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Standard Terminology Relating to Fatigue and Fracture Testing¹

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1. Scope

1.1 This terminology contains definitions, definitions of terms specific to certain standards, symbols, and abbreviations approved for use in standards on fatigue and fracture testing. The definitions are preceded by two lists. The first is an alphabetical listing of symbols used. (Greek symbols are listed in accordance with their spelling in English.) The second is an alphabetical listing of relevant abbreviations.

1.2 This terminology includes **Annex A1** on Units and **Annex A2** on Designation Codes for Specimen Configuration, Applied Loading, and Crack or Notch Orientation.

1.3 *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:²

- E6 Terminology Relating to Methods of Mechanical Testing
- E23 Test Methods for Notched Bar Impact Testing of Metallic Materials
- E28 Test Methods for Softening Point of Resins Derived from Pine Chemicals and Hydrocarbons, by Ring-and-Ball Apparatus
- E208 Test Method for Conducting Drop-Weight Test to Determine Nil-Ductility Transition Temperature of Ferritic Steels
- E338 Test Method of Sharp-Notch Tension Testing of High-Strength Sheet Materials (Withdrawn 2010)³

¹ This terminology is under the jurisdiction of ASTM Committee E08 on Fatigue and Fracture and is the direct responsibility of Subcommittee E08.02 on Terminology.

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² 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.

³ The last approved version of this historical standard is referenced on www.astm.org.

- E399 Test Method for Linear-Elastic Plane-Strain Fracture Toughness of Metallic Materials
- E436 Test Method for Drop-Weight Tear Tests of Ferritic Steels
- E467 Practice for Verification of Constant Amplitude Dynamic Forces in an Axial Fatigue Testing System
- E468 Practice for Presentation of Constant Amplitude Fatigue Test Results for Metallic Materials
- E561 Test Method for K_R Curve Determination
- E602 Test Method for Sharp-Notch Tension Testing with Cylindrical Specimens (Withdrawn 2010)³
- E604 Test Method for Dynamic Tear Testing of Metallic Materials
- E606 Test Method for Strain-Controlled Fatigue Testing
- E647 Test Method for Measurement of Fatigue Crack Growth Rates
- E739 Guide for Statistical Analysis of Linear or Linearized Stress-Life ($S-N$) and Strain-Life ($\epsilon-N$) Fatigue Data (Withdrawn 2024)³
- E740 Practice for Fracture Testing with Surface-Crack Tension Specimens
- E813 Test Method for J_{Ic} , A Measure of Fracture Toughness
- E992 Practice for Determination of Fracture Toughness of Steels Using Equivalent Energy Methodology
- E1049 Practices for Cycle Counting in Fatigue Analysis
- E1152 Test Method for Determining $J-R$ Curves
- E1221 Test Method for Determining Plane-Strain Crack-Arrest Fracture Toughness, K_{Ia} , of Ferritic Steels
- E1290 Test Method for Crack-Tip Opening Displacement (CTOD) Fracture Toughness Measurement (Withdrawn 2013)³
- E1304 Test Method for Plane-Strain (Chevron-Notch) Fracture Toughness of Metallic Materials
- E1450 Test Method for Tension Testing of Structural Alloys in Liquid Helium
- E1457 Test Method for Measurement of Creep Crack Growth Times in Metals
- E1681 Test Method for Determining Threshold Stress Intensity Factor for Environment-Assisted Cracking of Metallic Materials
- E1737 Test Method for J -Integral Characterization of Fracture Toughness (Withdrawn 1998)³
- E1820 Test Method for Measurement of Fracture Toughness

E1921 Test Method for Determination of Reference Temperature, T_0 , for Ferritic Steels in the Transition Range

E1942 Guide for Evaluating Data Acquisition Systems Used in Cyclic Fatigue and Fracture Mechanics Testing

E2207 Practice for Strain-Controlled Axial-Torsional Fatigue Testing with Thin-Walled Tubular Specimens

E2208 Guide for Evaluating Non-Contacting Optical Strain Measurement Systems

E2298 Test Method for Instrumented Impact Testing of Metallic Materials

E2443 Guide for Verifying Computer-Generated Test Results Through The Use Of Standard Data Sets

E2472 Test Method for Determination of Resistance to Stable Crack Extension under Low-Constraint Conditions

