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.

Designation: D2950/D2950M – 22

Standard Test Method for Density of Asphalt Mixtures in Place by Nuclear Methods[1]

This standard is issued under the fixed designation D2950/D2950M; 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 describes a test procedure for determining the density of asphalt mixtures by the attenuation of gamma radiation, where the source and detector(s) remain on the surface (backscatter method) or the source or detector is placed at a known depth up to 300 mm [12 in.] while the detector or source remains on the surface (direct transmission method).

1.2 The density, in mass per unit volume of the material under test, is determined by comparing the detected rate of gamma emissions with previously established calibration data.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the standard.

1.4 All observed and calculated values shall conform to the guide for significant digits and rounding established in Practice D6026.

1.5 For limitations, see Section 5 on Interferences.

1.6 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. It is the recommendation of Committee D04 that the following note be added to the end of the Significance and Use section of all applicable standards. Applicable standards are those in which measurement or calibration are made, sample are procured, or products are selected. The subcommittee shall determine the appropriateness of adding the note throughout the consensus process.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* For specific warning statements, see Section 7.

1.8 *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]

C670 Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials

D8 Terminology Relating to Materials for Roads and Pavements

D1188/D1188M Test Method for Bulk Specific Gravity and Density of Compacted Asphalt Mixtures Using Coated Samples

D2041/D2041M Test Method for Theoretical Maximum Specific Gravity and Density of Asphalt Mixtures

D2726/D2726M Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Asphalt Mixtures

D3665 Practice for Random Sampling of Construction Materials

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

D6026 Practice for Using Significant Digits and Data Records in Geotechnical Data

D6752/D6752M Test Method for Bulk Specific Gravity and Density of Compacted Asphalt Mixtures Using Automatic Vacuum Sealing Method

D6926 Practice for Preparation of Asphalt Mixture Specimens Using Marshall Apparatus

D7013/D7013M Guide for Calibration Facility Setup for Nuclear Surface Gauges

D7759/D7759M Guide for Nuclear Surface Moisture and Density Gauge Calibration

[1] This test method is under the jurisdiction of ASTM Committee D04 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.21 on Specific Gravity and Density of Asphalt Mixtures.

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[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.

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3. Terminology

3.1 *Definitions*—See Terminology D8 for general definitions.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *detector, n*—a device to detect and measure radiation.

3.2.2 *gamma (radiation) source, n*—a sealed source of radioactive material that emits gamma radiation as it decays.

3.2.3 *nuclear gauge, n*—a device containing one or more radioactive sources used to measure certain properties of asphalt mixtures.

3.2.4 *test count, n*—the measured output of a detector for a specific type of radiation for a given test.

4. Significance and Use

4.1 The test method described is useful as a rapid, nondestructive technique for determining the in-place density of compacted asphalt mixtures.

4.2 With proper calibration and confirmation testing, the test method is suitable for quality control and acceptance testing of compacted asphalt mixtures.

4.3 The test method can be used to establish the proper rolling effort and pattern to achieve the required density.

4.4 The nondestructive nature of the test allows repetitive measurements to be made at a single test location between roller passes and to monitor changes in density.

4.5 The density results obtained by this test method are relative. Correlation with other test methods such as D1188/D1188M, D2726/D2726M, or D6752/D6752M is required to convert the results obtained using this method to actual density. It is recommended that at least seven core densities and seven nuclear densities be used to establish a conversion factor. A new factor must be established at any time a change is made in the paving mixture or in the construction process.

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.

5. Interferences

5.1 The chemical composition of the material being tested may significantly affect the measurement, and adjustments may be necessary. Certain elements with atomic numbers greater than 20 may cause erroneously high test values.

5.2 The test method exhibits spatial bias in that the instrument is most sensitive to the density of the material in closest proximity to the nuclear source.

5.2.1 When measuring the density of an overlay, it may be necessary to employ a correction factor if the underlying material varies in thickness, mineral composition, or degree of consolidation at different points within the project. (See Annex A1.)

5.2.2 The surface roughness of the material being tested may cause lower than actual density determination.

5.3 Oversize aggregate particles in the source-detector path may cause higher than actual density determination.

5.4 The sample volume being tested is approximately 0.0028 m^3 [0.0989 ft^3] for the backscatter method and 0.0056 m^3 [0.198 ft^3] for the direct transmission method. The actual sample volume varies with the apparatus and the density of the material.

NOTE 2—The volume of field-compacted material represented by a test can be effectively increased by repeating the test at adjacent locations and averaging the results.

5.5 If samples of the measured material are to be taken for purposes of correlation with other test methods such as D1188/D1188M, D2726/D2726M, or D6752/D6752M, the volume measured can be approximated by a 200 mm [8 in.] diameter cylinder located directly under the center line of the radioactive source and detector(s). The height of the cylinder to be excavated will be the depth setting of the source rod when using the direct transmission method or approximately 75 mm [3 in.] when using the backscatter method (Note 3).

NOTE 3—If the layer of an asphalt mixture to be measured is less than the depth of measurement of the instrument, corrections must be made to the measurements to obtain accurate results due to the influence of the density of the underlying material. (See Annex A1 for the method used.)

6. Apparatus

6.1 *Nuclear Device*—An electronic counting instrument, capable of being seated on the surface of the material under test, and which contains:

6.1.1 *Gamma Source*—A sealed high-energy gamma source such as cesium or radium, and

6.1.2 *Gamma Detector*—Any type of gamma detector such as a Geiger-Mueller tube(s).

6.2 *Reference Standard*—A block of dense material used for checking instrument operation and to establish conditions for a reproducible reference-count rate.

6.3 *Scraper Plate*—A metal plate, straightedge, or other suitable leveling tool which may be used to level the test site to the required smoothness using fine sand or similar material.

6.4 *Drive Pin*—A steel rod of slightly larger diameter than the rod in the direct transmission instrument, to prepare a perpendicular hole in the material under test for inserting the rod. A drill may also be used.

7. Hazards

7.1 This equipment utilizes radioactive materials which may be hazardous to the health of the users unless proper precautions are taken. Users of this equipment must become familiar with applicable safety procedures and government regulations.

7.2 Effective user instructions together with routine safety procedures, such as source leak tests, recording and evaluation of film badge data, etc. are a recommended part of the operational guidelines for the use of this instrument.

7.3 A regulatory agency radioactive materials license may be required to possess this equipment.