



Standard Test Methods for Rubber Properties in Compression or Shear (Mechanical Oscillograph)¹

This standard is issued under the fixed designation D 945; 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.

This standard has been approved for use by agencies of the Department of Defense.

^{ε1} NOTE—Keywords were added and other corrections were made editorially in December 2001.

1. Scope

1.1 These test methods cover the use of the Yerzley mechanical oscillograph for measuring mechanical properties of rubber vulcanizates in the generally small range of deformation that characterizes many technical applications. These properties include resilience, dynamic modulus, static modulus, kinetic energy, creep, and set under a given force. Measurements in compression and shear are described.^{2,3}

1.2 The test is applicable primarily, but not exclusively, to materials having static moduli at the test temperature such that forces below 2 MPa (280 psi) in compression or 1 MPa (140 psi) in shear will produce 20 % deformation, and having resilience such that at least three complete cycles are produced when obtaining the damped oscillatory curve. The range may be extended, however, by use of supplementary masses and refined methods of analysis. Materials may be compared either under comparable mean stress or mean strain conditions.

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

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. For specific precautionary statement see 12.14.*

2. Referenced Documents

2.1 ASTM Standards:

¹ These test methods are under the jurisdiction of ASTM Committee D11 on Rubber and are the direct responsibility of Subcommittee D11.14 on Time and Temperature Dependent Physical Properties.

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² A survey of some aspects of hysteresis and modulus in dynamic performance of polymers is available in a paper by Payne, A. R., "The Role of Hysteresis in Polymers," *Rubber Journal*, January 1964, p. 36.

³ One method of correlating fundamental data from the Yerzley oscillograph with dynamic tests at constant amplitude is described by Baldwin, F. P., in his paper, "Determination of the Dynamic Properties of Rubberlike Materials by Means of a Modified Yerzley Oscillograph," *The Rubber Age*, April 1950.

D 832 Practice for Rubber Conditioning for Low-Temperature Testing⁴

D 1207 Recommended Practice for Classifying Elastomeric Compounds for Resilient Automotive Mountings⁵

D 4483 Practice for Determining Precision for Test Method Standards in the Rubber and Carbon Black Industries⁴

2.2 SAE Standard:

SAE J16 Classification of Elastomer Compounds for Automotive Resilient Mountings^{6 7}

3. Terminology

3.1 Descriptions of Terms Specific to This Standard:

3.2 *effective dynamic modulus*—calculated from the formula for simple harmonic motion in a damped free oscillation. It is a composite index which includes the effect of such diverse factors as nonlinearity of stress-strain, changing molecular energies, and heat losses.

3.3 *point modulus*—ratio of total stress (force/area) to total strain (change in dimension/unstressed dimension) at one point of the stress-strain curve. Sometimes called the "secant modulus," it is equal to the slope of a line from the origin to the chosen point.

3.4 *static modulus*—synonymous with "tangent modulus" and is the slope of the tangent to the stress-strain curve at a chosen point. It can provide a reference for comparison with the effective dynamic modulus at that point.

4. Summary of Test Methods

4.1 Specimens are loaded by an unbalanced lever and the resultant deflections are recorded on a chronograph. This permits calculations to be made of static modulus at any stage of a stepwise loading or unloading schedule. Creep and

⁴ *Annual Book of ASTM Standards*, Vol 09.01.

⁵ *Discontinued*—see 1971 *Annual Book of ASTM Standards*, Part 28.

⁶ Available from Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

⁷ The Yerzley oscillograph was originally described in detail in the paper by Yerzley, F. L., "A Mechanical Oscillograph for Routine Tests of Rubber and Rubber-Like Materials," *Proceedings, ASTM*, Vol 39, 1939, p. 1180; also *Rubber Chemistry and Technology*, Vol XIII, No. 1, January 1940, p. 149.