Designation: E132 – 17

Standard Test Method for Poisson's Ratio at Room Temperature[1]

This standard is issued under the fixed designation E132; 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 U.S. Department of Defense.

1. Scope

1.1 This test method covers the determination of Poisson's ratio from tension tests of structural materials at room temperature. This test method is limited to specimens of rectangular section and to materials in which and stresses at which creep is negligible compared to the strain produced immediately upon loading.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

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

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E4 Practices for Force Verification of Testing Machines

E6 Terminology Relating to Methods of Mechanical Testing

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E8 Test Methods for Tension Testing of Metallic Materials

E83 Practice for Verification and Classification of Extensometer Systems

E111 Test Method for Young's Modulus, Tangent Modulus, and Chord Modulus

E1012 Practice for Verification of Testing Frame and Specimen Alignment Under Tensile and Compressive Axial Force Application

3. Terminology

3.1 *Definitions:*Terms common to mechanical testing.

3.1.1 The definitions of mechanical testing terms that appear in Terminology E6 apply to this test method. These terms include extensometer and stress-strain diagram.

3.1.2 In addition, the following common terms that appear in Terminology E6 apply to this test method.

3.1.3 The terms accuracy, bias, and precision are used as defined in E177.

3.1.4 *axial strain, n*—linear strain in a plane parallel to the longitudinal axis of the specimen.

3.1.5 *Poisson's ratio, μ, n*—the negative of the ratio of transverse strain to the corresponding axial strain resulting from an axial stress below the proportional limit of the material.

3.1.5.1 *Discussion*—Poisson's ratio may be negative for some materials. For example, a tensile transverse strain will result from a tensile axial strain.

3.1.5.2 *Discussion*—Poisson's ratio will have more than one value if the material is not isotropic.

3.1.6 *proportional limit, [FL^{-2}], n*—the greatest stress that a material is capable of sustaining without any deviation from proportionality of stress to strain (Hooke's Law).

3.1.6.1 *Discussion*—Many experiments have shown that values observed for the proportional limit vary greatly with the sensitivity and accuracy of the testing equipment, eccentricity of loading, the scale to which the stress-strain diagram is plotted, and other factors. When determination of the proportional limit is required, the procedure and the sensitivity of the test equipment should be specified.

3.1.7 *transverse strain, ε_t, n*—linear strain in a plane perpendicular to the axis of the specimen.

3.1.7.1 *Discussion*—Transverse strain may differ with direction in anisotropic materials.

3.2 *Definitions of Terms Specific to This Standard:*

[1] This test method is under the jurisdiction of ASTM Committee E28 on Mechanical Testing and is the direct responsibility of Subcommittee E28.04 on Uniaxial Testing.

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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.

3.2.1 *longitudinal strain, ε_l, n*—the strain in the direction of the major axis of the specimen and parallel to the direction of the applied uniaxial force.

4. Significance and Use

4.1 When uniaxial force is applied to a solid, it deforms in the direction of the applied force, but also expands or contracts laterally depending on whether the force is tensile or compressive. If the solid is homogeneous and isotropic, and the material remains elastic under the action of the applied force, the lateral strain bears a constant relationship to the axial strain. This constant, called Poisson's ratio, is an intrinsic material property just like Young's modulus and Shear modulus.

4.2 Poisson's ratio is used for design of structures where all dimensional changes resulting from application of force need to be taken into account, and in the application of the generalized theory of elasticity to structural analysis.

4.3 In this test method, the value of Poisson's ratio is obtained from strains resulting from uniaxial stress only.

4.4 Above the proportional limit, the ratio of transverse strain to axial strain will depend on the average stress and on the stress range for which it is measured and, hence, should not be regarded as Poisson's ratio. If this ratio is reported, nevertheless, as a value of "Poisson's ratio" for stresses below the proportional limit, the range of stress should be reported.

