Designation: E1012 – 14

Standard Practice for Verification of Testing Frame and Specimen Alignment Under Tensile and Compressive Axial Force Application[1]

This standard is issued under the fixed designation E1012; 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 Included in this practice are methods covering the determination of the amount of bending that occurs during the application of tensile and compressive forces to notched and unnotched test specimens during routine testing in the elastic range. These methods are particularly applicable to the force levels normally used for tension testing, creep testing, and uniaxial fatigue testing. The principal objective of this practice is to assess the amount of bending exerted upon a test specimen by the ordinary components assembled into a materials testing machine, during routine tests.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E6 Terminology Relating to Methods of Mechanical Testing
E8 Test Methods for Tension Testing of Metallic Materials
E9 Test Methods of Compression Testing of Metallic Materials at Room Temperature
E21 Test Methods for Elevated Temperature Tension Tests of Metallic Materials
E83 Practice for Verification and Classification of Extensometer Systems
E251 Test Methods for Performance Characteristics of Metallic Bonded Resistance Strain Gages
E466 Practice for Conducting Force Controlled Constant Amplitude Axial Fatigue Tests of Metallic Materials
E606 Test Method for Strain-Controlled Fatigue Testing
E1237 Guide for Installing Bonded Resistance Strain Gages

2.2 *Other Documents:*

VAMAS Guide 42 A Procedure for the Measurement of Machine Alignment in Axial Testing

3. Terminology

3.1 *Definitions of Terms Common to Mechanical Testing:*

3.1.1 For definitions of terms used in this practice that are common to mechanical testing of materials, see Terminology E6.

3.1.2 *alignment, n*—the condition of a testing machine that influences the introduction of bending moments into a specimen (or alignment transducer) during the application of tensile or compressive forces.

3.1.3 *eccentricity [L], n*—the distance between the line of action of the applied force and the axis of symmetry of the specimen in a plane perpendicular to the longitudinal axis of the specimen.

3.1.4 *reduced section [L], n*—section in the central portion of the specimen which has a cross section smaller than the gripped ends.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *axial strain, a, n*—the average of the longitudinal strains measured by strain gages at the surface on opposite sides of the longitudinal axis of symmetry of the alignment transducer by multiple strain-sensing devices located at the same longitudinal position.

3.2.1.1 *Discussion*—This definition is only applicable to this standard. The term is used in other contexts elsewhere in mechanical testing.

3.2.2 *bending strain, b, n*—the difference between the strain at the surface and the axial strain (see Fig. 1).

3.2.2.1 *Discussion*—in general, the bending strain varies from point to point around and along the reduced section of the specimen. Bending strain is calculated as shown in Section 10.

3.2.3 *component (also known as force application component), n*—any of the parts used in the attachment of the load cell or grips to the testing frame, as well as any part, including the grips used in the application of force to the strain-gaged alignment transducer or the test specimen.

3.2.4 *grips, n*—that part of the force application components that directly attach to the strain-gage alignment transducer or the test specimen.

3.2.5 *microstrain, n*—strain expressed in micro-units per unit, such as micrometers/meter or microinches/in.

[1] This practice is under the jurisdiction of ASTM Committee E28 on Mechanical Testing and is the direct responsibility of Subcommittee E28.01 on Calibration of Mechanical Testing Machines and Apparatus.

