Designation: D7121 – 05 (Reapproved 2012)

Standard Test Method for Rubber Property—Resilience Using Schob Type Rebound Pendulum[1]

This standard is issued under the fixed designation D7121; 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 a means of determining the resilience of rubber, within a range of impact strain and strain rate, by means of the impacting and measuring apparatus conforming to the requirements described in this test method.

1.2 This test method is applicable to thermoset rubbers and thermoplastic elastomers, the hardness of which, at the specified test temperatures, lies between 30 and 85 IRHD (see Test Method D1415) or A/30 and A/85 (see Test Method D2240). It may also be applicable to some polyester, polyether foam, and plastic foam materials.

1.3 All materials, instruments, or equipment used for the determination of mass, force, or dimension shall have traceability to the National Institute for Standards and Technology, or other internationally recognized organization parallel in nature.

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

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

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D832 Practice for Rubber Conditioning For Low Temperature Testing

D1349 Practice for Rubber—Standard Conditions for Testing

D1415 Test Method for Rubber Property—International Hardness

D2240 Test Method for Rubber Property—Durometer Hardness

D3182 Practice for Rubber—Materials, Equipment, and Procedures for Mixing Standard Compounds and Preparing Standard Vulcanized Sheets

D3183 Practice for Rubber—Preparation of Pieces for Test Purposes from Products

D4483 Practice for Evaluating Precision for Test Method Standards in the Rubber and Carbon Black Manufacturing Industries

3. Summary of Test Method

3.1 This test method describes the determination of resilience, expressed as percentage resilience or rebound resilience, by a Schob Type pendulum rebound device as a ratio between the returned and applied energy when a spherically terminated mass impacts a test specimen under the conditions specified in this test method.

3.2 Resilience of the materials described is infinitely variable. It varies with temperature, strain rate (specifically related to the velocity of the indentor), and strain energy (specifically related to the mass of the indentor, coupled with velocity).

3.3 The variable factors, described and defined in this test method, will have effects on the outcomes of test results. Repetitive tests, under the defined conditions, on comparable materials, will provide meaningful, repeatable, and reproducible data.

4. Significance and Use

4.1 The Schob Type rebound pendulum is designed to measure the percentage resilience of a rubber compound as an indication of hysteretic energy loss that can also be defined by the relationship between storage modulus and loss modulus. The percent rebound measured is inversely proportional to the hysteretic loss.

4.1.1 Percentage resilience or rebound resilience are commonly used in quality control testing of polymers and compounding chemicals.

4.1.2 Rebound resilience is determined by a freely falling pendulum hammer that is dropped from a given height that impacts a test specimen and imparts to it a certain amount of energy. A portion of that energy is returned by the specimen to

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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.

the pendulum and may be measured by the extent to which the pendulum rebounds, whereby the restoring force is determined by gravity.

4.1.2.1 Since the energy of the pendulum is proportional to the vertical component of the displacement of the pendulum, it may be expressed as 1 – cos (of the angle of displacement) and percentage rebound resilience. *RB*, commonly called percentage rebound, is determined from the equation:

$$RB = \frac{1 - \cos(\text{angle of rebound})}{1 - \cos(\text{original angle})} \times 100 \quad (1)$$

4.1.2.2 The rebound resilience may be calculated as:

$$R = \frac{h}{H} \quad (2)$$

where:

h = apex height of the rebound, and
H = initial height.

4.1.2.3 The rebound resilience may also be determined by the measurement of the angle of rebound α. From the rebound angle α, the rebound resilience in percent is obtained according to the following formula:

$$R = (1 - \cos \alpha) \times 100 \quad (3)$$

5. Apparatus

5.1 Rebound resilience shall be measured by means of a Schob Type pendulum rebound device (see Fig. 1), which may be described as a pendulum-like, one-degree-of-freedom, mechanical oscillatory rebound device.

5.1.1 The device shall consist of a pendulum rod terminating in a hammer and hammer peen (spherical indentor) supported by a frame (see Fig. 2) so as to oscillate linearly or circularly under the action of a restoring force, which may be due to gravity or the elastic reactions of a torsion wire or springs. It shall also incorporate a specimen holder and a device by which to determine the outcome of the resilience test, either an analog scale with a pointer, or an equivalent digital electronic display.

5.2 The scale or display shall read either, or both, the angle of rebound and the horizontal rebound distance. The scale or display may be graduated uniformly or be calibrated in units of resilience.

5.3 The test specimen shall be securely held during mechanical conditioning and rebound measurement.

5.3.1 The surface against which the back of the test specimen is applied shall be metallic, flat, and smoothly finished, vertical and perpendicular to the impact velocity direction.

5.3.2 This flat face is a part of an anvil which shall, if free, have a mass of least 200 times the impacting mass.

5.3.3 Any type of suitable holding device may be used provided that it gives rebound resilience values that deviate not more than 0.2 (absolute rebound resilience) from those obtained with test specimens bonded to a rigid back plate.

