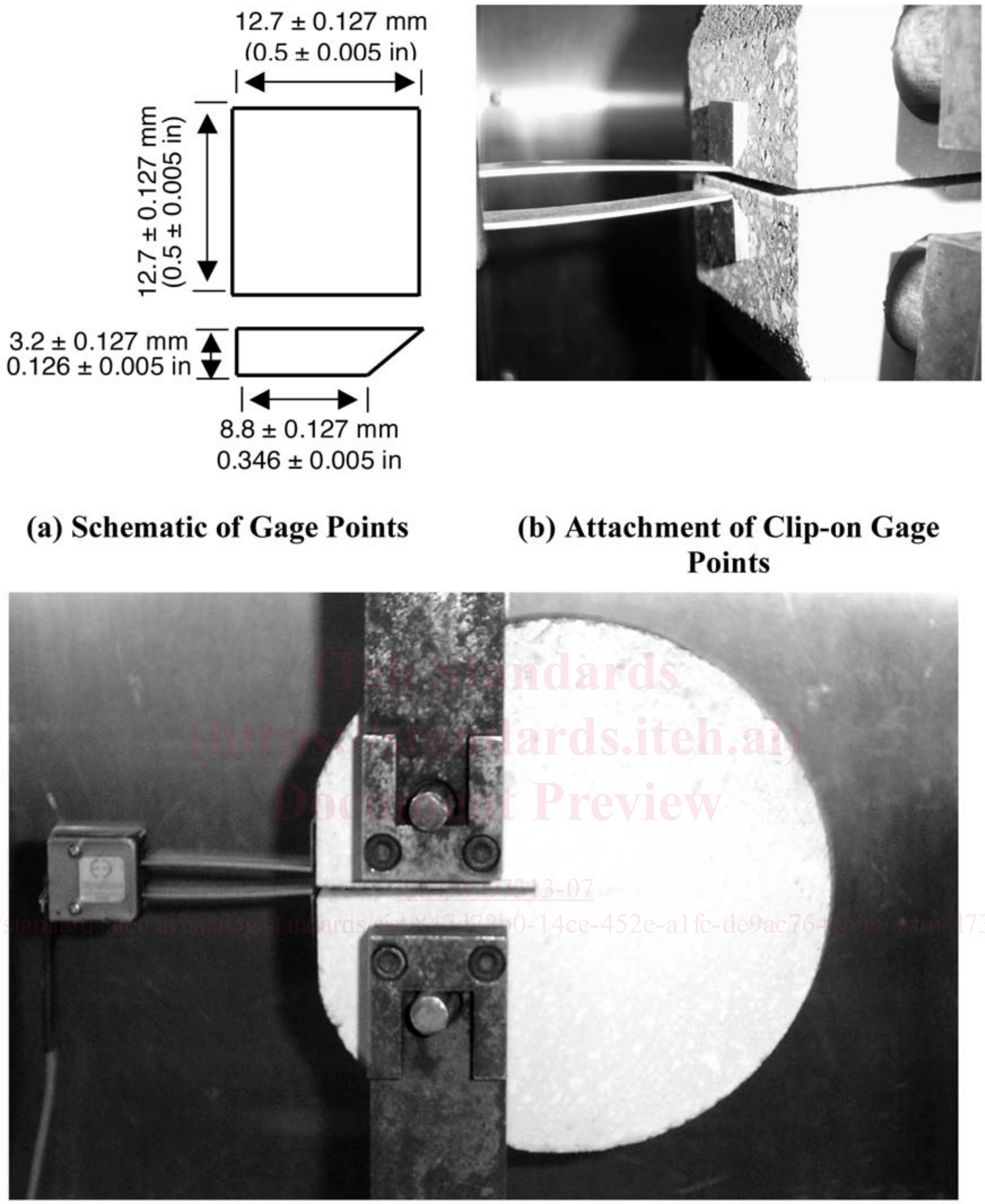
FIG. 1 Schematic of Loading Clevis

3.1.5 *notch tip*—end of notch where the crack will initiate and propagate.

4. Significance and Use

4.1 The test method was developed for determining the fracture resistance of asphalt-aggregate mixtures. The fracture resistance can help differentiate mixtures whose service life might be compromised by cracking. The test method is generally valid for specimens that are tested at temperatures of 10°C (50°F) or below (see Note 1). The specimen geometry is readily adapted to 150-mm diameter specimens, such as fabricated from Superpave® gyratory compactors (Test Method D 6925), that are used for the asphalt concrete design process. The specimen geometry can also be adapted for forensic investigations using field cores of pavements where thin lifts are present. This geometry has been found to produce satisfactory results for asphalt mixtures with nominal maximum aggregates size ranging from 4.75 to 19 mm.[5]

[5] Wagoner, M. P., Buttlar, W. G., Paulino, G. H., and Blankenship, P., "An Investigation of the Fracture Resistance of Hot-Mix Asphalt Concrete Using a Disk-Shaped Compact Tension Test," *Transportation Research Record: Journal of the Transportation Research Board, No. 1929*, Transportation Research Board of the National Academies, Washington DC, 2005, pp. 183-192.



(c) Test Set-up

FIG. 2 Example of Clip-on Gage and Attachment Procedures

NOTE 1—The stiffness of the asphalt binder tends to influence the assessment of a valid test as described in 7.4. For instance a soft asphalt binder, which may be required for a very cold climate might not lead to a mixture that would produce valid results at 10°C and conversely, a hard asphalt binder utilized in hot climates may require higher temperatures to provide any meaningful information.

5. Apparatus

5.1 *Loading*—Specimens shall be tested in a loading frame capable of delivering a minimum of 20 kN (4500 lb) in tension. The load apparatus shall be capable of maintaining a constant crack mouth opening displacement within 2 % of the target value throughout the test. Closed-loop servo-hydraulic or servo-pneumatic test frames are highly recommended, but not required if the CMOD rate meets the specifications listed above. The load cell shall have a resolution of 20 N (4.5 lb) or better.

5.2 *Loading Fixtures*—An example of a loading clevis suitable for testing of the specimen is shown in Fig. 1. The