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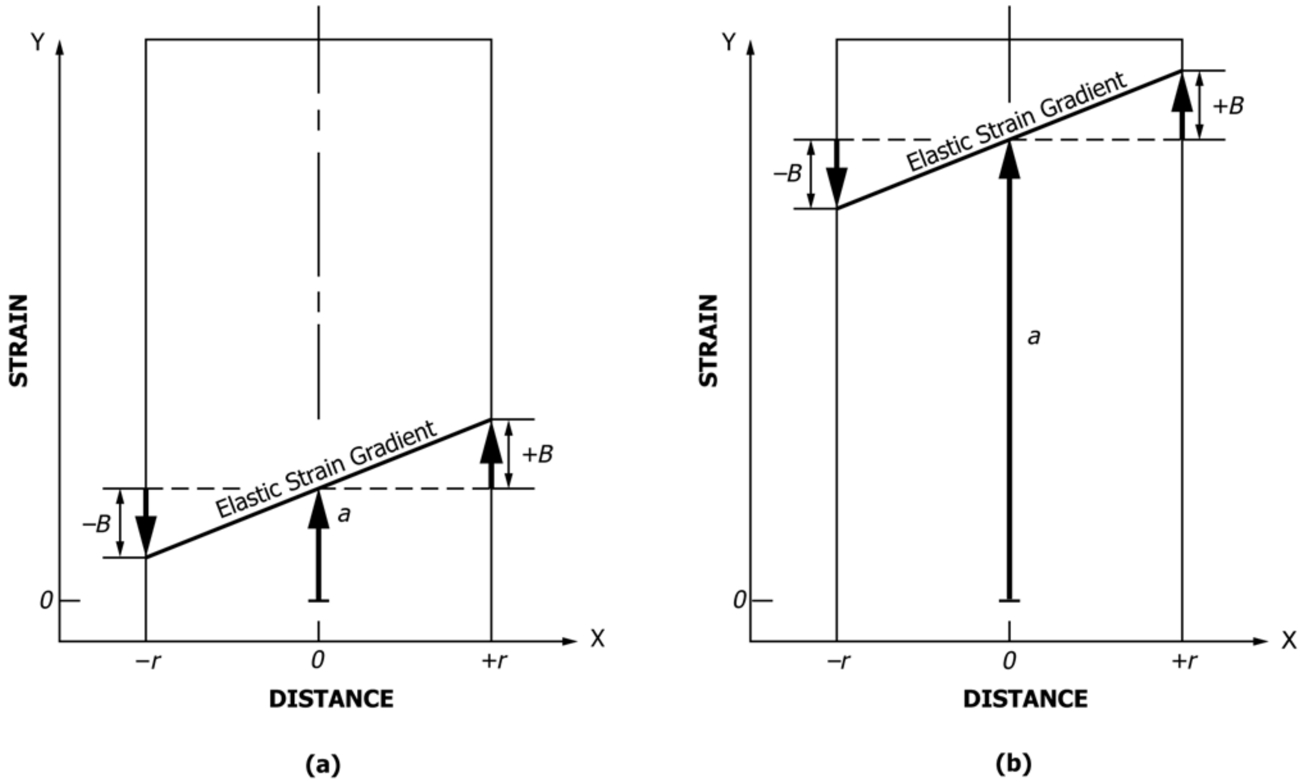
[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

*A Summary of Changes section appears at the end of this standard



NOTE 1—A bending strain, ±*B*, is superimposed on the axial strain, *a*, for low-axial strain (or stress) in (*a*) and high-axial strain (or stress) in (*b*). For the same bending strain ±*B*, a high-percent bending is indicated in (*a*) and a low-percent bending is indicated in (*b*).

FIG. 1 Schematic Representations of Bending Strains (or Stresses) That May Accompany Uniaxial Loading

3.2.6 *notched section [L], n*—the section perpendicular to the longitudinal axis of symmetry of the specimen where the cross-sectional area is intentionally at a minimum value in order to serve as a stress raiser.

3.2.7 *percent bending, PB, (also known as percent bending strain), n*—the ratio of the bending strain to the axial strain expressed as a percentage.

3.2.8 *strain-gaged alignment transducer, n*—the transducer used to determine the state of bending and the percent bending of a testing frame.

3.2.9 *Type 1 alignment, n*—the condition of a testing machine typically used for static or quasi-static testing including the non-rigid components and the positioning of the specimen within the grips which can introduce bending moments into the strain-gaged alignment transducer or test specimen during force application.

3.2.10 *Type 2 alignment, n*—the condition of a testing machine typically used for dynamic testing and all rigid parts of the load train which can introduce bending moments into the strain-gaged alignment transducer or test specimen force application.

4. Significance and Use

4.1 It has been shown that bending stresses that inadvertently occur due to misalignment between the applied force and the specimen axes during the application of tensile and compressive forces can affect the test results. In recognition of this effect, some test methods include a statement limiting the misalignment that is permitted. The purpose of this practice is to provide a reference for test methods and practices that require the application of tensile or compressive forces under conditions where alignment is important. The objective is to implement the use of common terminology and methods for verification of alignment of testing machines, associated components and test specimens.

4.2 Alignment verification intervals when required are specified in the methods or practices that require the alignment verification. Certain types of testing can provide an indication of the current alignment condition of a testing frame with each specimen tested. If a test method requires alignment verification, the frequency of the alignment verification should capture all the considerations i.e. time interval, changes to the testing frame and when applicable, current indicators of the alignment condition through test results.

4.3 Whether or not to improve axiality should be a matter of negotiation between the material producer and the user.

5. Verification of Alignment

5.1 A numerical requirement for alignment should specify the force, strain-gaged alignment transducer dimensions, and temperature at which the measurement is to be made. Alternate methods employed when strain levels are of particular importance may be used as described in Practices E466 or E606. When these methods are used, the numerical requirement should specify the strain levels, strain-gaged alignment transducer dimensions and temperature at which the measurement is to be made.

