Designation: D6084/D6084M – 13

# Standard Test Method for Elastic Recovery of Asphalt Materials by Ductilometer[1]

This standard is issued under the fixed designation D6084/D6084M; 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 assesses the elastic recovery of an asphalt material measured by the recoverable strain determined after severing an elongated briquet specimen of the material of the form described in 4.1. The specimens are pulled to a specified distance at a specified speed and at a specified temperature. Unless otherwise specified, the test shall be made at a temperature of 25 ± 0.5°C [77 ± 0.9°F] and with a speed of 5 cm/min ± 5 %.

1.2 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 non-conformance with the standard.

1.3 **Warning—**Mercury has been designated by the United States Environmental Protection Agency and many state agencies as a hazardous material that can cause central nervous system, kidney and liver damage. Mercury, or its vapor, may be hazardous to health and corrosive to materials. Caution should be taken when handling mercury and mercury containing products. See the applicable Material Safety Data Sheet (MSDS) for details and EPA's website (http://www.epa.gov/mercury/index.htm) for additional information. Users should be aware that selling mercury and/or mercury containing products into your state may be prohibited by state law.

1.4 *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:*[2]

C670 Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials
D5 Test Method for Penetration of Bituminous Materials
D113 Test Method for Ductility of Bituminous Materials
D1754 Test Method for Effects of Heat and Air on Asphaltic Materials (Thin-Film Oven Test)
D2872 Test Method for Effect of Heat and Air on a Moving Film of Asphalt (Rolling Thin-Film Oven Test)
D6934 Test Method for Residue by Evaporation of Emulsified Asphalt
D6997 Test Method for Distillation of Emulsified Asphalt
D7403 Test Method for Determination of Residue of Emulsified Asphalt by Low Temperature Vacuum Distillation
D7497 Practice for Recovering Residue from Emulsified Asphalt Using Low Temperature Evaporative Technique
E1 Specification for ASTM Liquid-in-Glass Thermometers
E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves
E77 Test Method for Inspection and Verification of Thermometers
E220 Test Method for Calibration of Thermocouples By Comparison Techniques
E644 Test Methods for Testing Industrial Resistance Thermometers
E1137/E1137M Specification for Industrial Platinum Resistance Thermometers
E2251 Specification for Liquid-in-Glass ASTM Thermometers with Low-Hazard Precision Liquids

[1] This test method is under the jurisdiction of ASTM Committee D04 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.44 on Rheological Tests.

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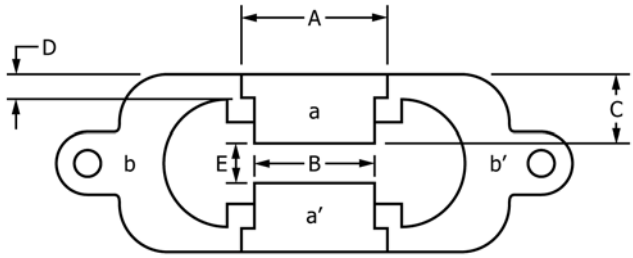
[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.




Spacer
A 36.0 ± 0.5 mm
B 30 ± 0.5 mm
C 17 ± 0.25 mm
D 6 ± 0.1 mm
E 10 ± 0.1 mm

**FIG. 1 Mold for Elastic Recovery Test Specimen**

## 3. Significance and Use

3.1 This test method is useful in confirming that a material has been added to the asphalt to provide a significant elastomeric characteristic. It does not necessarily identify the type or amount of material added.

## 4. Apparatus

4.1 *Mold*—The mold[3] shall be similar in design to that shown in Fig. 1. The mold shall be made of brass, 10.0 ± 0.1 mm thick, the ends *b* and *b′* being known as clips, and the parts *a* and *a′* as sides of the mold, with a brass base plate that is larger than the assembled mold. The dimensions of the assembled mold shall be as shown in Fig. 1 with the permissible variations indicated. (See Note 1.)

4.2 *Water Bath for Conditioning Specimen*—Maintain the water bath at the specified test temperature, varying not more than 0.5°C [0.9°F] from this temperature. The volume of water shall be not less than 10 L, and the specimen immersed to a depth of not less than 2.5 cm.

