



Designation: E561 – 20

Standard Test Method for K_R Curve Determination¹

This standard is issued under the fixed designation E561; 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 the determination of the resistance to fracture of metallic materials under Mode I loading at static rates using either of the following notched and precracked specimens: the middle-cracked tension M(T) specimen or the compact tension C(T) specimen. A K_R curve is a continuous record of toughness development (resistance to crack extension) in terms of K_R plotted against crack extension in the specimen as a crack is driven under an increasing stress intensity factor, K . (1)²

1.2 Materials that can be tested for K_R curve development are not limited by strength, thickness, or toughness, so long as specimens are of sufficient size to remain predominantly elastic to the effective crack extension value of interest.

1.3 Specimens of standard proportions are required, but size is variable, to be adjusted for yield strength and toughness of the materials.

1.4 Only two of the many possible specimen types that could be used to develop K_R curves are covered in this method.

1.5 The test is applicable to conditions where a material exhibits slow, stable crack extension under increasing crack driving force, which may exist in relatively tough materials under plane stress crack tip conditions.

1.6 The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are provided for information only and are not considered standard.

1.7 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the*

Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

2. Referenced Documents

2.1 *ASTM Standards:*³

E4 Practices for Force Verification of Testing Machines
E399 Test Method for Linear-Elastic Plane-Strain Fracture Toughness of Metallic Materials
E1823 Terminology Relating to Fatigue and Fracture Testing

2.2 *Other Document:*

AISC Steel Construction Manual⁴

3. Terminology

3.1 *Definitions*—Terminology E1823 is applicable to this method.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *apparent fracture toughness, K_{app} [$FL^{-3/2}$]*—The stress intensity factor, K , (under non-plane strain conditions of crack-tip stress) calculated using the initial crack size and the maximum force achieved during the test.

3.2.1.1 *Discussion*— K_{app} is an engineering estimate of toughness that can be used to calculate residual strength. K_{app} not only depends on the material, but also specimen type, size, and thickness and as such is not a material property

3.2.1.2 *Discussion*— K_{app} has been historically referred to as apparent plane-stress fracture toughness, however in practice it is used to describe apparent fracture toughness under non-plane strain conditions, for example the transition region between plane-strain and plane-stress.

3.2.2 *effective modulus, E_{eff} [FL^{-2}]*—an elastic modulus that allows a theoretical (modulus normalized) compliance to match an experimentally measured compliance for an actual initial crack size a_o .

3.2.3 K_c [$FL^{-3/2}$]

—The stress intensity factor, K_c , is measured as the value of K_R (the crack extension resistance under

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

³ For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

⁴ Available from American Institute of Steel Construction (AISC), One E. Wacker Dr., Suite 700, Chicago, IL 60601-1802, <http://www.aisc.org>.

*A Summary of Changes section appears at the end of this standard