E2714 Test Method for Creep-Fatigue Testing

E2760 Test Method for Creep-Fatigue Crack Growth Testing

E2899 Test Method for Measurement of Initiation Toughness in Surface Cracks Under Tension and Bending

G15 Terminology Relating to Corrosion and Corrosion Testing (Withdrawn 2010)³

2.2 ISO Standard:⁴

ISO 12135 Metallic materials

Symbol	Term
k_t	theoretical stress concentration factor (sometimes abbreviated stress concentration factor)
$K, K_I, K_2, K_3, K_I, K_{II}, K_{III}$	stress-intensity factor (see mode)
K_a	crack-arrest fracture toughness
K_{EAC}	stress intensity factor threshold for environment-assisted cracking
K_{Ia}	plane-strain crack-arrest fracture toughness
K_{IEAC}	stress intensity factor threshold for plane strain environment-assisted cracking
K_{Ic}	plane-strain fracture toughness
K_{IVM}, K_{IV}, K_{IVj}	plane-strain (chevron-notch) fracture toughness
K_{max}	maximum stress-intensity factor
K_{min}	minimum stress-intensity factor
K_o	stress-intensity factor at crack initiation
K_R	crack-extension resistance
n	cycles endured
N_f	fatigue life
P	force
P_a	force amplitude
P_m	mean force
P_M	precrack force
P_{max}	maximum force
P_{min}	minimum force
q	fatigue notch sensitivity
r	effective unloading slope ratio
r_c	critical slope ratio
r_y	plastic-zone adjustment
R	force ratio, stress ratio
s	sample standard deviation
S^2	sample variance
S	specimen span
S_a	stress amplitude
S_f	fatigue limit
S_m	mean stress
S_N	fatigue strength at N cycles
σ_c	crack strength
σ_N	nominal (net-section) stress
σ_r	residual strength
σ_s	sharp-notch strength
σ_{TS}	tensile strength
$\sigma_x, \sigma_y, \sigma_z$	normal stresses (refer to Fig. 1)
σ_Y	effective yield strength
σ_{YS}	yield strength
T	specimen temperature
t_T	transition time
t_t	total cycle period
$\tau_{xy}, \tau_{yz}, \tau_{zx}$	shear stresses (refer to Fig. 1)
u	displacement in x direction
v	displacement in y direction
$2V_m$	crack-mouth opening displacement
V_c	force-line displacement due to creep
w	displacement in z direction
W	specimen width
Y^*	stress-intensity factor coefficient
Y_m^*	minimum stress-intensity factor coefficient

3. Terminology

3.1 Alphabetical Listing of Principal Symbols Used in This Terminology:

Symbol	Term
a	crack depth, crack length, crack size, estimated crack size
a_e	effective crack size
a_n	notch length
a_o	original crack size
a_p	physical crack size
a/W	normalized crack size
A_N	net-section area
b	remaining ligament
b_o	original uncracked ligament
B	specimen thickness
B_N	net thickness
$2c$	surface-crack length
C	normalized K -gradient
$C^*(t)$	$C^*(t)$ – Integral
D	cycle ratio (n/N_f)
da/dN	fatigue crack growth rate
δ	crack-tip opening displacement (CTOD)
δd	specimen gage length
Δa	crack extension, estimated crack extension
ΔK	stress-intensity-factor range
ΔP	force range
ε_a	strain amplitude
ε_{in}	inelastic strain
G	crack-extension force
G_R	crack-extension resistance
h	notch height
H^*	specimen center of pin hole distance
Γ	the path of the J -integral
J	J -integral
J_{Ic}	plane-strain fracture toughness
J_R	crack-extension resistance
k_f	fatigue notch factor

3.2 Alphabetical Listing of Abbreviations Used:

CMOD	crack-mouth opening displacement
COD	see CTOD
CTOD	crack-tip opening displacement
DT	dynamic tear
EAC	environment-assisted cracking
K-EE	equivalent-energy fracture toughness
NTS	notch tensile strength
PS	part-through surface
SCC	stress corrosion cracking
SZW	stretch zone width

3.3 Definitions—Each definition is followed by the designation(s) of the standard(s) of origin. The listing of definitions is alphabetical.

alternating force—See **loading amplitude**.

³ Available from International Organization for Standardization (ISO), ISO Central Secretariat, Chemin de Blandinnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, <https://www.iso.org>.