



## Standard Test Method for Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures<sup>1</sup>

This standard is issued under the fixed designation D 3203; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope \*

1.1 This test method covers determination of the percent air voids in compacted dense and open bituminous paving mixtures.

1.2 *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:

D 1188 Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures, Using Paraffin-Coated Specimens<sup>2</sup>

D 2041 Test Method for Theoretical Maximum Specific Gravity of Bituminous Paving Mixtures<sup>2</sup>

D 2726 Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens<sup>2</sup>

D 3549 Test Method for Thickness or Height of Compacted Bituminous Paving Mixture Specimens<sup>2</sup>

D 4460 Practice for Calculating Precision Limits Where Values are Calculated from Other Test Methods<sup>2</sup>

E 12 Terminology Relating to Density and Specific Gravity of Solids, Liquids, and Gases<sup>3</sup>

### 3. Terminology

3.1 The terms *specific gravity* and *density* used in this test method are in accordance with Terminology E 12.

#### 3.2 Definitions:

3.2.1 *air voids*—the pockets of air between the bitumen-coated aggregate particles in a compacted bituminous paving mixture.

3.2.2 *dense bituminous paving mixtures*—bituminous paving mixtures in which the air voids are less than 10 % when compacted.

3.2.3 *open bituminous paving mixtures*—bituminous paving mixtures in which the air voids are 10 % or more when compacted.

3.2.3.1 *Discussion*—For borderline cases, a bituminous paving mixture shall be designated an open bituminous paving mixture if the calculated percent air voids, based on either 6.1 or 6.2, is 10 % or more.

### 4. Significance and Use

4.1 The percent of air voids in a bituminous mixture is used as one of the criteria in the design methods and for evaluation of the compaction imparted in bituminous paving projects.

### 5. Sampling

5.1 Samples for testing shall consist of specimens from laboratory molded mixtures or cores from field compacted mixtures.

### 6. Procedure

6.1 For dense bituminous paving mixtures, determine the bulk specific gravity of the compacted mixture either by Test Method D 1188 or by Test Method D 2726. Determine the theoretical maximum specific gravity by Test Method D 2041 on a comparable bituminous mixture to avoid the influence of differences in gradation, asphalt content, etc.

6.2 For open bituminous mixtures, determine the density of a regularly shaped specimen of compacted mixture from its dry mass (in grams) and its volume (in cubic centimetres). Obtain the height of the specimens by Test Method D 3549. Measure the diameter of the specimen at four locations and average. Calculate the volume of the specimen based on the average height and diameter measurement. Convert the density to bulk specific gravity by dividing by  $0.99707 \text{ g/cm}^3$  or  $997 \text{ kg/m}^3$ , the density of water at  $25^\circ\text{C}$  ( $77^\circ\text{F}$ ). Determine the theoretical maximum specific gravity by Test Method D 2041 on a comparable bituminous mixture to avoid the influence of differences in gradation, asphalt content, etc.

<sup>1</sup> 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 Bituminous Mixtures.

Current edition approved Sept. 15, 1994. Published November 1994. Originally published as D 3203 – 73. Last previous edition D 3203 – 91.

<sup>2</sup> *Annual Book of ASTM Standards*, Vol 04.03.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 15.05.

\*A Summary of Changes section appears at the end of this standard.

6.3 For borderline cases, a bituminous paving mixture shall be designated an open bituminous paving mixture if the calculated percent air voids, based on either 6.1 or 6.2, is 10 % or more.

6.4 For referee purposes, determine both the bulk specific gravity and the theoretical maximum specific gravity on aliquot portions of the same sample of compacted bituminous paving mixture.

**7. Calculation**

7.1 Calculate the percent air voids in a compacted bituminous paving mixture as follows:

$$\text{Percent air voids} = 100 (1 - (\text{bulk sp gr} / \text{theoretical maximum sp gr})) \tag{1}$$

**8. Precision and Bias**

8.1 The precision of this test method depends on the precision of test methods for bulk specific gravity and theoretical maximum specific gravity. It is computed by a procedure described in Practice D 4460. Since the computation for percent air voids in 7.1 involves the quotient of bulk specific gravity divided by the theoretical maximum specific gravity, the quotient formula is used:

$$\sigma_{x/y} = \sqrt{\frac{\bar{y}^2 \sigma_x^2 + \bar{x}^2 \sigma_y^2}{\bar{y}^4}} \tag{2}$$

where:

- $\sigma_{x/y}$  = standard deviation for determining precision limits of test results based on the quotient of test results from Test Method D 1188 or D 2726 and D 2041,
- $\bar{x}$  = mean (average) of x standard test results (bulk specific gravity, Test Method D 1188 or D 2726),
- $\bar{y}$  = mean (average) of y standard test results (theoretical maximum specific gravity, Test Method D 2041),
- $\sigma_x$  = standard deviation from the precision statement of x standard test results (bulk specific gravity, Test Method D 1188 or D 2726), and
- $\sigma_y$  = standard deviation from precision statement of y standard test results (maximum theoretical specific gravity, Test Method D 2041).

8.2 Criteria for judging the acceptability of percent air voids test results would be presented in the form:

	Standard Deviation	Acceptable Range of Two Results
Operator Precision	$\sigma_{x/y}$	$2.8 \sigma_{x/y}$

**APPENDIX**

(Nonmandatory Information)

**X1. EXAMPLE CALCULATION OF PRECISION**

X1.1 Assume the following precision data:

Bulk specific gravity, x

Average	Standard Deviation
2.423	0.007

Theoretical maximum specific gravity, y

Average	Standard Deviation
2.523	0.004

Then using the equation in 8.1:

$$\begin{aligned} \sigma_{x/y} &= \sqrt{\frac{(2.523)^2 (0.007)^2 + (2.423)^2 (0.004)^2}{(2.523)^4}} \\ &= 0.00316 \end{aligned} \tag{X1.1}$$

This value is in terms of air voids; therefore it should be multiplied by 100 to convert it into percentage. Therefore:

$$\sigma_{x/y} = 0.00316(100) = 0.32 \% \tag{X1.2}$$

## SUMMARY OF CHANGES

This section identifies the location of changes to this test method that have been incorporated since the last issue. Committee D-4 has highlighted those changes that affect the technical interpretation or use of this test method.

(1) Section 8 was revised.

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