Designation: D7369 – 20

Standard Test Method for Determining the Resilient Modulus of Asphalt Mixtures by Indirect Tension Test[1]

This standard is issued under the fixed designation D7369; 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 procedures for preparing and testing laboratory-fabricated or field-recovered cores of asphalt mixtures to determine resilient modulus values using a repeated-load indirect tension test.

1.2 The values stated in SI units are regarded as the standard. Values in parentheses are for informational use.

1.3 A precision and bias statement for this standard has not been developed at this time. Therefore, this standard should not be used for acceptance or rejection of a material for purchasing purposes.

1.4 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.

1.5 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D8 Terminology Relating to Materials for Roads and Pavements

D3666 Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials

D6925 Test Method for Preparation and Determination of the Relative Density of Asphalt Mix Specimens by Means of the Superpave Gyratory Compactor

D6926 Practice for Preparation of Asphalt Mixture Specimens Using Marshall Apparatus

D6931 Test Method for Indirect Tensile (IDT) Strength of Asphalt Mixtures

2.2 *Other Document:*

NCHRP Project 1-28A Research Results Digest Number 285—Laboratory Determination of Resilient Modulus for Flexible Pavement Design, January 2004

3. Terminology

3.1 *Definitions*—Definitions are in accordance with Terminology D8.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *contact load ($P_{contact}$), n*—the vertical load placed on the specimen to maintain a positive contact between the loading strip and the specimen. The suggested contact load is 8 % of the maximum load (0.08 P_{max}). The contact load should be not less than 22.2 N (5 lb) and no more than 89.0 N (20 lb).

3.2.2 *core, n*—an intact cylindrical specimen of pavement material, which is removed from the pavement by drilling and sampling at the designated location. A core may consist of or include one, two, or more than two different layers.

3.2.3 *cyclic load (resilient vertical load, P_{cyclic}), n*—load applied to a specimen, which is directly used to calculate resilient modulus.

$$P_{cyclic} = P_{max} - P_{contact} \quad (1)$$

3.2.4 *haversine-shaped load form, n*—the required load pulse for the resilient modulus test. The load pulse is in the form (1-cos θ)/2 with the cyclic load varying from the contact load ($P_{contact}$) to the maximum load (P_{max}).

3.2.5 *instantaneous resilient modulus, n*—determined from the deformation-time plots (both horizontal and vertical) as described in Section 10.

3.2.6 *lift, n*—that part of the pavement produced with similar material and placed with similar equipment and techniques. The lift thickness is the thickness of the compacted

[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 Nov. 1, 2020. Published December 2020. Originally approved in 2009. Last previous edition approved in 2011 as D7369 – 11, which was withdrawn January 2020 and reinstated in November 2020. DOI: 10.1520/D7369-20.

[2] 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.

asphalt mixture that is achieved with one pass of the laydown machine and the subsequent compaction process and can be equal to or less than the core thickness or length.

3.2.7 *maximum applied load (P_{max}), n*—the maximum total load applied to the sample, including the contact and cyclic (resilient) loads. A P_{max} load of 400 N (89.9 lb) is suggested for testing.

$$P_{max} = P_{contact} + P_{cyclic} \tag{2}$$

3.2.8 *test specimen, n*—that part of the layer which is used for, or in, the specified test. The thickness of the test specimen can be equal to or less than the layer thickness.

3.2.9 *total deformation, n*—determined from the deformation-time plots (both horizontal and vertical) as described in Section 10.

4. Summary of Test Method

4.1 The repeated-load indirect tension resilient modulus test of asphalt mixtures is conducted through repetitive applications of compressive loads in a haversine waveform. The compressive load is applied along a vertical diametral plane of a cylindrical specimen of asphalt concrete. The resulting horizontal and vertical deformations of the specimen are measured. Values of resilient Poisson's ratio are calculated using recoverable vertical and horizontal deformations. The resilient modulus values are subsequently calculated using the calculated Poisson's ratio. Two separate resilient modulus values are obtained. One, termed *instantaneous* resilient modulus, is calculated using the instantaneous recoverable deformation that occurs during the unloading portion of one load-unload cycle. The other, termed *total* resilient modulus, is calculated using total recoverable deformation which includes both the instantaneous recoverable and the time-dependent continuing recoverable deformation during the unload or rest-period portion of one cycle.