4.5 Deviations from isotropy should be suspected if the Poisson's ratio, μ, determined by the method described below differs significantly from that determined when the ratio *E/G* of Young's modulus, *E*, to shear modulus, *G*, is substituted in the following equation:

$$\mu = (E/2G) - 1 \quad (1)$$

where *E* and *G* must be measured with greater precision than the precision desired in the measurement of μ.

4.6 The accuracy of the determination of Poisson's ratio is usually limited by the accuracy of the transverse strain measurements because the percentage errors in these measurements are usually greater than in the axial strain measurements. Since a ratio rather than an absolute quantity is measured, it is only necessary to know accurately the relative value of the calibration factors of the extensometers. Also, in general, the values of the applied forces need not be accurately known. It is frequently expedient to make the determination of Poisson's ratio concurrently with determinations of Young's modulus and the proportional limit.

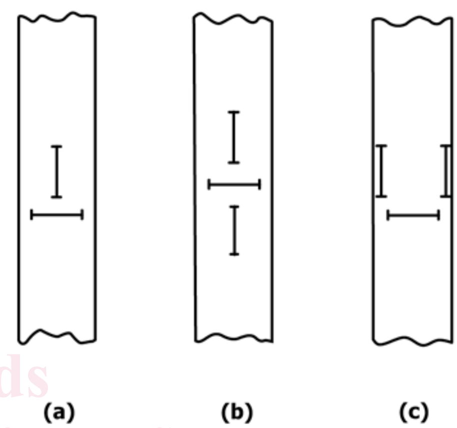
5. Apparatus

5.1 *Forces*—Forces shall be applied either by verified dead weights or in a testing machine that has been calibrated in accordance with Practices E4.

5.2 *Extensometers*—Class B-1 extensometers or better, as described in Practice E83, shall be used except as otherwise provided in the product specifications.

NOTE 1—If exceptions are provided in the product specification so that extensometers of types other than those covered in Practice E83 are used, it may be necessary to apply corrections, for example, the correction for the transverse sensitivity[3] of bonded resistance gages.

5.2.1 At least two pairs of extensometers should be used—one pair for measuring longitudinal strain and the other for transverse strain, with the extensometers of each pair parallel to each other and on opposite sides of the specimen. Additional extensometers may be used to check on alignment or to obtain better average strains in the case of unavoidable variations in thickness. The extensometers should be placed on the specimen with a free distance of at least one specimen width between any extensometer and the nearest fillet, and at least two specimen widths between any extensometer and the nearest grip.



NOTE 1—Each symbol indicates the location of a pair of extensometers on opposite sides of the specimen.

FIG. 1 Three Possible Arrangements of Extensometers

NOTE 2—Three possible arrangements of extensometers, among the many that have been used, are shown in Fig. 1. Arrangement (a), Fig. 1, which requires only two pairs of extensometers, can be used if the conditions are very nearly ideal with respect to axiality of applied force and constancy of cross-section within the length in which the extensometers are placed. An additional pair of extensometers is used in arrangement (b) to provide some compensation for the effect of a uniform variation in thickness in the longitudinal direction. The other arrangement of three pairs of extensometers, arrangement (c), provides a check on alignment.

5.3 *Alignment Devices*—Grips and other devices for obtaining and maintaining axial alignment are shown in Test Methods E8.

6. Test Specimens

6.1 *Selection and Preparation of Specimens*—Select and prepare test specimens that are straight and uniform in thickness and representative of the material being tested.

6.2 *Dimensions*—The tested length of the specimen should be at least five times the tested width, and the length between the grips should be seven times the tested width. The tested width shall be least equal to the tested thickness. The radius of the fillets shall not be not less than the minimum width of the specimen. The width shall be constant over the entire length where the extensometers are placed and for an additional

[3] Perry, C. C., and Lissner, H. R., *The Strain Gage Primer*, McGraw-Hill Book Co., New York, NY, 1955, pp. 141–146.