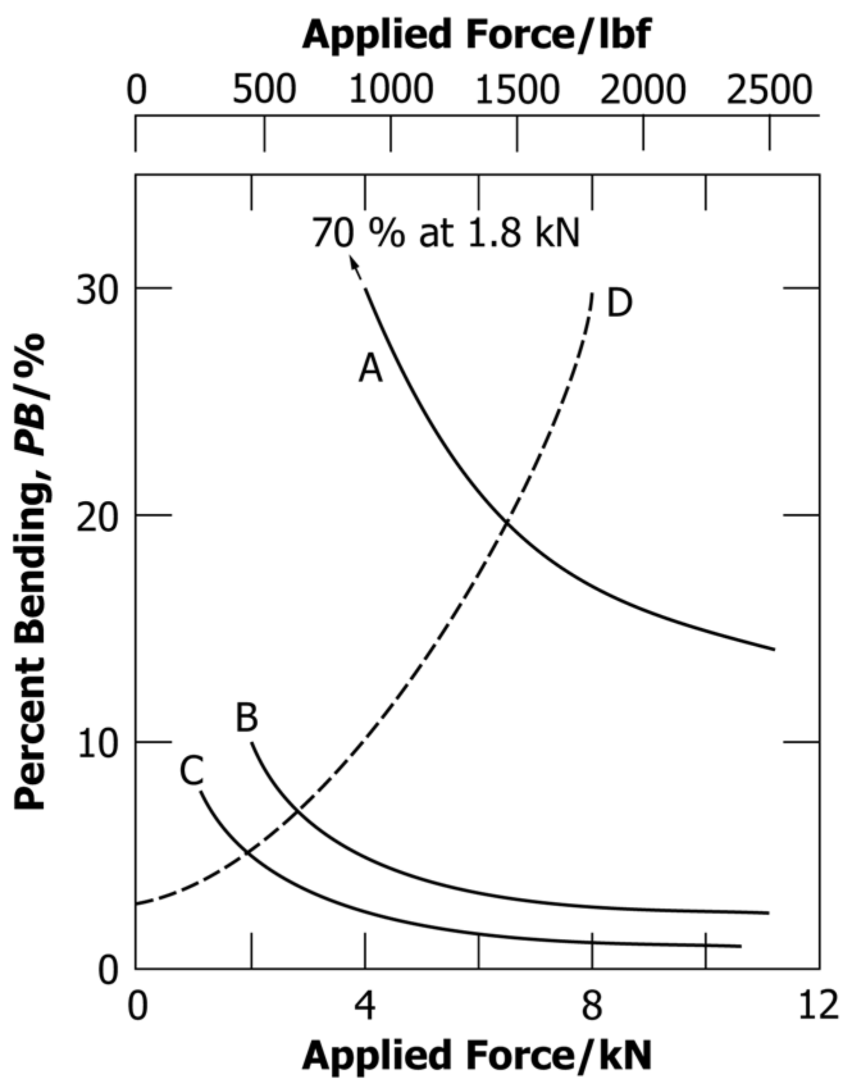
NOTE 1—For a misaligned load train, the percent bending usually decreases with increasing applied force. (See Curves A, B, and C in Fig. 2.) However, in some severe instances, percent bending may increase with increasing applied force. (See Curve D in Fig. 2.)

5.2 For a verification of alignment to be reported in compliance with the current revision of E1012 a strain-gaged alignment transducer shall be used. This applies to both Type 1 and Type 2 levels of alignment verification.

5.2.1 This standard defines two types of classified testing machine alignment per the classification criteria. The type of alignment shall be noted on the report.

5.2.2 When performing an alignment of a testing machine for the first time or if normally fixed components have been adjusted or repaired, a mechanical alignment of the testing machine should be performed. For tensile and fatigue equipment, this step can be accomplished by means of a dial indicator for concentricity alignment adjustment and with precision shims or feeler gauges with the components brought together for angularity alignment adjustment. For creep and stress-rupture machines incorporating lever arms, this step may be accomplished by means of precision shims or feeler gauges, and/or double knife-edge couplings, and/or suitable components below the lower crosshead of the testing machine. Severe damage may occur to a strain-gaged alignment transducer if this step is omitted. A Mechanical Alignment is a preliminary step, but is not a substitute for a verification of alignment using a strain-gaged alignment transducer.

5.3 *Testing Machine Alignment Type 1*—A general alignment verification of the defined load train components. It is understood that some parts of the testing machine (i.e. the crosshead, actuator or grip faces) may be moved or exchanged in normal day to day testing. This alignment verification should



NOTE 1—Curve A: Machine 1, threaded grip ends (1)

NOTE 2—Curve B: Machine 2, buttonhead grip ends (1)

NOTE 3—Curve C: Machine 3, grips with universal couplings (2)

NOTE 4—Curve D: schematic representation of a possible response from a concentrically misaligned load train (3)

FIG. 2 Effects of Applied Force on Percent Bending for Different Testing Machines and Gripping Methods