



Standard Test Method for Plane-Strain Fracture Toughness of Metallic Materials¹

This standard is issued under the fixed designation E 399; 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.

1. Scope

1.1 This test method covers the determination of the plane-strain fracture toughness (K_{Ic}) of metallic materials by tests using a variety of fatigue-cracked specimens having a thickness of 0.063 in. (1.6 mm) or greater.² The details of the various specimen and test configurations are shown in Annex A1-Annex A7 and Annex A9.

NOTE 1—Plane-strain fracture toughness tests of thinner materials that are sufficiently brittle (see 7.1) can be made with other types of specimens (1).³ There is no standard test method for testing such thin materials.

1.2 This test method also covers the determination of the specimen strength ratio R_{sx} where x refers to the specific specimen configuration being tested. This strength ratio is a function of the maximum load the specimen can sustain, its initial dimensions and the yield strength of the material.

1.3 Measured values of plane-strain fracture toughness stated in inch-pound units are to be regarded as standard.

1.4 This test method is divided into two main parts. The first part gives general information concerning the recommendations and requirements for K_{Ic} testing. The second part is composed of annexes that give the displacement gage design, fatigue cracking procedures, and special requirements for the various specimen configurations covered by this method. In addition, an annex is provided for the specific procedures to be followed in rapid-load plane-strain fracture toughness tests.

¹ This test method is under the jurisdiction of ASTM Committee E-8 on Fatigue and Fracture and is the direct responsibility of Subcommittee E08.07 on Linear-Elastic Fracture.

Current edition approved Nov. 30, 1990. Published April 1991. Originally published as E 399 – 70 T. Last previous edition E 399 – 83.

² For additional information relating to the fracture toughness testing of aluminum alloys, see Method B 645.

³ The boldface numbers in parentheses refer to the list of references at the end of this test method.

General information and requirements common to all specimen types are listed as follows:

	Sections
Referenced Documents	2
Terminology	3
Stress-Intensity Factor	3.1.1
Plane-Strain Fracture Toughness	3.1.2
Summary of Test Method	4
Significance and Use	5
Precautions	5.1.1-5.1.3
Practical Applications	5.2
Apparatus	6
Loading Fixtures	6.2
Displacement Gage Design	Annex A1
Displacement Measurements	6.3
Specimen Size, Configurations, and Preparation	7
Specimen Size Estimates	7.1
Standard and Alternative Specimen Configurations	7.2
Forms of Fatigue Crack Starter Notch	7.3.1
Fatigue Cracking	Annex A2
Crack Extension Beyond Starter	7.3.2.2
Measurements before Testing	
Thickness	8.2.1
Width	8.2.3
Starter Notch Root Radius	7.3.1
Specimen Testing	
Loading Rate	8.3
Test Record	8.4
Measurements after Testing	
Crack Length	8.2.2
Crack Plane Angle	8.2.4
Calculation and Interpretation of Results	9
Analysis of Test Record	9.1
Validity Requirements on P_{max}/P_Q	9.1.2
Validity Requirements on Specimen Size	9.1.3
Crack Plane Orientation Designations	9.2
Fracture Appearance Descriptions	9.3
Reporting	10
Precision and Bias	11
Special Requirements for Rapid Load $K_{Ic}(t)$ Tests	Annex A7