5. Significance and Use

5.1 Resilient modulus can be used in the evaluation of materials quality and as input for pavement design, evaluation, and analysis. With this method, the effects of temperature and load on resilient modulus can also be investigated. This modulus test can be run on pavement cores because of specimen orientation.

NOTE 1—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 Specification D3666 are generally considered capable of competent and objective testing, sampling, inspection, etc. Users of this standard are cautioned that compliance with Specification D3666 alone does not completely ensure reliable results. Reliable results depend on many factors; following the suggestions of Specification D3666 or some similar acceptable guideline provides a means of evaluating and controlling some of those factors.

6. Apparatus

6.1 *Testing Machine*—Testing machine shall be a closed-loop, servo-electric, electro-hydraulic, or pneumatic testing machine with a function generator capable of applying a haversine-shaped load pulse over a range of load durations, load levels, and rest periods.

6.2 *Loading Device*—Loading device should be capable of testing 101.6 or 152.4 mm (4 or 6 in.) diameter specimens of thicknesses up to 63.5 mm (2.5 in.). The device should be compact enough to be used within an environmental chamber. It should have a fixed bottom loading plate and a moving upper loading plate. The movement of the upper plate should be guided by two columns, one on each side of the specimen and equidistant from the loading axis and the loading strips, to ensure it has minimal translational or rotational motion during loading of the specimen. The guide columns shall have a near frictionless bearing surface. The surface of the guide columns shall be frequently inspected for any grooves caused due to friction. Alignment of the device within the loading system shall be achieved so that such friction is limited. The upper plate shall be rigid enough to prevent excessive or undue deflection during loading. The loading strips shall be perpendicular to the line connecting the two guide columns, Fig. 1.

6.3 *Temperature-Control System*—The temperature-control system should be capable of maintaining a temperature of 5 to 45 °C (41 to 113 °F) ±1.0 °C (±2 °F). The system shall include a temperature-controlled cabinet large enough to house the loading device and space adequate to precondition specimens at a time prior to testing, as described in 8.3.

6.4 *Measurement and Recording System*—The measurement and recording system shall include sensors for measuring and simultaneously recording horizontal and vertical deformations and loads. The system shall be capable of recording horizontal and vertical deformations in the range of 0.00038 mm (0.000015 in.) of deformation. Load cells shall be accurately calibrated with a resolution of 8.9 N (2 lb) or better.

6.4.1 *Data Acquisition*—The measuring or recording devices must provide real-time deformation and should be capable of monitoring readings on tests conducted to 1 Hz.

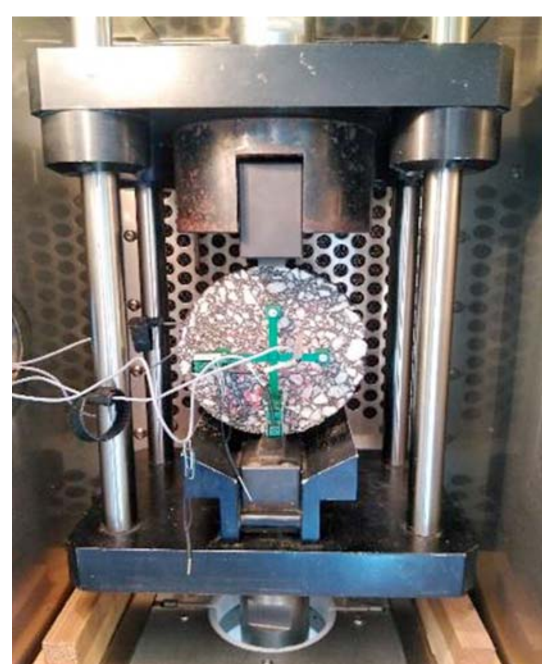

FIG. 1 Specimen with Loading Strip Parts