

ISO 12135:2021 (E)

Metallic materials — Unified method of test for the determination of quasistatic fracture toughness

Contents

	Foreword
1	Scope
2	Normative references
3	Terms and definitions
4	Symbols and abbreviated terms
5	General requirements
5.1	General
5.2	Fracture parameters
5.3	Fracture toughness symbols
5.4	Test specimens
5.4.1	Specimen configuration and size
5.4.2	Specimen preparation
5.4.2.1	Material condition
5.4.2.2	Crack plane orientation
5.4.2.3	Machining
5.4.2.4	Fatigue precracking
5.4.2.4.1	General
5.4.2.4.2	Equipment and fixtures
5.4.2.4.3	Bend specimens
5.4.2.4.4	Compact specimens
5.4.2.5	Side grooving
5.5	Pre-test requirements
5.5.1	Pre-test measurements
5.5.2	Crack shape/length requirements
5.6	Test apparatus
5.6.1	Calibration
5.6.2	Force application
5.6.3	Displacement measurement
5.6.4	Test fixtures
5.7	Test requirements
5.7.1	Three-point bend testing
5.7.1.1	Specimen fixture alignment
5.7.1.2	Crack-tip opening displacement
5.7.1.3	J-integral
5.7.2	Compact tension testing
5.7.2.1	Specimen and fixture alignment
5.7.2.2	Crack-tip opening displacement
5.7.2.3	J-integral
5.7.3	Specimen test temperature
5.7.4	Recording
5.7.5	Testing rates
5.7.6	Test analyses
5.8	Post-test crack measurements
5.8.1	General
5.8.2	Initial crack length, a_0
5.8.3	Stable crack extension, Δa
5.8.4	Unstable crack extension

- 6 **Determination of fracture toughness for stable and unstable crack extension**
 - 6.1 General
 - 6.2 Determination of plane strain fracture toughness, K_{Ic}
 - 6.2.1 General
 - 6.2.2 Interpretation of the test record for FQ
 - 6.2.3 Calculation of K_Q
 - 6.2.4 Qualification of K_Q as K_{Ic}
 - 6.3 Determination of fracture toughness in terms of δ
 - 6.3.1 Determination of F_c and V_c , F_u and V_u , or F_{uc} and V_{uc}
 - 6.3.2 Determination of F_m and V_m
 - 6.3.3 Determination of V_p
 - 6.3.4 Calculation of δ_0
 - 6.3.5 Qualification of δ_0 fracture toughness value
 - 6.4 Determination of fracture toughness in terms of J
 - 6.4.1 Determination of F_c and V_c or q_c , F_u and V_u or q_u , or F_{uc} and V_{uc} or q_{uc}
 - 6.4.2 Determination of F_m and q_m
 - 6.4.3 Determination of U_p
 - 6.4.4 Calculation of J_0
 - 6.4.5 Qualification of J_0 fracture toughness value
- 7 **Determination of resistance curves δ - Δa and J - Δa and initiation toughness $\delta_{0,2BL}$ and $J_{0,2BL}$ and δ_i and J_i for stable crack extension**
 - 7.1 General
 - 7.2 Test procedure
 - 7.2.1 General
 - 7.2.2 Multiple-specimen procedure
 - 7.2.3 Single-specimen procedure
 - 7.2.4 Final crack front straightness
 - 7.3 Calculation of J and δ
 - 7.3.1 Calculation of J
 - 7.3.2 Calculation of δ
 - 7.4 R-curve plot
 - 7.4.1 Plot construction
 - 7.4.2 Data spacing and curve fitting
 - 7.5 Qualification of resistance curves
 - 7.5.1 Qualification of J - Δa resistance curves
 - 7.5.1.1 J_{max} is calculated for each specimen as the smallest of:
 - 7.5.2 Qualification of δ - Δa resistance curves
 - 7.6 Determination and qualification of $J_{0,2BL}$ and $\delta_{0,2BL}$
 - 7.6.1 Determination of $J_{0,2BL}$
 - 7.6.2 Determination of $\delta_{0,2BL}$
 - 7.7 Determination of initiation toughness J_i and δ_i by scanning electron microscopy (SEM)
- 8 **Test report**
 - 8.1 Organization
 - 8.2 Specimen, material and test environment
 - 8.2.1 Specimen description
 - 8.2.2 Specimen dimensions
 - 8.2.3 Material description
 - 8.2.4 Additional dimensions
 - 8.2.5 Test environment
 - 8.2.6 Fatigue precracking conditions
 - 8.3 Test data qualification
 - 8.3.1 Limitations
 - 8.3.2 Crack length measurements
 - 8.3.3 Fracture surface appearance
 - 8.3.4 Pop-in
 - 8.3.5 Resistance curves
 - 8.3.6 Checklist for data qualification
 - 8.4 Qualification of K_{Ic}
 - 8.5 Qualification of $\delta_c(B)$, $\delta_u(B)$, $\delta_{uc}(B)$ or $\delta_m(B)$
 - 8.6 Qualification of $J_c(B)$, $J_u(B)$, $J_{uc}(B)$ or $J_m(B)$
 - 8.7 Qualification of the δ -R Curve