4.3 *Testing Machine*—For elongating the briquet of asphalt material, any apparatus may be used that is so constructed that the specimen will be continuously immersed in water, while the two clips are pulled apart at a uniform speed, as specified, without undue vibration. A variation of ±5 % is permissible. The water in the tank of the testing machine shall cover the specimen both above and below it by at least 2.5 cm and shall be maintained within ±0.5°C [0.9°F] of the test temperature. The testing machine shall incorporate a means by which the elongation can be measured in centimetres. (See Note 2.)

4.4 *Thermometer*—A thermometer for monitoring the temperature of the water bath. The thermometer shall be one of the following:

4.4.1 A liquid-in-glass thermometer of suitable range with subdivisions and maximum scale error of 0.1°C [0.2°F] which conforms to the requirements of Specification E1. The thermometer shall be standardized in accordance with one of the methods in Test Method E77.

4.4.2 A liquid-in-glass thermometer of suitable range with subdivisions and maximum scale error of 0.1°C [0.2°F] which conforms to the requirements of Specification E2251. The thermometer shall be standardized in accordance with one of the methods in Test Method E77.

4.4.3 A platinum resistance thermometer (PRT) with a probe which conforms to the requirements of Specification E1137/E1137M. The PRT shall have a 3- or 4-wire configuration and the overall sheath length shall be at least 50 mm [2 in.] greater than the immersion depth. The PRT system (probe and readout) shall be standardized in accordance with Test Methods E644. Corrections shall be applied to ensure measurements within 0.1°C [0.2°F].

4.4.4 A metal-sheathed thermistor with a sensor substantially similar in construction to the PRT probe described in 4.4.3. The thermistor system (sensor and readout) shall be standardized in accordance with Test Methods E644. Corrections shall be applied to ensure measurements within 0.1°C [0.2°F].

4.5 *Scissors*—Any type of conventional scissors capable of cutting the bituminous material at the test temperature.

4.6 *Oven*—An oven capable of maintaining 135 ± 5°C [275 ± 10°F].

4.7 *Sieves*—300-µm [No. 50] and 850-µm [No. 20] sieves, 75 mm [3 in.] in diameter, in accordance with Specification E11.

4.8 *Release Agent*—A mixture such as glycerin with Dextrin, talc or Kaolin (china clay) or 1 g Versamid Resin per 100 g castor oil (not generic mineral oil) used to coat the bottom and sides of the mold to prevent the specimen from sticking to the mold. Other materials may be used for this purpose if they have been shown not to affect the physical properties of the test specimen.

4.9 *Trimming Tool*—A straight-edged putty knife or spatula.

NOTE 1—Clips for the mold are the same as specified in Fig. 1 of Test Method D113.

NOTE 2—The testing machine may be the same as specified in Test Method D113.

[3] The sole source of supply of the apparatus known to the committee at this time is Humboldt Manufacturing Company, 7300 W. Agatite Ave., Chicago, IL 60656. If you are aware of alternative suppliers, please provide this information to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee[1], which you may attend.

NOTE 3—In those cases where the elastic recovery specimens are conditioned in the standard penetration bath at 25°C [77°F], the thermometer as prescribed for Test Method D5 may be used.

## 5. Sample Preparation

5.1 *Emulsified Asphalt Residue*—If the sample is a residual product recovered from emulsified asphalt by means of the methods described in Test Methods D6934, D6997, D7403, or Practice D7497, stir the heated residue and immediately pour portions of the residue into suitable molds for making the required tests. If it is suspected there is foreign matter in the residue, pour the material through a 300 µm [No. 50] sieve that has been preheated at 135 ± 5°C [275 ± 10°F] prior to pouring into the test molds. (See Note 4.)

5.2 *Unaged Sample*—If the sample is an asphalt binder, carefully heat the sample in a covered container to prevent local overheating until it has become sufficiently fluid to pour. Use an oven set at 135 ± 5°C [275 ± 10°F] for sample heating. If it is suspected that the sample contains foreign matter, strain the melted sample through a 300 µm [No. 50] sieve that has been preheated at 135 ± 5°C [275 ± 10°F]. (See Note 5.)

5.3 *Aged Sample*—If the sample is a conditioned residue obtained from Test Method D1754 or D2872, combine the residue into a single container, cover, and heat in an oven set at 135 ± 5°C [275 ± 10°F]. If it is suspected that the sample contains foreign matter, strain the melted sample through a 300-µm [No. 50] sieve that has been preheated at 135 ± 5°C [275 ± 10°F]. (See Note 5.)