5.3.3.1 Examples of suitable holding devices include suction (by vacuum), mechanical clamping devices, and combinations of the two.

5.3.3.2 No lateral restraint shall be applied to the test specimen in order to allow it to bulge freely when impacted.

5.4 If measurements are to be carried out at a series of temperatures different from the ambient temperature, the pendulum instrument shall be operated in accordance with Practices D832 and D1349.

5.4.1 The apparatus shall be checked for correct operation in the range of temperatures used.

5.4.2 Samples shall be conditioned at temperature and removed as quickly as possible to the tester (see 8.1.3).

6. Test Specimens

6.1 Test specimens shall be prepared in accordance with Practices D3182 and D3183 either by molding or by cutting. They shall be free of fabric or any other reinforcing materials.

6.2 Test specimen size shall be as described by the instrument manufacturer or as agreed upon by supplier and customer.

6.3 The test specimens shall have flat, smooth, and parallel surfaces, finished, if necessary, by buffing. If the impacted surface is cohesive, the effect shall be minimized by dusting the surface with talc or an equivalent material.

6.3.1 Specimens may be prepared by plying samples cut from a standard test slab (see Practices D3182 and D3183). These samples shall be plied, without cementing, to the thickness required. Such plies shall be smooth, flat, and of uniform thickness. The results obtained with these specimens so prepared will not necessarily be identical with those obtained using a solid specimen of the same material and state of cure.

6.3.1.1 Plying of no more than three test specimens of the same material may be used to obtain a greater thickness. It is necessary that the surfaces of the test specimens be very smooth, and lateral suction may help in ensuring their contact.

6.3.1.2 Plying of test specimens introduces additional uncertainties, and shall be used only for comparative measurements.

6.4 The test shall be performed no earlier than 16 h and no later than 28 days beyond the time of vulcanization.

6.5 The time between vulcanization and testing shall not exceed 120 days for finished articles.

6.5.1 Alternatively, the time between vulcanization and testing may be agreed upon between laboratories or customer and supplier.

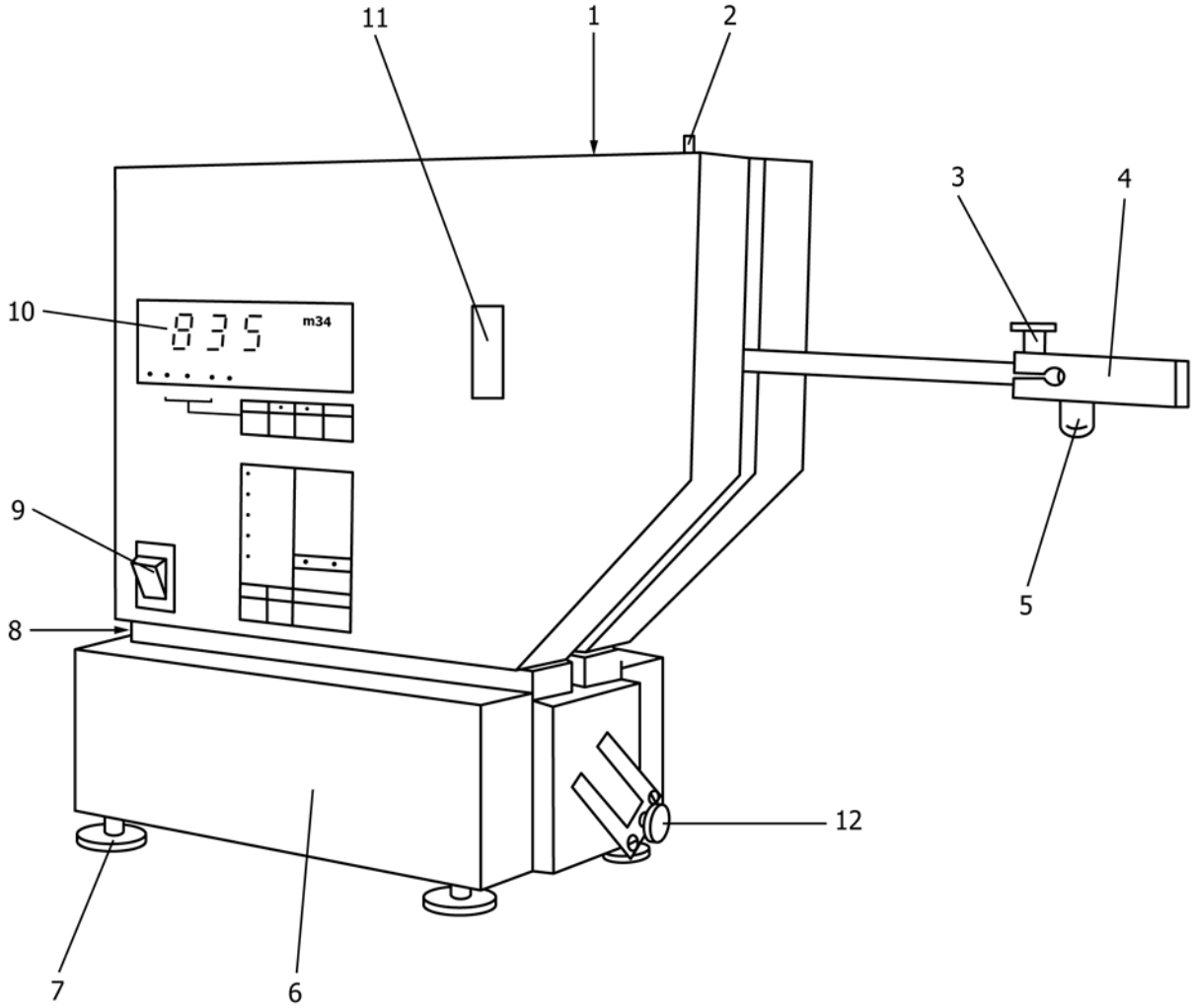
6.6 Samples and test specimens shall be protected from light as completely as possible during the interval between vulcanization and testing.