8.8	Qualification of the J-R Curve
8.9	Qualification of $\delta_{0,2BL}(B)$ as $\delta_{0,2BL}$
8.10	Qualification of $J_{0,2BL}(B)$ as $J_{0,2BL}$
Annex A (informative) Determination of δ_i and J_i	
A.1	General
A.2	Critical stretch zone width (SZW) measurement
A.3	Determination of δ_i
A.4	Determination of J_i
Annex B (normative) Crack plane orientation	
Annex C (informative) Example test reports	
C.1	Specimen, material and test environment
C.2	Data qualification
C.3	Resistance curve data
C.4	Qualification of KQ as K _{Ic}
C.5	Qualification of $\delta_c(B)$, $\delta_u(B)$, $\delta_{uc}(B)$ or $\delta_m(B)$
C.6	Qualification of $J_c(B)$, $J_u(B)$, $J_{uc}(B)$ or $J_m(B)$
C.7	Qualification of δ -R curve
C.8	Qualification of J-R curve
C.9	Qualification of $\delta_{Q0,2BL}(B)$ as $\delta_{0,2BL}$
C.10	Qualification of $J_{Q0,2BL}$ as $J_{0,2BL}$
Annex D (informative) Stress intensity factor coefficients and compliance relationships	
D.1	Stress intensity factor coefficients
D.1.1	Three-point bend specimens
D.1.2	Compact specimens
D.2	Elastic compliance relationship
D.2.1	Three-point bend specimens instrumented for measurement of force F versus crack-mouth opening displacement VM1
D.2.2	Compact specimens instrumented for measurement of F versus crack-mouth opening displacement VM2
D.2.3	Three-point bend specimens instrumented for measurement of F versus load-line displacement q_{e1}
D.2.4	Compact specimens instrumented for measurement of F versus load-line displacement q_{e2}
Annex E (informative) Measurement of load-line displacement q in the three-point bend test	
Annex F (informative) Derivation of pop-in formulae	
Annex G (informative) Analytical methods for the determination of V_p and U_p	
G.1	General
G.2	Plastic displacement, V_p
G.3	Plastic area, U_p
Annex H (informative) Guidelines for single-specimen methods	
H.1	General
H.2	Unloading compliance technique
H.3	Test recommendations
H.3.1	Compliance measurement
H.3.2	Digital signal resolution
H.3.3	Autographic signal resolution
H.4	Procedure
H.4.1	Precycling
H.4.2	Loading rate
H.4.3	Crack length measurements
H.4.4	Termination of test
H.5	Crack length calculation
H.5.1	Bend specimen: Crack-mouth opening displacement (CMOD) measured at the specimen surface
H.5.2	Bend specimen: Compliance based on load-point displacement
H.5.3	Compact specimens

H.5.4	Rotation correction for compact specimens
H.6	Resistance to crack extension
H.6.1	General
H.6.2	Estimated initial crack length
H.6.3	Estimated crack extension
H.6.4	Resistance curves
H.7	Electrical potential techniques
H.7.1	AC potential method
H.7.2	Interpretation of test records
H.8	DC potential methods
H.8.1	Method 1
H.8.1.1	Procedure
H.8.1.2	Interpretation of test records
H.8.2	Method 2
H.8.2.1	Procedure
H.8.2.2	Interpretation of test records

Annex I (normative) Power-law fits to crack extension data (see Reference [42])

Page count: 100