NOTE 4—In the case of higher viscosity emulsified asphalt residues or residues from lower temperature distillations that will not pass a 300-µm (No. 50) sieve, an 850-µm (No. 20) sieve may be used.

NOTE 5—In those cases where the samples are not sufficiently fluid to pour at 135°C [275°F], higher temperatures may be used. In the case of higher viscosity materials that will not pass a 300 µm [No. 50] sieve, an 850 µm [No. 20] sieve may be used.

## 6. Procedure

6.1 Assemble the mold on the brass plate. Thoroughly coat the surface of the plate and the interior surfaces of the sides of the mold, *a* and *a′*, with a thin layer of release agent to prevent the test material from sticking. The plate upon which the mold shall be placed shall be perfectly flat and level so that the bottom surface of the mold will be in contact throughout. After sample preparation as described in Section 5, thoroughly stir the sample and pour into the mold. In filling the mold, take care not to disarrange the pieces of the mold, thus distorting the shape. In filling, take care to pour and place material in a stream back and forth from end to end until the mold is more than level full. Allow the filled mold to cool to room temperature for 35 ± 5 min. Then place in the water bath at the test temperature for 30 ± 5 min. Remove the test specimens from the water bath and immediately trim the excess material with a hot trimming tool to make the molds just level full. (See Note 6.)

6.2 *Keeping Specimens at Standard Temperature*—Place the trimmed specimen and mold in the water bath at the specified test temperature for 90 ± 5 min prior to testing. Remove the specimen from the plate by a shearing action between specimen and plate, avoiding any bending of the test specimen. Remove the side pieces *a* and *a′* being careful not to distort or fracture the specimen. Attach the specimen to the testing machine and immediately test the specimen.

6.3 *Testing, Procedure A*—Attach the rings at each end of the clips to the pins or hooks in the testing machine and pull the two clips apart at a uniform speed to an elongation of 10 ± 0.25 cm unless otherwise specified. Stop the elongation and immediately cut the test specimen into two halves at the midpoint using the scissors. Allow the specimen to remain in the testing machine in an undisturbed condition at the specified temperature for a period of 60 min. After the 60-min time period, carefully move the traveling carriage back to a position where the ends of the specimens just touch. If the specimen ends have sagged, carefully lift them to their original level prior to adjusting the ends to touch. Record the total length of the specimen with the severed ends just touching each other.

6.4 *Testing, Procedure B*—Attach the rings at each end of the clips to the pins or hooks in the testing machine and pull the two clips apart at a uniform speed to an elongation of 20 ± 0.25 cm. Stop the elongation and maintain the specimen in this position for 5 min. Then cut the test specimen into two halves at the midpoint using the scissors. Allow the specimen to remain in the testing machine in an undisturbed condition at the specified temperature for a period of 60 min. After the 60-min time period, carefully move the traveling carriage back to a position where the ends of the specimens just touch. If the specimen ends have sagged, carefully lift them to their original level prior to adjusting the ends to touch. Record the total length of the specimen with the severed ends just touching each other.

6.5 If the asphalt material comes in contact with the surface of the water or the bottom of the bath, the test shall not be considered normal. Adjust the specific gravity of the bath by the addition of either methyl alcohol, ethylene glycol, or sodium chloride so that the asphalt material neither comes to the surface of the water, nor touches the bottom of the bath at any time during the test, and rerun the test. If the sample fractures before reaching the specified elongation, the test shall not be considered normal.

NOTE 6—Mixing of clips and sides from different manufacturers may result in sample dimensions other than specified. Measure the width at the cross section of the assembled mold and compare to Fig. 1.

## 7. Calculation and Report

7.1 Calculate the percent recovery as follows:

$$\text{Recovery, \%} = \frac{E - X}{E} \times 100 \quad (1)$$

where:

$E$ = original elongation of the specimen, cm, and
$X$ = elongation of the specimen, at the completion of the specified recovery time, with severed ends just touching, cm.

