



# Standard Test Method for Rubber Property—Resilience Using a Goodyear-Healey Rebound Pendulum<sup>1</sup>

This standard is issued under the fixed designation D 1054; 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.

<sup>e1</sup> NOTE—Adjunct reference was corrected editorially in April 2006.

## 1. Scope

1.1 This test method covers the determination of impact resilience and penetration of rubber by means of the Goodyear-Healey rebound pendulum, see Fig. 1.

1.1.1 The term rubber, used within this method, shall refer to those substances classified as thermoplastic elastomers, vulcanized (thermoset) rubber, elastomeric materials, and cellular materials.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only. Many of the stated dimensions in SI are direct conversions from the U.S. Customary System to accommodate the instrumentation, practices and procedures that existed prior to the Metric Conversion Act of 1975.

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

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:*<sup>2</sup>

**D 3182** Practice for Rubber—Materials, Equipment, and Procedures for Mixing Standard Compounds and Preparing Standard Vulcanized Sheets

**D 3183** Practice for Rubber—Preparation of Pieces for Test Purposes from Products

**D 4483** Practice for Evaluating Precision for Test Method Standards in the Rubber and Carbon Black Manufacturing Industries

**E 145** Specification for Gravity-Convection And Forced-Ventilation Ovens

2.2 *ASTM Adjuncts:*

Goodyear-Healey Rebound Pendulum Drawings and Parts List<sup>3</sup>

## 3. Summary of Test Method

3.1 *Impact Resilience*—A freely falling pendulum hammer that is dropped from a given height impacts a test specimen, imparting a certain amount of energy. A portion of that energy is returned by the specimen to the pendulum and may be measured by the extent to which the pendulum rebounds. 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 impact resilience. *RB*, is readily determined from the equation.

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

3.1.1 The value *RB* is commonly called percentage rebound.

3.2 *Penetration*—Dynamic stiffness is a factor that influences impact resilience. A convenient index of stiffness is the depth to which the penetration striker penetrates the test specimen upon impact.

## 4. Significance and Use

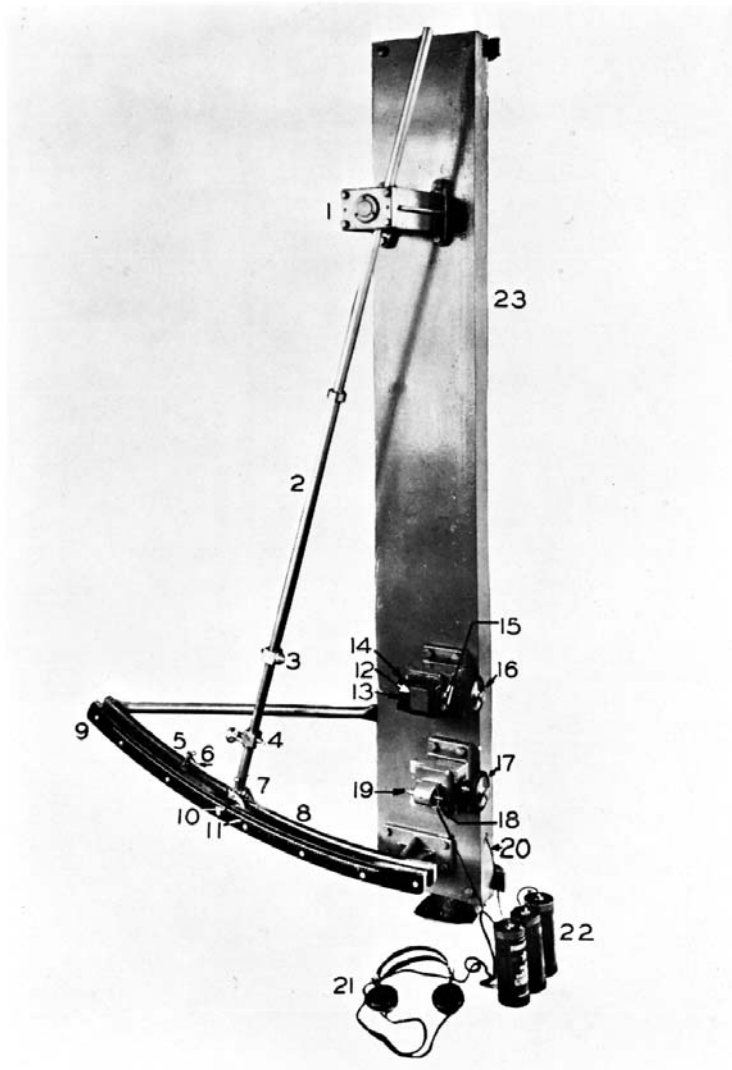
4.1 The Goodyear-Healey<sup>3</sup> rebound pendulum is designed to measure percent resilience of a rubber compound as an indication of hysteretic energy loss that can also be defined by the relationship between storage modulus and loss modulus. The percent rebound measured is inversely proportional to the hysteretic loss.

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee D11 on Rubber and is the direct responsibility of Subcommittee D11.14 on Time and Temperature-Dependent Physical Properties.

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<sup>2</sup> 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.

<sup>3</sup> The rebound pendulum is no longer available from the Goodyear Tire and Rubber Co., Process Engineering and System Designs, Dept. 109 E, 1144 East Market Street, Akron, OH 44316. Technical and engineering drawings for its manufacture and the reproduction of replacement parts are available at a nominal cost from ASTM International Headquarters. Order Adjunct No. ADJD1054. Original adjunct produced in 2000.



NOTE 1—Except where rough finish is indicated, all surfaces shall be machined to a smooth finish within the dimensions and tolerances indicated. Boiler-plate steel is suitable material.

FIG. 1 Goodyear-Healey Rebound Pendulum

4.2 Deflection is determined by measuring the depth of penetration of the rebound ball into the rubber block under test.

4.3 Percent resilience and deflection are commonly used in quality control testing of polymers and compounding chemicals, especially reinforcing material.

## 5. Apparatus

5.1 *Rebound Pendulum*—The Goodyear-Healey rebound pendulum (see Fig. 1) shall consist of the following:

- 5.1.1 Ball bearings (1), which support the pendulum,
- 5.1.2 Free swinging pendulum (2),
- 5.1.3 Penetration striker (3),
- 5.1.4 Contact for the indentation reading (4),
- 5.1.5 Release device (5 and 6),

- 5.1.6 Pawls (7),
  - 5.1.7 Pawl rack (8),
  - 5.1.8 Pointer (10),
  - 5.1.9 Anvil (12),
  - 5.1.10 Quadrant with an angular scale (11),
  - 5.1.11 Specimen holder (14),
  - 5.1.12 Penetration micrometer (16, 17, and 18),
  - 5.1.13 Headphones (21) and a dry battery circuit (22), or other suitable power supply, attached to the penetration micrometer for determining when the moment of contact of the contact for the indentation reading (4), and
  - 5.1.14 Vertical base (23).
- 5.2 The steel pendulum bar (2) shall conform to the following dimensions: