



# Standard Test Method for Plane-Strain (Chevron-Notch) Fracture Toughness of Metallic Materials<sup>1</sup>

This standard is issued under the fixed designation E1304; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This test method covers the determination of plane-strain (chevron-notch) fracture toughnesses,  $K_{Iv}$  or  $K_{IvM}$ , of metallic materials. Fracture toughness by this method is relative to a slowly advancing steady state crack initiated at a chevron-shaped notch, and propagating in a chevron-shaped ligament (Fig. 1). Some metallic materials, when tested by this method, exhibit a sporadic crack growth in which the crack front remains nearly stationary until a critical load is reached. The crack then becomes unstable and suddenly advances at high speed to the next arrest point. For these materials, this test method covers the determination of the plane-strain fracture toughness,  $K_{Ivj}$  or  $K_{IvM}$ , relative to the crack at the points of instability.

NOTE 1—One difference between this test method and Test Method E399 (which measures  $K_{Ic}$ ) is that Test Method E399 centers attention on the start of crack extension from a fatigue precrack. This test method makes use of either a steady state slowly propagating crack, or a crack at the initiation of a crack jump. Although both methods are based on the principles of linear elastic fracture mechanics, this difference, plus other differences in test procedure, may cause the values from this test method to be larger than  $K_{Ic}$  values in some materials. Therefore, toughness values determined by this test method cannot be used interchangeably with  $K_{Ic}$ .

1.2 This test method uses either chevron-notched rod specimens of circular cross section, or chevron-notched bar specimens of square or rectangular cross section (Figs. 1-10). The terms “short rod” and “short bar” are used commonly for these types of chevron-notched specimens.

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

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 appro-*

*priate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

- E4 Practices for Force Verification of Testing Machines
- E8/E8M Test Methods for Tension Testing of Metallic Materials
- E399 Test Method for Linear-Elastic Plane-Strain Fracture Toughness  $K_{Ic}$  of Metallic Materials
- E1823 Terminology Relating to Fatigue and Fracture Testing

## 3. Terminology

### 3.1 Definitions:

3.1.1 The terms described in Terminology E1823 are applicable to this test method.

3.1.2 *stress-intensity factor*,  $K_I$  [ $\text{FL}^{-3/2}$ ]*—*the magnitude of the mathematically ideal crack-tip stress field (stress-field singularity) for mode I in a homogeneous linear-elastic body.

3.1.2.1 *Discussion*—Values of  $K$  for mode I are given by the following equation:

$$K_I = \lim_{r_x \rightarrow 0} \sigma_y [2\pi r_x]^{1/2}$$

where:

$r_x$  = distance from the crack tip to a location where the stress is calculated and

$\sigma_y$  = the principal stress  $r_x$  normal to the crack plane.

### 3.2 Definitions of Terms Specific to This Standard:

3.2.1 *plane-strain (chevron-notch) fracture toughness*,  $K_{Iv}$  or  $K_{Ivj}$  [ $\text{FL}^{-3/2}$ ]*—*under conditions of crack-tip plane strain in a chevron-notched specimen:  $K_{Iv}$  relates to extension resistance with respect to a slowly advancing steady-state crack.  $K_{Ivj}$  relates to crack extension resistance with respect to a crack which advances sporadically.

3.2.1.1 *Discussion*—For slow rates of loading the fracture toughness,  $K_{Iv}$  or  $K_{Ivj}$ , is the value of stress-intensity factor as

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