7.1.1 Report to the nearest whole percent the average of three normal tests as the elastic recovery of the sample.

Lab No. _____

| Sample No. | 1A | 1B | 1C | 2A | 2B | 2C | Notes |
|---|---|---|---|---|---|---|---|
| Date:<br><br>Test Temp. | | | | | | | |
| Speed (cm/min) | | | | | | | |
| Elongation (cm) | | | | | | | |
| Hold Time (min) | | | | | | | |
| | | | | | | | |
| Orig. Elongation (E) | | | | | | | |
| Elongation after (X) | | | | | | | |
| % Elastic Recovery | | | | | | | |
| Avg. % Elastic Recovery | | | | | | | |

| | |
|---|---|
| Additional Info.<br><br>Project:<br>Type Mat:<br><br>Handling Conditions<br>A.C. - Sieve Size:<br>Pour Temp:<br>? Reheat:<br><br>Emul. - Dist. Temp:<br>Sieve Size<br>? Reheat<br>Pour Temp. | |

**FIG. 2 Sample Report Form**

7.2 If a normal test is not obtainable on three tests, report the elastic recovery as being unobtainable under the conditions of the test.

7.3 It is suggested that a form sheet as shown in Fig. 2 be used to record the specific test conditions and results.

7.3.1 Record the sample thermal history handling information, such as distillation temperature (if applicable), the pouring temperature, and whether or not the sample has been reheated, as shown in Fig. 2.

## 8. Precision and Bias[4]

8.1 *Procedure A Precision*—Criteria for judging the acceptability of two single measurements (see Note 7) obtained by this test method are given as follows:

NOTE 7—Although this test method describes a result as the average of three single measurements, the precision estimates shown as follows are based on the analysis of single measurements. For comparing two test results, the single-operator (1*s*) and (*d*2*s*) estimates would be reduced by a factor of $1/\sqrt{3}$. The multilaboratory (1*s*) and (*d*2*s*) estimates would not change.

NOTE 8—The figures given in Column 2 are the standard deviations that have been found to be appropriate for the materials and mean values described in Column 1. The figures given in Column 3 are the limits that should not be exceeded by the difference between the results on two test specimens.

[4] This is based on the analysis of data resulting from tests by nine laboratories using Procedure A, each testing three replicate specimens. The conditions for this research report were as follows:

Test Temperature — 25°C
Speed — 5 cm/min
Elongation — 10 cm

| Materials Index | Standard Deviation[A] | Acceptable Range of Two Results[A] |
|---|---|---|
| Single-operator precision: | | |
| 1 (unmodified) | 0.91 | 2.6 |
| 2 (modified) | 0.56 | 1.6 |
| Multilaboratory precision: | | |
| 1 (unmodified) | 2.32 | 6.5 |
| 2 (modified) | 1.71 | 4.8 |

[A] These numbers represent, respectively, the (1*s*) and (*d*2*s*) limits as described in Practice C670.

8.2 *Procedure B Precision*—Criteria for judging the acceptability of two single measurements is based on an interlaboratory study conducted on three polymer modified PG materials by 11 laboratories. Materials and overall average determinations (based on three measurements) for each material were as follows:

| Material | Average Recovered Elasticity, % |
|---|---|
| PG70-28 | 58.67 |
| PG76-22 | 78.51 |
| PG64-34 | 95.71 |

8.3 *Single-operator Precision for Sets of Three tests Averaged and Reported as a Test Result:*

8.3.1 The test method calls for reporting the average of three test results. For materials with elastic recovery less than 75 %, the standard deviation has been found to be 1.93 %.[5] Therefore, the range (difference between highest and lowest) of the three individual measurements used in calculating the average should not exceed 12 %. For materials with recovered elasticity more than 75%, the standard deviation has been found to be 0.56 %.[5] Therefore, the range of the three individual measurements used in calculating the average should not exceed 3.5 %.

8.4 *For Averages Based on Three Measurements:*

8.4.1 The single-operator coefficient of variation has been found to be 1.74 %.[5] Therefore, results of two properly conducted tests by the same operator on the same sample using the same ductilometer should not differ from each other by more than 5.0 % of their average.

8.4.2 The multi-laboratory coefficient of variation has been found to be 2.29 %.[5] Therefore, results of two different laboratories on identical samples of a material should not differ from each other by more than 6.5 % of their average[5].

8.5 *Bias*—Since there is no accepted reference material for determining the bias in this test method, no statement on bias is made.

## 9. Keywords

9.1 asphalt; ductility; elastic; recovery

[5] These numbers represent, respectively, the (1s) and (d2s) limits as described in Practice C670.