



Designation: E 1820 – 99a

Standard Test Method for Measurement of Fracture Toughness¹

This standard is issued under the fixed designation E 1820; 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 procedures and guidelines for the determination of fracture toughness of metallic materials using the following parameters: K , J , and CTOD (δ). Toughness can be measured in the R -curve format or as a point value. The fracture toughness determined in accordance with this test method is for the opening mode (Mode I) of loading.

1.2 The recommended specimens are single-edge bend, [SE(B)], compact, [C(T)], and disk-shaped compact, [DC(T)]. All specimens contain notches that are sharpened with fatigue cracks.

1.2.1 Specimen dimensional (size) requirements vary according to the fracture toughness analysis applied. The guidelines are established through consideration of material toughness, material flow strength, and the individual qualification requirements of the toughness value per values sought.

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.*

NOTE 1—Other standard methods for the determination of fracture toughness using the parameters K , J , and CTOD are contained in Test Methods E 399, E 813, E 1152, E 1290, and E 1737. This test method was developed to provide a common method for determining all applicable toughness parameters from a single test.

2. Referenced Documents

2.1 ASTM Standards:

- E 4 Practices for Force Verification of Testing Machines²
- E 8 Test Methods for Tension Testing of Metallic Materials²
- E 21 Test Methods for Elevated Temperature Tension Tests of Metallic Materials²
- E 399 Test Method for Plane-Strain Fracture Toughness of Metallic Materials²

¹ This test method is under the jurisdiction of ASTM Committee E-8 on Fatigue and Fracture and is the direct responsibility of Subcommittee E08.08 on Elastic-Plastic Fracture Mechanics Technology.

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² Annual Book of ASTM Standards, Vol 03.01.

E 813 Test Method for J_{IC} , A Measure of Fracture Toughness²

E 1152 Test Method for Determining J - R Curves²

E 1290 Test Method for Crack-Tip Opening Displacement (CTOD) Fracture Toughness Measurement²

E 1737 Test Method for J-Integral Characterization of Fracture Toughness²

E 1823 Terminology Relating to Fatigue and Fracture Testing²

3. Terminology

3.1 Terminology E 1823 is applicable to this test method.

3.2 Definitions:

3.2.1 *compliance* [LF^{-1}], n —the ratio of displacement increment to load increment.

3.2.2 *crack displacement* [L], n —the separation vector between two points (on the surfaces of a deformed crack) that were coincident on the surfaces of an ideal crack in the undeformed condition.

3.2.2.1 *Discussion*—In this practice, displacement, v , is the total displacement measured by clip gages or other devices spanning the crack faces.

3.2.3 *crack extension*, Δa [L], n —an increase in crack size.

3.2.4 *crack-extension force*, G [FL^{-1} or FLL^{-2}], n —the elastic energy per unit of new separation area that is made available at the front of an ideal crack in an elastic solid during a virtual increment of forward crack extension.

3.2.5 *crack size*, a [L], n —a lineal measure of a principal planar dimension of a crack. This measure is commonly used in the calculation of quantities descriptive of the stress and displacement fields, and is often also termed crack length or depth.

3.2.5.1 *Discussion*—In practice, the value of a is obtained from procedures for measurement of physical crack size, a_p , original crack size, a_o , and effective crack size, a_e , as appropriate to the situation being considered.

3.2.6 *crack-tip opening displacement (CTOD)*, δ [L], n —the crack displacement due to elastic and plastic deformation at variously defined locations near the original (prior to an application of load) crack tip.

3.2.6.1 *Discussion*—In this test method, CTOD is the displacement of the crack surfaces normal to the original (unloaded) crack plane at the tip of the fatigue precrack, a_o . In this test method, CTOD is calculated at the original crack length,