Designation: E606/E606M – 21

Standard Test Method for Strain-Controlled Fatigue Testing[1]

This standard is issued under the fixed designation E606/E606M; 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 the determination of fatigue properties of nominally homogeneous materials by the use of test specimens subjected to uniaxial forces. It is intended as a guide for fatigue testing performed in support of such activities as materials research and development, mechanical design, process and quality control, product performance, and failure analysis. While this test method is intended primarily for strain-controlled fatigue testing, some sections may provide useful information for force-controlled or stress-controlled testing.

1.2 The use of this test method is limited to specimens and does not cover testing of full-scale components, structures, or consumer products.

1.3 This test method is applicable to temperatures and strain rates for which the magnitudes of time-dependent inelastic strains are on the same order or less than the magnitudes of time-independent inelastic strains. No restrictions are placed on environmental factors such as temperature, pressure, humidity, medium, and others, provided they are controlled throughout the test, do not cause loss of or change in dimension with time, and are detailed in the data report.

NOTE 1—The term *inelastic* is used herein to refer to all nonelastic strains. The term *plastic* is used herein to refer only to the time-independent (that is, noncreep) component of inelastic strain. To truly determine a time-independent strain the force would have to be applied instantaneously, which is not possible. A useful engineering estimate of time-independent strain can be obtained when the strain rate exceeds some value. For example, a strain rate of 1×10^{-3} sec^{-1} is often used for this purpose. This value should increase with increasing test temperature.

1.4 This test method is restricted to the testing of uniform gage section test specimens subjected to axial forces as shown in Fig. 1(a). Testing is limited to strain-controlled cycling. The test method may be applied to hourglass specimens, see Fig. 1(b), but the user is cautioned about uncertainties in data analysis and interpretation. Testing is done primarily under constant amplitude cycling and may contain interspersed hold times at repeated intervals. The test method may be adapted to guide testing for more general cases where strain or temperature may vary according to application specific histories. Data analysis may not follow this test method in such cases.

1.5 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.6 *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]

A370 Test Methods and Definitions for Mechanical Testing of Steel Products
E3 Guide for Preparation of Metallographic Specimens
E4 Practices for Force Verification of Testing Machines
E8/E8M Test Methods for Tension Testing of Metallic Materials
E9 Test Methods of Compression Testing of Metallic Materials at Room Temperature
E83 Practice for Verification and Classification of Extensometer Systems
E111 Test Method for Young's Modulus, Tangent Modulus, and Chord Modulus
E112 Test Methods for Determining Average Grain Size
E132 Test Method for Poisson's Ratio at Room Temperature
E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods
E209 Practice for Compression Tests of Metallic Materials at Elevated Temperatures with Conventional or Rapid Heating Rates and Strain Rates

[1] This test method is under the jurisdiction of ASTM Committee E08 on Fatigue and Fracture and is the direct responsibility of Subcommittee E08.05 on Cyclic Deformation and Fatigue Crack Formation.

