



Designation: E399 – 20

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

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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 fracture toughness (K_{Ic} and optionally K_{Isi}) of metallic materials under predominantly linear-elastic, plane-strain conditions using fatigue precracked specimens having a thickness of 1.6 mm (0.063 in.) or greater² subjected to slowly, or in special (elective) cases rapidly, increasing crack-displacement force. Details of test apparatus, specimen configuration, and experimental procedure are given in the annexes. Two procedures are outlined for using the experimental data to calculate fracture toughness values:

1.1.1 The K_{Ic} test procedure is described in the main body of this test standard and is a mandatory part of the testing and results reporting procedure for this test method. The K_{Ic} test procedure is based on crack growth of up to 2 % percent of the specimen width. This can lead to a specimen size dependent rising fracture toughness resistance curve, with larger specimens producing higher fracture toughness results.

1.1.2 The K_{Isi} test procedure is described in **Appendix X1** and is an optional part of this test method. The K_{Isi} test procedure is based on a fixed amount of crack extension of 0.5 mm, and as a result, K_{Isi} is less sensitive to specimen size than K_{Ic} . This less size-sensitive fracture toughness, K_{Isi} , is called size-insensitive throughout this test method. **Appendix X1** contains an optional procedure for reinterpreting the force-displacement test record recorded as part of this test method to calculate the additional fracture toughness value, K_{Isi} .

NOTE 1—Plane-strain fracture toughness tests of materials thinner than 1.6 mm (0.063 in.) that are sufficiently brittle (see 7.1) can be made using other types of specimens (1).³ There is no standard test method for such thin materials.

¹ This test method is under the jurisdiction of ASTM Committee E08 on Fatigue and Fracture and is the direct responsibility of Subcommittee E08.07 on Fracture Mechanics.

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² For additional information relating to the fracture toughness testing of aluminum alloys, see Practice B645.

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

1.2 This test method is divided into two parts. The first part gives general recommendations and requirements for testing and includes specific requirements for the K_{Ic} test procedure. The second part consists of Annexes that give specific information on displacement gage and loading fixture design, special requirements for individual specimen configurations, and detailed procedures for fatigue precracking. Additional annexes are provided that give specific procedures for beryllium and rapid-force testing, and the K_{Isi} test procedure, which provides an optional additional analysis procedure for the test data collected as part of the K_{Ic} test procedure.

1.3 General information and requirements common to all specimen configurations:

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