



Standard Test Method for Determining Plane-Strain Crack-Arrest Fracture Toughness, K_{Ia} , of Ferritic Steels¹

This standard is issued under the fixed designation E 1221; 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 employs a side-grooved, crack-line-wedge-loaded specimen to obtain a rapid run-arrest segment of flat-tensile separation with a nearly straight crack front. This test method provides a static analysis determination of the stress intensity factor at a short time after crack arrest. The estimate is denoted K_a . When certain size requirements are met, the test result provides an estimate, termed K_{Ia} , of the plane-strain crack-arrest toughness of the material.

1.2 The specimen size requirements, discussed later, provide for in-plane dimensions large enough to allow the specimen to be modeled by linear elastic analysis. For conditions of plane-strain, a minimum specimen thickness is also required. Both requirements depend upon the crack arrest toughness and the yield strength of the material. A range of specimen sizes may therefore be needed, as specified in this test method.

1.3 If the specimen does not exhibit rapid crack propagation and arrest, K_a cannot be determined.

1.4 Values stated in inch-pound units are to be regarded as the standards. SI units are provided for information only.

1.5 *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.*

2. Referenced Documents

2.1 ASTM Standards:

E 8 Test Methods for Tension Testing of Metallic Materials²

E 23 Test Methods for Notched Bar Impact Testing of Metallic Materials²

E 208 Test Method for Conducting Drop-Weight Test to Determine Nil-Ductility Transition Temperature of Ferritic Steels²

E 399 Test Method for Plane-Strain Fracture Toughness of Metallic Materials²

E 616 Terminology Relating to Fracture Testing²

E 1304 Test Method for Plane-Strain (Chevron Notch) Fracture Toughness of Metallic Materials²

3. Terminology

3.1 Definitions:

3.1.1 Definitions in Terminology E 616 are applicable to this test method.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *conditional value of the plane-strain crack-arrest fracture toughness, K_{Qa} ($FL^{-3/2}$)*—the conditional value of K_{Ia} calculated from the test results and subject to the validity criteria specified in this test method.

3.2.1.1 *Discussion*—In this test method, side-grooved specimens are used. The calculation of K_{Qa} is based upon measurements of both the arrested crack length and of the crack-mouth opening displacement prior to initiation of a fast-running crack and shortly after crack arrest.

3.2.2 *crack-arrest fracture toughness, K_a ($FL^{-3/2}$)*—the value of the stress intensity factor shortly after crack arrest.

3.2.2.1 *Discussion*—The in-plane specimen dimensions must be large enough for adequate enclosure of the crack-tip plastic zone by a linear-elastic stress field.

3.2.3 *plane-strain crack-arrest fracture toughness, K_{Ia} ($FL^{-3/2}$)*—the value of crack-arrest fracture toughness, K_a , for a crack that arrests under conditions of crack-front plane-strain.

3.2.3.1 *Discussion*—The requirements for attaining conditions of crack-front plane-strain are specified in the procedures of this test method.

3.2.4 *stress intensity factor at crack initiation, K_o ($FL^{-3/2}$)*—the value of K at the onset of rapid fracturing.

3.2.4.1 *Discussion*—In this test method, only a nominal estimate of the initial driving force is needed. For this reason, K_o is calculated on the basis of the original (machined) crack (or notch) length and the crack-mouth opening displacement at the initiation of a fast-running crack.

4. Summary of Test Method

4.1 This test method estimates the value of the stress intensity factor, K , at which a fast running crack will arrest. This test method is made by forcing a wedge into a split-pin, which applies an opening force across the crack starter notch in

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

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² *Annual Book of ASTM Standards*, Vol 03.01.