6.7 If the test specimen is buffed, the interval between buffing and testing shall not exceed 72 h.

7. Tester Verification

7.1 Since there are no absolute standards available for this tester, the instrument's performance should be verified on a regular basis:

7.1.1 Follow manufacturer's recommendations for physical verification of the instrument.



1 Bubble Level
2 Release
3 Pendulum Angle Adjusting Screw
4 Pendulum Mass
5 Hammer (indentor)
6 Anvil
7 Leveling Feet
8 Anvil Positioning Screw
9 Power Switch
10 Display
11 Observation Window
12 Specimen Holder

FIG. 1 Typical Schob Type Pendulum Rebound Apparatus

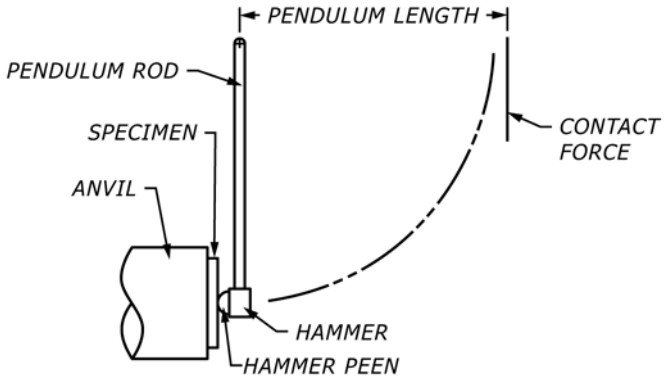


FIG. 2 Schematic Detail of the Schob Device

7.1.2 Obtain or produce one or two standard samples, preferably one with high (90 %) resilience and one with low (20 to 30 %) resilience. Test these samples normally to verify instrument performance.

8. Test Conditions

8.1 The standard laboratory temperature of 23 ± 2°C (73.4 ± 3.6°F) is the preferred temperature of the test.

8.1.1 Tests may also be carried out at other temperatures as agreed upon between laboratories or customer and supplier.

8.1.2 The temperature tolerance shall not exceed ±1°C.

8.1.3 When tests are conducted at temperatures other than that in 8.1, the sample should be conditioned for at least 30 min or until uniformity of temperature is reached, then removed quickly to the tester to reduce the temperature change before testing.

9. Procedure

9.1 After conditioning and mounting the test specimen in the holding device, carry out mechanical conditioning by subjecting the test specimen to no fewer than three and not more than seven successive impacts, so as to reach a practically constant rebound amplitude.

9.2 Immediately after the impacts for mechanical conditioning, apply three more impacts at the same velocity to test specimen and note the three rebound readings.

9.3 Convert these three readings, if necessary (see Section 4), to resilience values, expressed as a percentage. Their median shall be taken as the rebound resilience of the test specimen.

9.4 Calculate the average of the values for the two (or more) test specimens.

10. Test Report

10.1 The test report shall include:

10.2 *Test Details:*

10.2.1 Full description of the sample and its origin, including vulcanization date,

10.2.2 Dimensions of the test specimen,

10.2.3 Compound details and curing conditions, if known,

10.2.4 Preparation of test specimens, for example whether molded or cut and if the specimens were plied,

10.2.5 Any relevant facts about the pretest history of test specimens,

10.2.6 Apparatus employed, and

10.2.7 Methodology used.

10.3 *Test Results:*

10.3.1 Number of test specimens tested, and

10.3.2 Calculated mean value or rebound resilience, in percent, for the test specimens.

11. Precision and Bias

11.1 Precision and bias have not been determined. An interlaboratory test program (ITP) will be conducted within the allotted time.

11.2 The standard definitions relative to precision and bias, as defined in Practice D4483, have been included for reference.

12. Keywords

12.1 impact; oscillatory device; pendulum rebound; rebound; resilience; rubber