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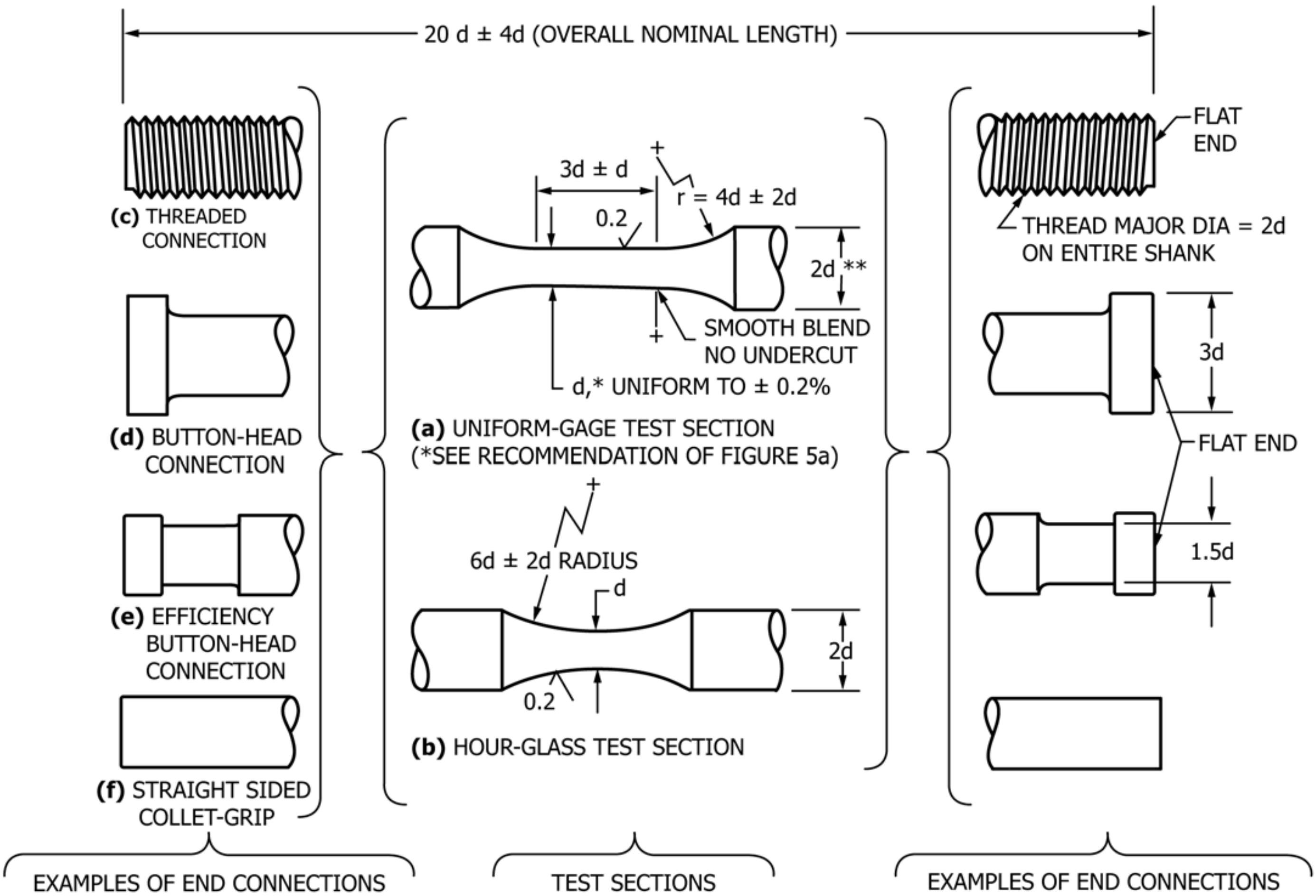
[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.



NOTE 1—* Dimension d is recommended to be 6.35 mm [0.25 in.]. See 7.1. Centers permissible. ** This diameter may be made greater or less than 2d depending on material hardness. In typically ductile materials diameters less than 2d are often employed and in typically brittle materials diameters greater than 2d may be found desirable.

NOTE 2—Threaded connections are more prone to inferior axial alignment and have greater potential for backlash, particularly if the connection with the grip is not properly designed.

FIG. 1 Recommended Low-Cycle Fatigue Specimens

E337 Test Method for Measuring Humidity with a Psychrometer (the Measurement of Wet- and Dry-Bulb Temperatures)
E384 Test Method for Microindentation Hardness of Materials
E399 Test Method for Linear-Elastic Plane-Strain Fracture Toughness of Metallic Materials
E466 Practice for Conducting Force Controlled Constant Amplitude Axial Fatigue Tests of Metallic Materials
E467 Practice for Verification of Constant Amplitude Dynamic Forces in an Axial Fatigue Testing System
E468 Practice for Presentation of Constant Amplitude Fatigue Test Results for Metallic Materials
E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method
E739 Practice for Statistical Analysis of Linear or Linearized Stress-Life (***S-N***) and Strain-Life (ε-***N***) Fatigue Data
E1012 Practice for Verification of Testing Frame and Specimen Alignment Under Tensile and Compressive Axial Force Application
E1049 Practices for Cycle Counting in Fatigue Analysis
E1245 Practice for Determining the Inclusion or Second-Phase Constituent Content of Metals by Automatic Image Analysis
E1823 Terminology Relating to Fatigue and Fracture Testing

3. Terminology

3.1 The definitions in this test method are in accordance with Terminology E1823.

3.2 *Definitions:* Additional definitions associated with time-dependent deformation behavior observed in tests at elevated homologous temperatures are as follows:

3.2.1 *hold period,* τ_h—the time interval within a cycle during which the stress or strain is held constant.

3.2.2 *inelastic strain,* ε_{in}—the strain that is not elastic.

3.2.2.1 *Discussion*—For isothermal conditions, ε_{in} is calculated by subtracting the elastic strain from the total strain.

3.2.3 *total cycle period,* τ_t—the time for the completion of one cycle. The parameter τ_t can be separated into hold and non-hold (that is, steady and dynamic) components: